[redacted]

5541590

Class	Subclass	ISSUE CLASSIFICATION
340	903	MT

UTILITY SERIAL NUMBER	PATENT DATE	PATENT NUMBER
08/375,249	JUL 30 1996	

SERIAL NUMBER	FILING DATE	CLASS	SUBCLASS	GROUP ART UNIT	EXAMINER
08/375,249	01/19/95	340	903	2617	SWARTHOUT

APPLICANTS

TOMOYUKI NISHIO, KAWASAKI, JAPAN.

CONTINUING DATA********
VERIFIED THIS APPLN IS A CON OF 08/097,178 07/27/93 ABN
BAS

FOREIGN/PCT APPLICATIONS********
VERIFIED JAPAN 229,201/92 08/04/92
BAS

NOTE-DISCLAIMER
The term of this patent shall not extend beyond the expiration date of Pat. No. 5,371,108.

Foreign priority claimed 35 USC 119 conditions met	Verified and Acknowledged	Examiner's initials	AS FILED	STATE OR COUNTRY	SHEETS DRWGS.	TOTAL CLAIMS	INDEP. CLAIMS	FILING FEE RECEIVED	ATTORNEY'S DOCKET NO.
☑ yes ☐ no	☑ yes ☐ no	BAS	→	JPX	7	4	1	$730.00	K-1518

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VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

U.S. DEPT. of COMMERCE • Patent and Trademark Office–PCT-436L (rev. 7-94)

PARTS OF APPLICATION FILED SEPARATELY

G. Bureau
Applications Examiner

NOTICE OF ALLOWANCE MAILED		CLAIMS ALLOWED	
2-13-96	Assistant Examiner	Total Claims: 4	Print Claim: 1

ISSUE FEE		DRAWING		
Amount Due	Date Paid	Sheets Drwg.	Figs. Drwg.	Print Fig.
$1250.00	4-30-96	7	11	4

Brent Swarthout
BRENT A. SWARTHOUT
PRIMARY EXAMINER
GROUP 2600
Primary Examiner

ISSUE BATCH NUMBER T67

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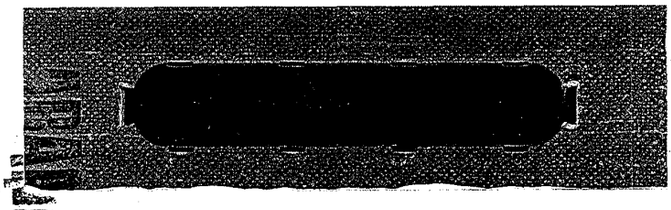

Class	Subclass	ISSUE CLASSIFICATION
340	903	

UTILITY SERIAL NUMBER	PATENT DATE	PATENT NUMBER
07/097178		

SERIAL NUMBER	FILING DATE	CLASS	SUBCLASS	GROUP ART UNIT	EXAMINER
08/097,178	07/27/93	340	903	2617	Swarthout

APPLICANTS

TOMOYUKI NISHIO, KAWASAKI-SHI, JAPAN.

CONTINUING DATA********
VERIFIED
None BAS

FOREIGN/PCT APPLICATIONS********
VERIFIED JAPAN 229,201/92 08/04/92
BAS

Foreign priority claimed / 35 USC 119 conditions met	Verified and Acknowledged	AS FILED	STATE OR COUNTRY	SHEETS DRWGS.	TOTAL CLAIMS	INDEP. CLAIMS	FILING FEE RECEIVED	ATTORNEY'S DOCKET NO.
☑ yes ☐ no / ☐ yes ☒ no	BAS (Examiner's initials)	→	JPX	7	7	1	$710.00	K1398

ADDRESS

KANESAKA AND TAKEUCHI
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ARLINGTON, VA 22202

TITLE

VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

U.S. DEPT. of COMM.-Pat. & TM Office — PTO-436L (rev. 10-78)

PARTS OF APPLICATION FILED SEPARATELY	Applications Examiner

NOTICE OF ALLOWANCE MAILED	Assistant Examiner	CLAIMS ALLOWED: Total Claims	CLAIMS ALLOWED: Print Claim

ISSUE FEE: Amount Due	ISSUE FEE: Date Paid	DRAWING: Sheets Drwg.	DRAWING: Figs. Drwg.	DRAWING: Print Fig.

Label Area

Primary Examiner

ISSUE BATCH NUMBER

PREPARED FOR ISSUE

Form PTO-436A (rev. 8/92)

(FACE)

BAR CODE LABEL

U.S. PATENT APPLICATION

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT
08/375,249	01/19/95	340	2617

APPLICANT

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FOREIGN/PCT APPLICATIONS********
VERIFIED JAPAN 229,201/92 08/04/92

STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS	FILING FEE RECEIVED	ATTORNEY DOCKET NO.
JPX	7	4	1	$730.00	K-1518

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TITLE

VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

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BAR CODE LABEL	U.S. PATENT APPLICATION

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT
08/097,178	07/27/93	340	2617

APPLICANT

TOMOYUKI NISHIO, KAWASAKI-SHI, JAPAN.

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FOREIGN/PCT APPLICATIONS********
VERIFIED JAPAN 229,201/92 08/04/92

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STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS	FILING FEE RECEIVED	ATTORNEY DOCKET NO.
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08 097178

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INITIALS _____

ABANDONED

CONTENTS

		Date Received or Mailed
	1. ~~Application~~ RWM Prts papers.	
	2. ~~Substitute~~ Declaration	9/29/93
2-8-94	3. ~~Plan of~~ Ops Smos	2-18-94 MDH
	4. Amdt A	May 16, 1994
7/2	5. ~~Final~~ Rej 3 mths	4-26-94 MM
	6. Req Ext of Time (2) & Amdt B (NE)	12-22-94
1/4	7. Advisory Action	1-5-95 Rej
3/6	8. Notice of Abandonment	3-16-95 MH
	9. Req Ext of Time	3-20-95
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08/375249

PATENT APPLICATION

08375249

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CONTENTS

Date Entered or Counted			Date Received or Mailed
agh	1.	Application _____ papers.	
	10	Post Amdt C	Jan 19, 1995
	11	Post Amdt D	Jan 19, 1995
6/5	12	Rej 3 months	Dec 28 95
	13	Amdt E	July 5, 1995
9/13	14	Rej (3 mos)	9-15-95
	15	Terminal Disclaimer	12-14-95
2/7/96	16	Notice of allowance	2-13-96 S.C
5/15/96	17	Formal Drawings (2 sheets) set 1	4/30/96
	18	PTO Grant JUL 30 1996	
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US005541590A

United States Patent [19]

Nishio

[11] Patent Number: 5,541,590

[45] Date of Patent: *Jul. 30, 1996

[54] **VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS**

[75] Inventor: **Tomoyuki Nishio**, Kawasaki, Japan

[73] Assignee: **Takata Corporation**, Tokyo, Japan

[*] Notice: The term of this patent shall not extend beyond the expiration date of Pat. No. 5,377,108.

[21] Appl. No.: **375,249**

[22] Filed: **Jan. 19, 1995**

Related U.S. Application Data

[63] Continuation of Ser. No. 97,178, Jul. 27, 1993, abandoned.

[30] **Foreign Application Priority Data**

Aug. 4, 1992 [JP] Japan 4-229201

[51] **Int. Cl.**[6] **G08G 1/16**

[52] **U.S. Cl.** **340/903**; 340/435; 348/148; 364/424.04; 395/23; 395/905

[58] **Field of Search** 340/435, 995, 340/903, 905; 348/170, 113, 148, 149; 364/424.01, 424.04, 424.05; 395/905.22, 11, 21, 23; 382/104, 157

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4001493	7/1991	Germany .
04008639	1/1992	Japan .
9002985	3/1990	WIPO .

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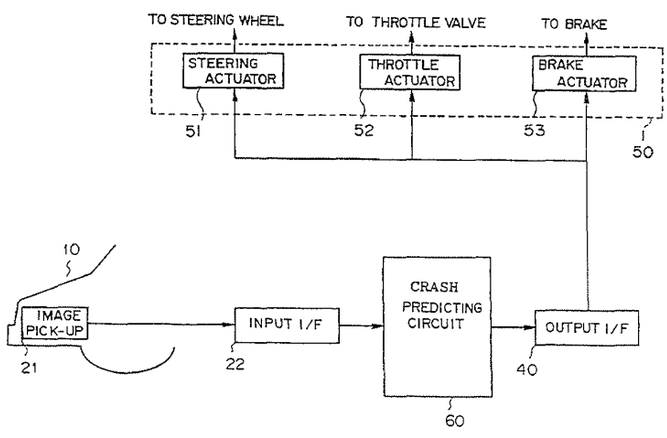
Rumelhart et al "Parallel Distributed Processing", vol. 1 pp. 161, 162, copyrighted 1986.

Primary Examiner—Brent A. Swarthout
Attorney, Agent, or Firm—Kanesaka & Takeuchi

[57] **ABSTRACT**

A system for predicting and evading crash of a vehicle includes an image pick-up device mounted on the vehicle for picking up images of actual ever-changing views when the vehicle is on running to produce actual image data, a crash predicting device associated with said image pick-up device, said crash predicting device being successively supplied with the actual image data for predicting occurrence of crash between the vehicle and potentially dangerous objects on the roadway to produce an operational signal when there is possibility of crash and a safety drive ensuring device connected to said crash predicting device for actuating, in response to the operational signal, an occupant protecting mechanism which is operatively connected thereto and equipped in the vehicle. The crash predicting device includes a neural network which is previously trained with training data to predict the possibility of crash, the training data representing ever-changing views previously picked-up from said image picking-up device during driving of the vehicle for causing actual crash.

4 Claims, 7 Drawing Sheets



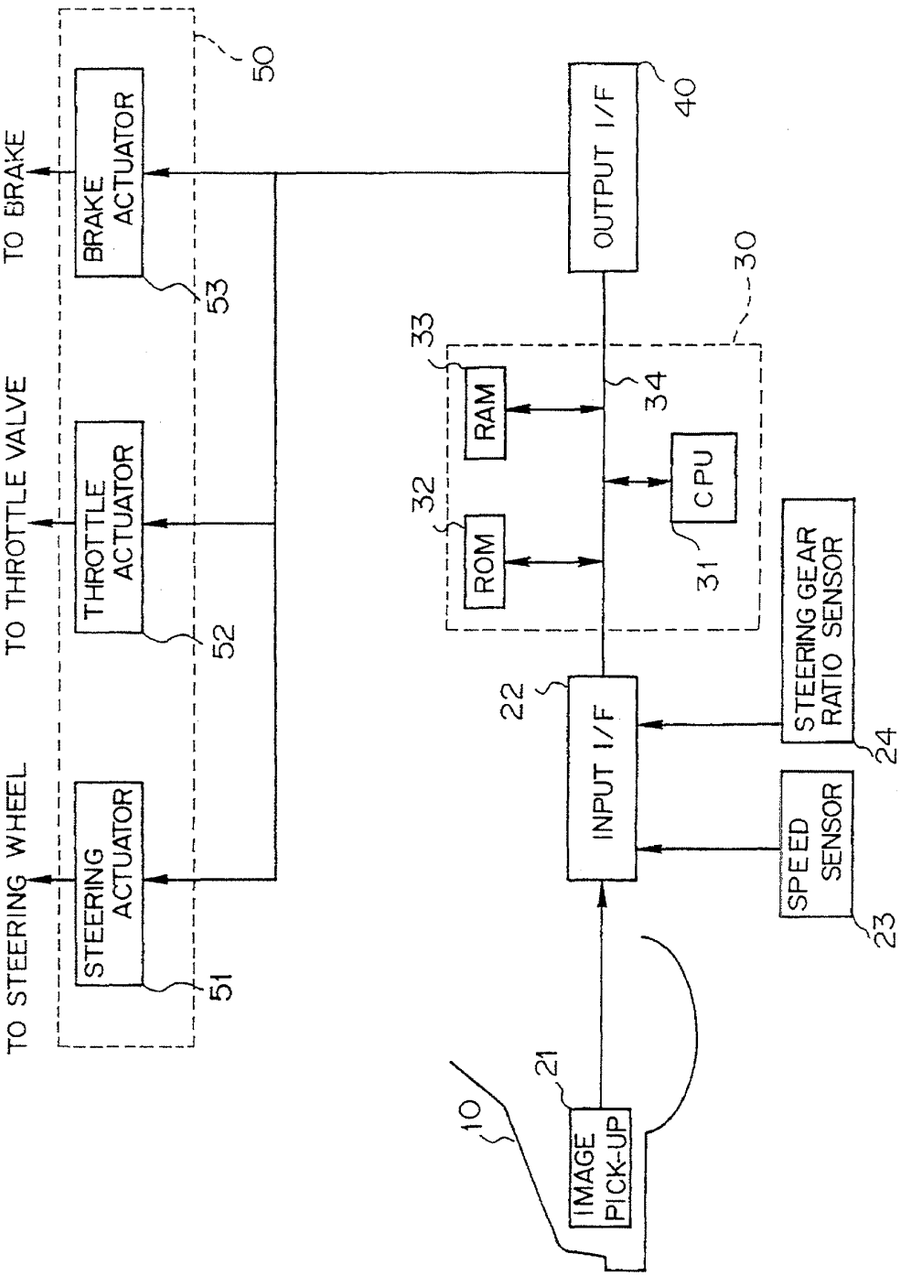


FIG. 1 PRIOR ART

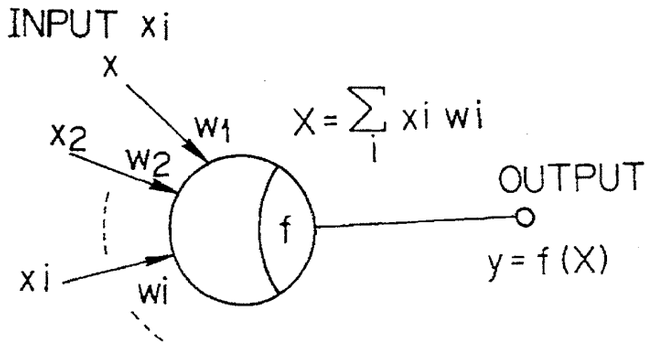


FIG. 2
PRIOR ART

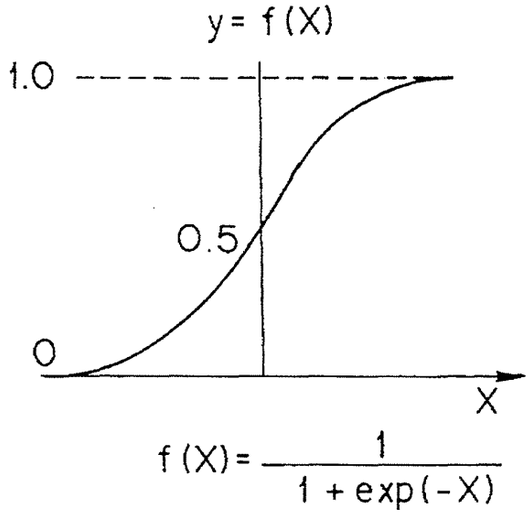


FIG. 3
PRIOR ART

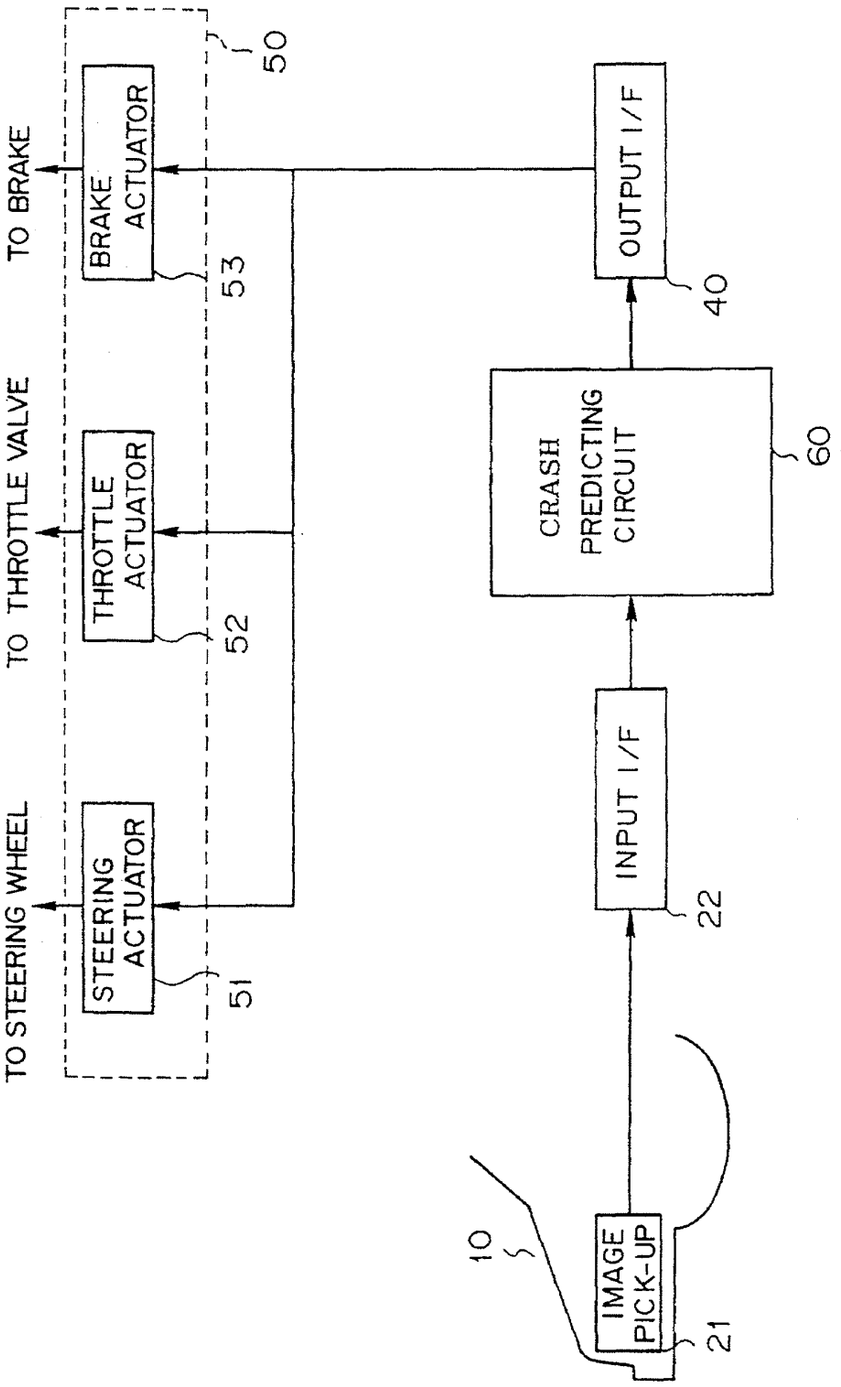

TO STEERING WHEEL
TO THROTTLE VALVE
TO BRAKE
STEERING ACTUATOR
THROTTLE ACTUATOR
BRAKE ACTUATOR
51
52
53
50
IMAGE PICK-UP
21
10
INPUT I/F
22
CRASH PREDICTING CIRCUIT
60
OUTPUT I/F
40

FIG. 4

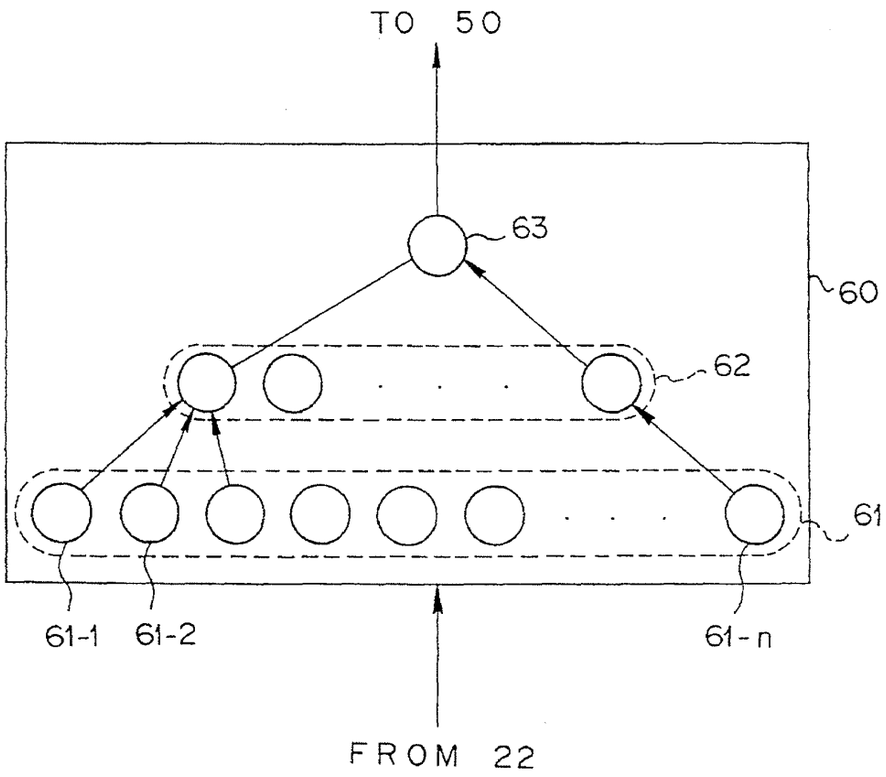
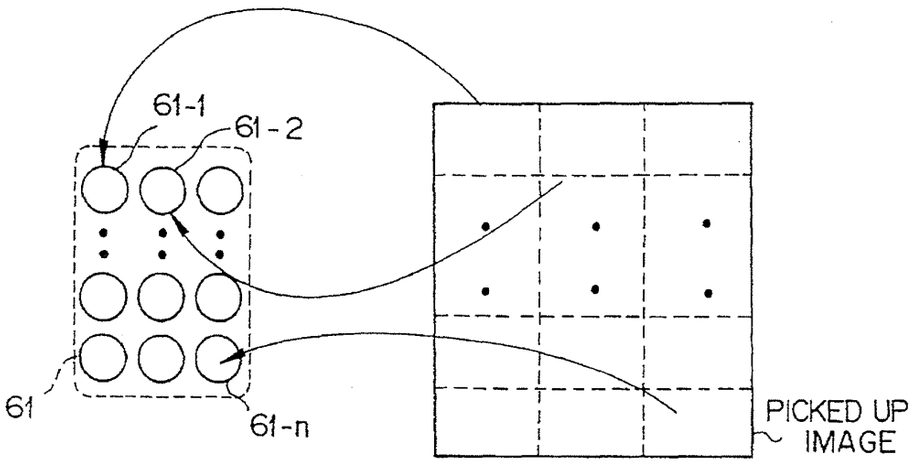

TO 50
63
60
62
61
61-1
61-2
61-n
FROM 22

FIG. 5(a)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61
61-n
PICKED UP IMAGE

FIG. 5(b)

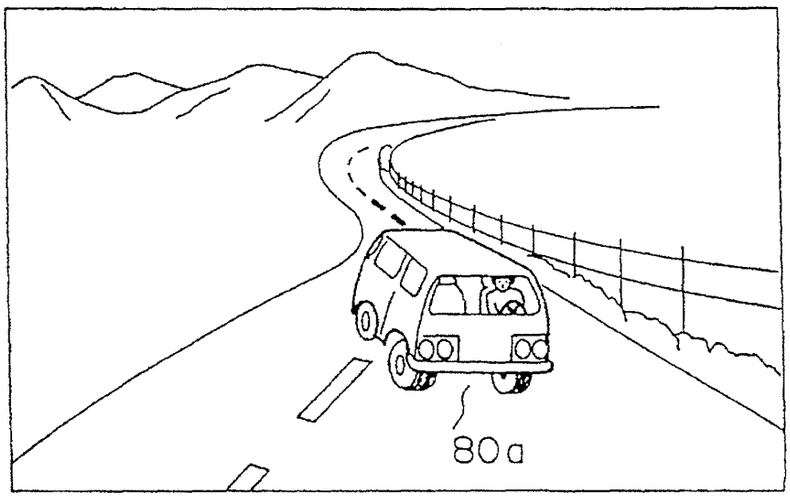

FIG. 6(a)

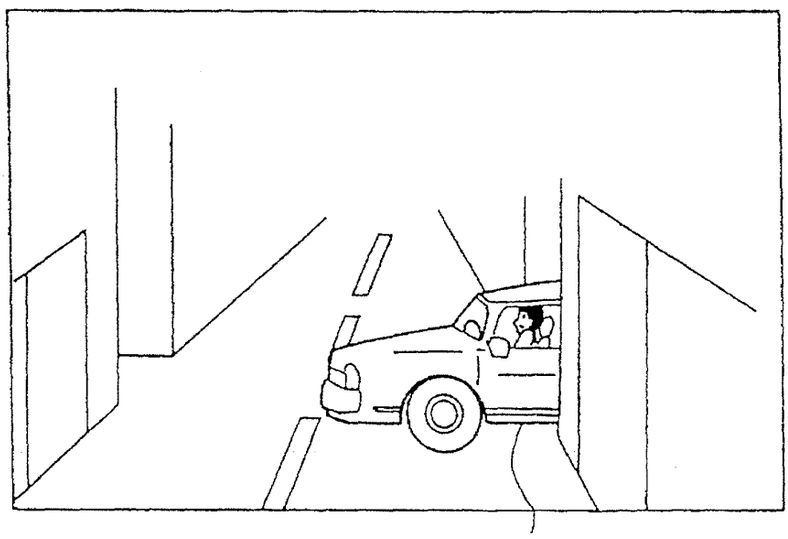

FIG. 6(b)

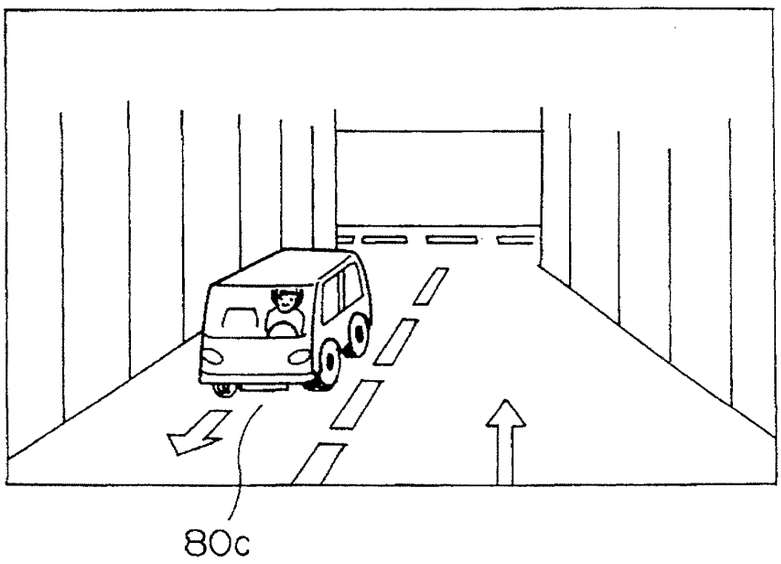

FIG. 7

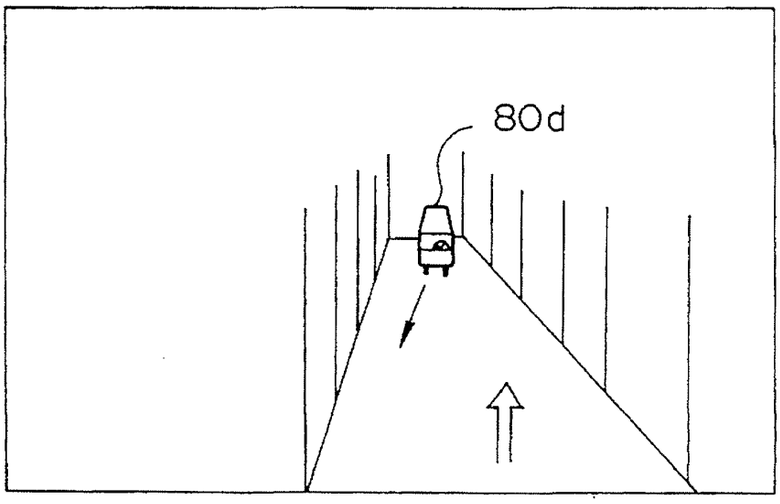

FIG. 8

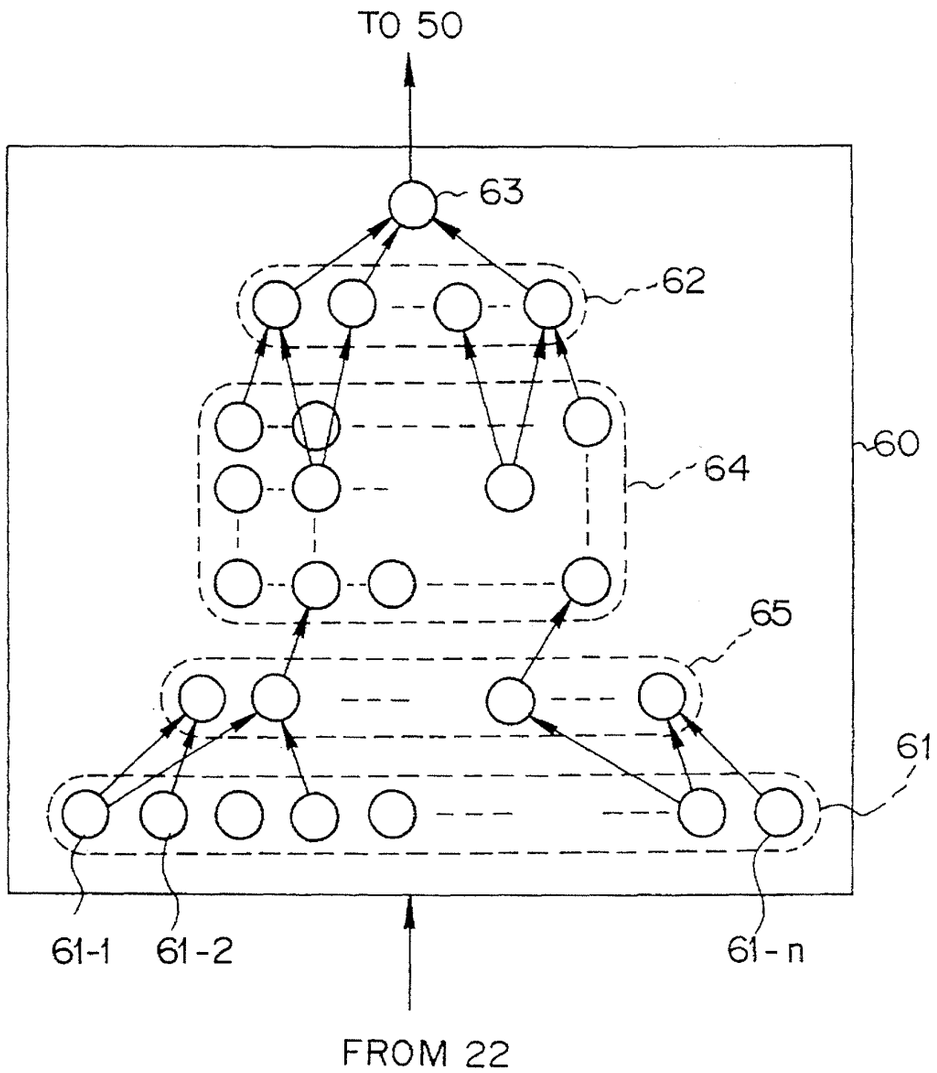

FIG. 9

VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

This application is a continuation of application Ser. No. 08/097,178, filed Sep. 27, 1993, now abandoned.

BACKGROUND OF THE INVENTION

This invention generally relates to a system for predicting and evading crash of a vehicle, in case of

In driving a car, a driver unconsciously senses various conditions through the objects in view and, as a case may be, he must take an action to evade any possible crash or collision. However, drivers will often be panicked at the emergency. Such a panicked driver may not properly handle the vehicle. Besides, the response delay to stimuli in varying degrees is inherent to human beings, so that it is physically impossible in some cases to evade crash or danger. With this respect, various techniques have been developed to evade collision by means of mounting on a vehicle a system for determining the possibility of crash in a mechanical or electrical manner before it happens. Accidents could be reduced if drivers had an automatic system or the like warning of potential collision situations.

An automobile collision avoidance radar is typically used as this automatic system. Such an automobile collision avoidance radar is disclosed in, for example, M. Kiyoto and A. Tachibana, Nissan Technical Review: Automobile Collision-Avoidance Radar, Vol. 18, Dec. 1982 that is incorporated by reference herein in its entirety. The radar disclosed comprises a small radar radiation element and antennas installed at the front end of a vehicle. A transmitter transmits microwaves through the radiation element towards the headway. The microwave backscatter from a leading vehicle or any other objects as echo returns. The echo returns are received by a receiver through the antennas and supplied to a signal processor. The signal processor carries out signal processing operation to calculate a relative velocity and a relative distance between the object and the vehicle. The relative velocity and the relative distance are compared with predetermined values, respectively, to determine if the vehicle is going to collide with the object. The high possibility of collision results in activation of a proper safety system or systems.

However, the above mentioned radar system has a disadvantage of faulty operation or malfunctions, especially when the vehicle implementing this system passes by a sharp curve in a road. The radar essentially detects objects in front of the vehicle on which it is mounted. The system thus tends to incorrectly identify objects alongside the road such as a roadside, guard rails or even an automobile correctly running on the adjacent lane.

An intelligent vehicle has also been proposed that comprises an image processing system for cruise and traction controls. The views ahead the vehicle are successively picked up as image patterns. These image patterns are subjected to pattern matching with predetermined reference patterns. The reference patterns are classified into some categories associated with possible driving conditions. For example, three categories are defined for straight running, right turn and left turn. When a matching result indicates the presence of potentially dangerous objects in the picked up image, a steering wheel and a brake system are automatically operated through a particular mechanism to avoid or evade crash to that object.

The image processing system of the type described is useful in normal driving conditions where the pattern matching can be effectively made between the image patterns successively picked up and the reference patterns for safety driving control. However, image patterns representing various conditions on the roadway should be stored previously in the intelligent vehicle as the reference patterns. Vehicle orientation at initiation of crash varies greatly, so that huge numbers of reference patterns are required for the positive operation. This means that only a time-consuming calculation will result in a correct matching of the patterns, which is not suitable for evading an unexpected crash.

It is, of course, possible to increase operational speed of the pattern matching by using a large image processor. However, such a processor is generally complex in structure and relatively expensive, so that it is difficult to apply the same as the on-vehicle equipment. In addition, on-vehicle image processors, if achieved, will perform its function sufficiently only in the limited applications such as a supplemental navigation system during the normal cruising.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a system for predicting and evading crash of a vehicle using neural networks.

Another object of the present invention is to provide a system capable of training neural networks by means of collected image data representing scenes along the moving direction of a vehicle until the vehicle collides with something.

It is yet another object of the present invention to provide a system for predicting crash though matching operation between data obtained on driving a vehicle and data learned by neural networks. It is still another object of the present invention to provide a system for evading crash of a vehicle using neural networks to actuate a vehicle safety system for protecting an occupant.

In order to achieve the above mentioned objects, the present invention is provided with a system for predicting and evading crash of a vehicle comprising: an image pick-up device mounted on the vehicle for picking up images of ever-changing views when the vehicle is on running to produce image data; a crash predicting circuit associated with the image pick-up device, the crash predicting circuit being successively supplied with the image data for predicting occurrence of crash between the vehicle and potentially dangerous objects on the roadway to produce an operational signal when there is possibility of crash; and a safety driving ensuring device connected to the crash predicting circuit for actuating, in response to the operational signal, occupant protecting mechanism which is operatively connected thereto and equipped in the vehicle; wherein the crash predicting circuit comprises a neural network which is previously trained with training data to predict the possibility of crash, the training data representing ever-changing views previously picked-up from the image picking-up device during driving of the vehicle and just after actual crash.

The neural network comprises at least an input layer and an output layer, and the training data are supplied to the input layer while the output layer is supplied with, as teacher data, flags representing expected and unexpected crash, respectively, of the vehicle. In addition, the neural network may comprise a two-dimensional self-organizing competitive learning layer as an intermediate layer.

Other advantages and features of the present invention will be described in detail in the following preferred embodiments thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a conventional system for predicting and evading crash of a vehicle;

FIG. **2** is a schematic view showing a processing element in atypical neural network;

FIG. **3** is a graphical representation of a sigmoid function used as a transfer function for training neural networks;

FIG. **4** is a block diagram of a system for predicting and evading crash of a vehicle using neural networks according to the first embodiment of the present invention;

FIG. **5**(*a*) is a schematic structural diagram of a crash predicting circuit in FIG. **4** realized by a neural network of three layers;

FIG. **5**(*b*) shows an example of an input layer consisting of a two-dimensional array of processing elements of the neural network shown in FIG. **5**(*a*);

FIGS. **6**(*a*) and **6**(*b*) are exemplified views picked up, as the training image data supplied to the neural network, at different time instances during driving an experimental vehicle;

FIG. **7** is a view showing an example of an image data obtained during driving a utility vehicle;

FIG. **8** is a view showing another example of an image data obtained during driving a utility vehicle; and

FIG. **9** is a block diagram of a system for predicting and evading crash using neural networks according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A conventional system for predicting and evading crash of a vehicle is described first to facilitate an understanding of the present invention. Throughout the following detailed description, similar reference numerals refer to similar elements in all figures of the drawing.

In the following description, the term "crash" is used in a wider sense that relates to all unexpected traffic accidents. Accidents other than crash include a turnover or fall of a vehicle, with which the phenomenon of "crash" is associated in some degrees, so that the term crash is used as a cause of traffic accidents.

As shown in FIG. **1**, an image pick-up device **21** is mounted at a front portion of an automobile **10** to pick up ever-changing images as analog image data. This image pick-up device **21** is any one of suitable devices such as a charge-coupled-device (CCD) camera. The image data are subject to sampling for a sampling range $_{\Delta}T$ at a predetermined sampling interval $_{\Delta}t$. The image data are collected up to crash. In this event, the image pick-up range of the image pick-up device **21** corresponds to a field of view observed through naked eyes.

The image pick-up device **21** is connected to an input interface **22**. The analog image data obtained by the image pick-up device **21** are supplied to the input interface **22**. The input interface **22** serves as an analog-to-digital converter for converting the analog image data into digital image data. More particularly, the picked up images are digitized by means of dividing the same into tiny pixels (data elements) isolated by grids. It is preferable to eliminate noises and distortions at this stage. The input interface **22** is also connected to a speed sensor **23**, a steering gear ratio sensor **24** and a signal processor **30**. The speed sensor **23** supplies velocity data to the signal processor **30** through the input interface **22**. The velocity data represents an actual velocity of the automobile **10** at the time instant when the image pick-up device **21** picks up an image of a view. Likewise, the steering gear ratio sensor **24** supplies steering gear ratio data to the signal processor **30** through the input interface **22**. The steering gear ratio data represents an actual steering gear ratio of the automobile **10**.

The signal processor **30** comprises a central processing unit (CPU) **31**, a read-only memory (ROM) **32** and a random-access memory (RAM) **33**. CPU **31**, ROM **32** and RAM **33** are operatively connected to each other through a data bus **34**. To evade potentially dangerous objects, CPU **31** carries out calculation operation in response to the image, velocity and steering gear ratio data given through the input interface **22**. CPU **31** performs proper functions according to programs stored in ROM **32** and RAM **33**. The outputs of the signal processor **30** is transmitted through an output interface **40**. ROM **32** stores a table relating to numerical values required for the calculation. It also stores a table representing operational amount for a safety drive ensuring arrangement **50**. On the other hand, RAM **33** stores programs for use in calculating an optimum operational amount for the safety drive ensuring arrangement **50**. A program for this purpose is disclosed in, for example, Teruo Yatabe, Automation Technique: Intelligent Vehicle, pages 22–28.

The signal processor **30** first determines, according to the picked up image data, whether there is a space available on the roadway to pass through. When there is enough space to pass through and a potentially dangerous object is present on the roadway, the signal processor **30** calculates optimum operational amount for the safety drive for ensuring arrangement **50** to operate the same. In FIG. **1**, the safety drive ensuring arrangement **50** consists of a steering actuator **51**, a throttle actuator **52** and a brake actuator **53**. If the signal processor **30** determines that it is necessary to operate these actuators, it produces steering gear ratio command, set velocity command, and brake operation command. The steering actuator **51**, the throttle actuator **52** and the brake actuator **53** are operated depending on the condition in response to the steering gear ratio command, the set velocity command and the brake operation command, respectively.

The actuators are for use in actuating occupant protecting mechanism such as a brake device. Operation of these actuators is described now.

The steering actuator **51** is a hydraulic actuator for use in rotating steering wheel (not shown) in an emergency. In this event, the steering wheel is automatically rotated according to the steering gear ratio and rotational direction indicated by the steering gear ratio command. The operational amount of the steering or hydraulic actuator can be controlled in a well-known manner through a servo valve and a hydraulic pump, both of which are not shown in the figure.

The throttle actuator **52** acts to adjust opening amount of a throttle valve (not shown) to decrease speed while evading objects or so on.

The brake actuator **53** performs a function to gradually decrease speed of a vehicle in response to the brake operational command. The brake actuator **53** is also capable of achieving sudden brake operation, if necessary.

As mentioned above, CPU **31** carries out its operation with the tables and programs stored in ROM **32** and RAM **33**, respectively, calculating for all picked up image data.

The conventional system is thus disadvantageous in that the calculation operation requires relatively long time interval as mentioned in the preamble of the instant specification.

On the contrary, a system according to the present invention uses image data representing ever-changing views picked up from a vehicle until it suffers from an accident. These image data are used for training a neural network implemented in the present system. After completion of the training, the neural network is implemented in a utility vehicle and serves as a decision making circuit for starting safety driving arrangements to evade crash, which otherwise will certainly happen. The neural network predicts crash and evades the same by means of properly starting an automatic steering system or a brake system.

A well-known neural network is described first to facilitate an understanding of the present invention and, following which preferred embodiments of the present invention will be described with reference to the drawing.

A neural network is the technological discipline concerned with information processing system, which is still in a development stage. Such artificial neural network structure is based on our present understanding of biological nervous systems. The artificial neural network is a parallel, distributed information processing structure consisting of processing elements interconnected unidirectional signal channels called connections. Each processing element has a single output connection that branches into as many collateral connections as desired.

A basic function of the processing elements is described below.

As shown in FIG. **2**, each processing element can receive any number of incoming functions while it has a single output connection that can fan out to form multiple output connections. Thus the artificial neural network is by far more simple than the networks in a human brain. Each of the input data x**1**, x**2**, . . . , xi is multiplied by its corresponding weight coefficient w**1**, w**2**, . . . , wi, respectively, and the processing element sums the weighted inputs and passes the result through a nonlinearity. Each processing element is characterized by an internal threshold or offset and by the type of nonlinearity and processes a predetermined transfer function to produce an output f(X) corresponding to the sum ($X=\sum xi \cdot wi$). In FIG. **2**, xi represents an output of an i-th processing element in an (s-**1**)-th layer and wi represents a connection strength or the weight from the (s-**1**)-th layer to the s-th layer. The output f(X) represents energy condition of each processing element. Though the neural networks come in a variety of forms, they can be generally classified into feedforward and recurrent classes. In the latter, the output of each processing element is fed back to other processing elements via weights. As described above, the network has an energy or an energy function that will be minimum finally. In other words, the network is considered to have converged and stabilized when outputs no longer change on successive iteration. Means to stabilize the network depends on the algorithm used.

The back propagation neural network is one of the most important and common neural network architecture, which is applied to the present invention. In this embodiment, the neural network is used to determine if there is a possibility of crash. When the neural network detects the possibility of crash, it supplies an operational command to a safety ensuring unit in a manner described below. As well known in the art, the back propagation neural network is a hierarchical design consisting of fully interconnected layers of processing elements. More particularly, the network architecture comprises at least an input layer and an output layer. The network architecture may further comprise additional layer or N hidden layers between the input layer and the output layer where N represents an integer that is equal to or larger than zero. Each layer consists of one or more processing elements that are connected by links with variable weights. The net is trained by initially selecting small random weights and internal thresholds and then presenting all training data repeatedly. Weights are adjusted after every trial using information specifying the correct result until weights converge to an acceptable value. The neural network is thus trained to automatically generate and produce a desired output for an unknown input.

Basic learning operation of the back propagation neural network is as follows. First, input values are supplied to the neural network as the training data to produce output values, each of which is compared with a correct or desired output value (teacher data) to obtain information indicating a difference between the actual and desired outputs. The neural network adjusts the weights to reduce the difference between them. More particularly, the difference can be represented by a well-known mean square error. During training operation, the network adjusts all weights to minimize a cost function equal to the mean square error. Adjustment of the weights is achieved by means of back propagation transferring the error from the output layer to the input layer. This process is continued until the network reaches a satisfactory level of performance. The neural network trained in the above mentioned manner can produce output data based on the input data even for an unknown input pattern.

The generalized delta rule derived with the steepest descent may be used to optimize the learning procedure that involves the presentation of a set of pairs of input and output patterns. The system first uses the input data to produce its own output data and then compares this with the desired output. If there is no difference, no learning takes place and otherwise the weights are changed to reduce the difference. As a result of this it becomes possible to converge the network after a relatively short cycle of training.

To train the net weights input data (training data) are successively supplied to the processing elements in the input layer. Each processing element is fully connected to other processing elements in the next layer where a predetermined calculation operation is carried out. In other words, the training input is fed through to the output. At the output layer the error is found using, for example, a sigmoid function and is propagated back to modify the weight on a connection. The goal is to minimize the error so that the weights are repeatedly adjusted and updated until the network reaches a satisfactory level of performance. A graphical representation of sigmoid functions is shown in FIG. **3**.

In this embodiment a sigmoid function as shown in FIG. **3** is applied as the transfer function for the network. The sigmoid function is a bounded differentiable real function that is defined for all real input values and that has a positive derivative everywhere. The central portion of the sigmoid (whether it is near 0 or displaced) is assumed to be roughly linear. With the sigmoid function it becomes possible to establish effective neural network models.

As a sigmoid function parameter in each layer, a y-directional scale and a y-coordinate offset are defined. The y-directional scale is defined for each layer to exhibit exponential variation. This results in improved convergence efficiency of the network.

It is readily understood that other functions may be used as the transfer function. For example, in a sinusoidal func-

tion a differential coefficient for the input sum in each processing element is within a range equal to that for the original function. To use the sinusoidal function results in extremely high convergence of training though the hardware for implementing the network may be rather complex in structure.

An embodiment of the present invention is described with reference to FIGS. **4** through **9**.

FIG. **4** is a block diagram of a system for predicting and evading crash of a vehicle using neural networks according to the first embodiment of the present invention. A system in FIG. **4** is similar in structure and operation to that illustrated in FIG. **1** other than a crash predicting circuit **60**. Description of the similar components will thus be omitted by the consideration of evading redundancy. FIG. **5** is a schematic structural diagram of the crash predicting circuit **60** illustrated in FIG. **4** formed by a neural network of three layers.

The crash predicting circuit **60** in this embodiment is implemented by a neural network architecture of a hierarchical design with three layers as shown in FIG. **5**(*a*). The input layer **61** consists of n processing elements **61-1** through **61**-n arranged in parallel as a one-dimensional linear form. Each processing element in the input layer **61** is fully connected in series to the processing elements in a hidden layer **62** of the network. The hidden layer **62** is connected to an output layer **63** of a single processing element to produce an operational command described below. FIG. **5**(*b*) shows an input layer consisting of a two-dimensional array of processing elements. In this event, the image data are supplied to the input layer as a two-dimensional data matrix of n divisions. Basically, the input and the hidden layers can have any geometrical form desired. With the two-dimensional array, the processing elements of each layer may share the same transfer function, and be updated together. At any rate, it should be considered that each processing element is fully interconnected to the other processing elements in the next layer though only a part of which are shown in FIG. **5**(*a*) to evade complexity.

Referring now to FIG. **6** in addition to FIG. **5**, illustrated are views picked up, as the image data for use in training the neural network. The image pick-up device **21** picks up ever-changing images as analog image data as described above in conjunction with the conventional system. This image pick-up device **21** is also any one of suitable devices such as a CCD camera. The image pick-up operation is carried out during running of a vehicle at higher speed than a predetermined one. The image data are subject to sampling for a sampling range $_{\Delta}T$ at a predetermined sampling interval $_{\Delta}t$. The image data are collected before and just after pseudo crash. The image pick-up range of the image pick-up device **21** corresponds to a field of view observed through naked eyes. A view shown in FIG. **6**(*a*) is picked up when a station wagon (estate car) **80***a* on the opposite lane comes across the center line. A view shown in FIG. **6**(*b*) is picked up when an automobile **80***b* suddenly appears from a blind corner of a cross-street. These ever-changing images are collected as the training data for the neural network.

The image data effectively used for the crash evasive purpose are those which allow continuous recognition of the ever-changing views before and just after pseudo crash. With this respect, the image pick-up device **21** picks up the images of a vehicle or other obstructions form a relatively short distance. In addition, the picked up images preferably are distinct reflections from the outside views.

The data elements consisting of one image are simultaneously supplied to the input layer **61** in parallel. In other words, each data element is supplied to the respective processing element of the input layer **61**. The digital image data may be normalized before being supplied to the input layer **61** to increase a data processing speed. However, each processing element of the input layer **61** essentially receives the data element obtained by dividing the image data previously. The data elements are subjected to feature extraction when supplied to the hidden layer **62**.

In typical image processing, feature extraction is carried out according to any one of various methods of pattern recognition to clearly identify shapes, forms or configurations of images. The feature-extracted data are quantized to facilitate subsequent calculations. In this event, separate analytical procedure is used for region partitioning or for extraction of configuration strokes. In other words, a particular program is necessary for each unit operation such as region partitioning, feature extraction, vectorization and so on. Compared with this, the prediction system according to the present invention requires no program based on each operation or procedure because a unique algorithm is established on completion of network training. This single algorithm allows to perform necessary functions without using separate algorithms or programs.

In a preferred embodiment, the feature extraction is directed to the configuration of an object defining the driving lanes such as shoulders, curbs, guard rails or the center line. The feature may also be extracted on regions such as carriageways. The neural network learns these configurations and regions during training process. This process is continued until the network reaches a satisfactory level of performance. The neural network is thus trained while carrying out feature extraction on the input image. Weights are adjusted after every trial on the quantized image data, so that the latest training data is weighted according to the latest result of adjustment and then supplied to the hidden layer **62**. In addition, the neural network can be trained with image data including an object at time-varying positions. In this event, any one of suitable methods may be used for digital image processing.

In the present embodiment, each digital data indicative of a view at a certain sampling time instance is divided into n data elements. A product of n represents a positive integer which is equal in number to the processing elements in the input layer **61**. In other words, the series of time sequential data are picked up as continuous n data elements to be supplied in parallel to the n by m processing elements in the input layer **61** as the training data. At the same time, an operational signal is supplied to the output layer **63** of the network as teacher data. The operational signal may be a logic "1" for representing crash of the automobile **10** after elapse of a predetermined time interval from the sampling time instant corresponding to the image data just having been supplied to the input layer **61**.

In the same manner, the picked up image data and its corresponding teacher data are successively supplied to the crash predicting circuit **60**. The crash predicting circuit **60** is continuously trained until the network reaches a satisfactory level of performance. After completion of training, the network is capable of matching the picked up image with the possibility of crash. The accuracy of prediction is improved by means of supplying images for a case of "safe" state to the neural network on learning.

The neural network thus learns the relative position between the vehicle on which it is mounted and objects at a short distance ahead of the vehicle. As a result of this learning, the crash predicting circuit **60** enables prediction of

crash expected to happen a few seconds later according to this relative position. While outside views change every moment and a vehicle in practice encounters various objects and situations, a series of repeated training can yield stereotyped data patterns.

The neural network program that has already been trained can be memorized in a read only memory (ROM) as an application. In this event the network program is memorized after being compiled and translated into a machine language. The ROM is implemented in a predetermined IC chip or the like as an inherent circuit. The IC chip is mounted on a circuit for the air bag system in an automobile.

As mentioned above, the crash predicting circuit **60** supplies the operational signal to the safety drive ensuring arrangement **50** when it predicts occurrence of crash. In response to this operational signal the safety drive ensuring arrangement **50** can perform proper function to evade crash.

For more clear understanding of the present invention, two cases where automobiles **80***a*, **80***d* running in "safe" state are explained. FIG. **7** shows an exemplified image including an oncoming vehicle **80***c* running on the opposite lane. The situation being far from danger as shown in FIG. **7** may allow the system of the present invention to bypass the crash predicting circuit **60**. Alternatively, the crash predicting circuit **60** may produce an operational signal of logic "0" to represent this "safe" condition.

A view shown in FIG. **8** represents a situation when a vehicle **80***d* on the opposite lane comes across the center line in the far distance ahead. The vehicle **80***d* is going to return to the lane where it ought to be. The subsequent image data indicate that the oncoming vehicle **80***d* takes an action to evade crash. In other words, the oncoming vehicle **80***d* is expected to return to the proper lane before the vehicle mounting the crash predicting circuit **60** passes by the vehicle **80***d*. Accordingly, the crash predicting circuit **60** determines that there are no hazardous objects ahead.

If a vehicle on the opposite lane comes across the center line or a vehicle suddenly appears from a blind corner of a cross-street as shown in FIGS. **5**(*a*) and **5**(*b*), the crash predicting circuit **60** carries out prediction operation in accordance with the image data showing these situations. Expected hazards make the crash predicting circuit **60** actuate the safety drive ensuring arrangement **50** in the manner described above.

Another embodiment of the present invention will be described below in which the neural network comprises an intermediate layer having a self-organization function and a competitive learning function to positively respond to various unknown data with less training data. As well known in the art, in the self-organization a network modifies itself in response to inputs. Examples of the use of self-organizing training include the competitive learning law applied to the present embodiment.

As shown in FIG. **9** the neural network according to this embodiment comprises a two-dimensional self-organized competitive learning layer **64** interposed between the input layer **61** and the hidden layer **62**. The two-dimensional self-organized competitive learning layer **64** is referred as to the two-dimensional Kohonen layers (2D-K layer) which in this embodiment comprises p by q layers consisting of a two-dimensional array of processing elements. The input layer **61** may consist of either one or two-dimensional array of processing elements. The 2D-K layer **64** can have any geometrical form desired. In this embodiment, it is also considered that each processing element is fully interconnected to the other processing elements in the next layer though only a part of which are shown in FIG. **9** to evade complexity.

The processing elements in the 2D-K layer **64** compete with one another to determine the "winner" on the basis of minimum distance. More particularly, a predetermined distance can be obtained by, in this embodiment, n processing elements for each set of the input data. The similarity for each of the n input data corresponds to the distance to select similar combination of processing elements. The selected processing elements becomes "winner" for facilitating determination on attributes of unknown data.

More particularly, the winning three Kohonen's processing elements are determined among the fourth processing elements to supply output data. Unknown data are preprocessed on the basis of classification for the input data due to the self-organization on learning. The output value thereof is supplied to the subsequent hidden layer.

With an additional normalization layer **65** may be interposed between the input layer **61** and the 2D-K layer **64** as shown in FIG. **9**. With this normalization layer **65**, the learning efficiency in the 2D-K layer **64** will be sufficiently improved. Addition of the 2D-K layer **64** contributes to a surprising number of information processing capabilities for unknown data as well as a remarkably improved convergence efficiency on learning.

The neural network having the 2D-K layer can be completed by means of expanding the above mentioned back propagation method so that the learning procedure can be determined in a similar manner as in the back propagation method.

The self-organization requires that the system uses, during adaptation of initial several thousands times, no other information other than the incoming patterns and no data are fed back from the output layer. After completion of self-organization the network is trained according to the back propagation algorithm. The neural network having a structure according to this embodiment can be trained with less data for a shorter period of training cycle.

In the above mentioned second embodiment, the neural network already trained can be coded by using a programming language such as C-language. The network may be used as an imperative application system or packaged as a control microprocessor. In this event, the network can be memorized in a read only memory for every one type of commercial vehicles.

For algorithm that can be logically established easily a well-known expert system may be applied to achieve a prediction system using a combination of logic circuit for the neural network and the expert system.

While the above embodiments have thus been described in conjunction with automatic crash evasive operation, it is possible to give precedence to the driver's operation. For example, it is possible to issue appropriate warnings to the driver before actuation of the safety drive ensuring arrangement **50**. For this purpose, an audible signal such as an alarm sound may be generated to alert the driver to potential hazards.

It should be understood that the present invention is not limited to the particular embodiments shown and described above, and various changes and modifications may be made without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A system for predicting and evading crash of a vehicle comprising:

image pick-up means mounted on the vehicle for picking up images of actual views in a direction of running of the vehicle while running of the vehicle,

crash predicting means having a neural network, said neural network containing previously taken image data formed of successive scenes for causing accidents and being trained by a back propagation method for recognizing conditions in image data which cause said accidents, said neural network having an input layer formed of processing elements arranged parallel to each other, said input layer continuously receiving actual image data obtained from the image pick-up means, said neural network receiving the actual image data obtained from the image pick-up means while running of the vehicle, evaluating the actual image data by comparing it to said previously taken image data for causing the accidents, judging if the vehicle is predicted to crash based on the comparison of said previously taken image data with an object noticed in the actual image data of the image pick-up means, and outputting an operational signal in case of prediction of occurrence of a crash with said object, and

safety drive ensuring means connected to said crash predicting means, said safety drive ensuring means, in response to the operational signal, operating to evade the crash between the vehicle and the object for protecting an occupant of the vehicle.

2. A system as claimed in claim **1**, wherein said neural network further includes an output layer formed of a single processing element and connected to the processing elements of the input layer in series, said input layer instantaneously receiving said actual image data from the image pick-up means, and said output layer outputting a binary signal for indicating if said crash is predicted to occur in response to the actual image data inputted to the input layer.

3. A system as claimed in claim **2**, wherein in a training of the neural network by the back propagation method, said input layer receives the previously taken image data formed of successive scenes for causing the accidents and receives said binary signal from said output layer indicating that the accidents occurred in said successive scenes, said neural network, during the driving of the vehicle after the training, evaluating said actual image data obtained from the image pick-up means to determine if it corresponds to said previously taken image data for causing accidents.

4. A system as claimed in claim **3**, wherein said neural network containing trained data is memorized in a ROM for constituting the crash predicting means, said ROM being included in a circuit for the safety drive ensuring means.

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Sir:

Transmitted herewith for filing is the patent application of:

Inventor: Tomoyuki Nishio

For: VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Enclosed are:
[X] 7 sheet of drawings([X] formal [ ] informal).
[X] 23 pages of specification.
[X] Declaration.
[ ] Information disclosure statement and ___ reference(s).
[ ] Preliminary amendment.
[ ] Verified statement of Small Entity Status.
[X] Assignment to Takata Corporation
[ ] Charge $40 to my Deposit Account No. 11-0219 for recording Assignment.
[ ] Inventor's information sheet.

CLAIMS FILED

FOR	Number filed	Number Extra	Rate	Basic Fee $710.00
Total Claims	7 (over 20)		x $22	
Independent Claims	1 (over 3)		x $74	
[ ] Multiple dependent claim			$230	
[ ] Reduce by 50% for small entity				
[ ] Foreign language filing fee			$130	
		TOTAL FILING FEE		$710.00

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A duplicate copy of this sheet is attached.

[X] Please charge any further filing fee, extension fee under 37 CFR 1.17(a),(b),(c) and (d) and other fee in prosecuting the application (except issue fee) in connection with this application to Patent Office Deposit Account No. 11-0219.

[X] A check in the amount of $ 750.00 to cover the filing fee and assignment fee is enclosed.

[X] Applicant hereby claims the benefit of the filing date of the following foreign application under the provisions of 35 USC 119 of which certified copies

[X] will follow [ ] are enclosed

Japanese Patent Application No. 229,201/92
filed on August 4, 1992.

KANESAKA AND TAKEUCHI

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VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Background of the Invention

This invention generally relates to a system for predicting and evading crash of a vehicle, ~~which otherwise will certainly be happened.~~

~~A driver has an unconscious and immediate sense of various conditions through the objects in view and, as a case may be, he must take an action to evade any possible crash or collision.~~ However, drivers will often be panicked at the emergency ~~of above their sense.~~ Such a panicked driver may ~~sometimes be the last one who can cope with the emergency to ensure the active safety of~~ the vehicle. Besides, the response delay to stimuli in varying degrees is inherent to human beings, so that it is impossible in some cases to evade crash or danger ~~by physical considerations~~. With this respect, various techniques have been developed to evade collision by means of mounting on a vehicle a system for determining the possibility of crash in a mechanical or electrical manner before it happens. Accidents could be reduced if drivers had an automatic system or the like warning of potential collision situations.

An automobile collision avoidance radar is typically used as this automatic system. Such an automobile collision avoidance radar is disclosed in, for example, M. Kiyoto and A. Tachibana, Nissan Technical Review: Automobile Collision-Avoidance Radar, Vol. 18, Dec. 1982 that is incorporated by reference herein in its entirety. The radar disclosed comprises a small radar radiation element and antennas installed at the front end of a vehicle. A transmitter transmits microwaves through the radiation element towards the headway. The microwave backscatter from a leading vehicle or any other objects as echo returns. The echo

returns are received by a receiver through the antennas and supplied to a signal processor. The signal processor carries out signal processing operation to calculate a relative velocity and a relative distance between the object and the vehicle. The relative velocity and the relative distance are compared with predetermined values, respectively, to determine if the vehicle is going to collide with the object. The high possibility of collision results in activation of a proper safety system or systems.

However, the above mentioned radar system has a disadvantage of faulty operation or malfunctions, especially when the vehicle implementing this system passes by a sharp curve in a road. The radar essentially detects objects in front of the vehicle on which it is mounted. The system thus tends to incorrectly identify objects alongside the road such as a roadside, guard rails or even an automobile correctly running on the adjacent lane.

An intelligent vehicle has also been proposed that comprises an image processing system for cruise and traction controls. The views ~~Ever-changing views spreading~~ ahead the vehicle are successively picked up as image patterns. These image patterns are subjected to pattern matching with predetermined reference patterns. The reference patterns are classified into some categories associated with possible driving conditions. For example, three categories are defined for straight running, right turn and left turn. When a matching result indicates the presence of potentially dangerous objects in the picked up image, a steering wheel and a brake system are automatically operated through a particular mechanism to avoid or evade crash to that object.

The image processing system of the type described is useful in normal driving conditions where the pattern matching can be effectively made between the image

patterns successively picked up and the reference patterns for safety driving control. However, image patterns representing various conditions on the roadway should be stored previously in the intelligent vehicle as the reference patterns. Vehicle orientation at initiation of crash varies greatly, so that huge numbers of reference patterns are required for the positive operation. This means that only a time-consuming calculation will result in a correct matching of the patterns, which is not suitable for evading an unexpected crash.

It is, of course, possible to increase operational speed of the pattern matching by using a large ~~dedicated~~ image processor. However, such a ~~dedicated~~ processor is generally complex in structure and relatively expensive, so that it is difficult to apply the same as the on-vehicle equipment. In addition, on-vehicle image processors, if achieved, will perform its function sufficiently only in the limited applications such as a supplemental navigation system during the normal cruising.

Summary of the Invention

An object of the present invention is to provide a system for predicting and evading crash of a vehicle using neural networks.

Another object of the present invention is to provide a system capable of training neural networks by means of collected ~~collecting~~ image data representing scenes ~~ever-changing-vistas~~ along the moving ~~travel~~ direction of a vehicle until the vehicle collides with something.

It is yet another object of the present invention to provide a system for predicting crash though matching operation between data obtained on driving a vehicle and data learned by neural networks. It is still another object of the present invention to provide a system for evading crash of a vehicle using neural networks to actuate a vehicle safety system for protecting an

occupant.

In order to achieve the above mentioned objects, the present invention is provided with a system for predicting and evading crash of a vehicle comprising: an image pick-up device mounted on the vehicle for picking up images of ever-changing views when the vehicle is on running to produce image data; a crash predicting circuit associated with the image pick-up device, the crash predicting circuit being successively supplied with the image data for predicting occurrence of crash between the vehicle and potentially dangerous objects on the roadway to produce an operational signal when there is possibility of crash; and a safety driving ensuring device connected to the crash predicting circuit for actuating, in response to the operational signal, occupant protecting mechanism which is operatively connected thereto and equipped in the vehicle; wherein the crash predicting circuit comprises a neural network which is previously trained with training data to predict the possibility of crash, the training data representing ever-changing views previously picked-up from the image picking-up device during driving of the vehicle and just after actual crash.

The neural network comprises at least an input layer and an output layer, and the training data are supplied to the input layer while the output layer is supplied with, as teacher data, flags representing expected and unexpected crash, respectively, of the vehicle. In addition, the neural network may comprise a two-dimensional self-organizing competitive learning layer as an intermediate layer.

Other advantages and features of the present invention will be described in detail in the following preferred embodiments thereof.

Brief Description of the Drawings

Fig. 1 is a block diagram of a conventional system for predicting and evading crash of a vehicle;

Fig. 2 is a schematic view showing a processing element in a typical neural network;

Fig. 3 is a graphical representation of a sigmoid function used as a transfer function for training neural networks;

Fig. 4 is a block diagram of a system for predicting and evading crash of a vehicle using neural networks according to the first embodiment of the present invention;

Fig. 5(a) is a schematic structural diagram of a crash predicting circuit in Fig. 4 realized by a neural network of three layers;

Fig. 5(b) shows an example of an input layer consisting of a two-dimensional array of processing elements of the neural network shown in Fig. 5(a);

Figs. 6(a) and 6(b) are exemplified views picked up, as the training image data supplied to the neural network, at different time instances during driving an experimental vehicle;

Fig. 7 is a view showing ~~an~~ example of an image data obtained during driving a utility vehicle;

Fig. 8 is a view showing another example of ~~an~~ image data obtained during driving a utility vehicle; and

Fig. 9 is a block diagram of a system for predicting and evading crash using neural networks according to the second embodiment of the present invention.

Detailed Description of the Preferred Embodiments

A conventional system for predicting and evading crash of a vehicle is described first to facilitate an understanding of the present invention. Throughout the following detailed description, similar reference numerals refer to similar elements in all figures of the drawing.

In the following description, the term "crash" is used in a wider sense that relates to all unexpected

traffic accidents. Accidents other than crash include a turnover or fall of a vehicle, with which the phenomenon of "crash" is associated in some degrees, ~~therefore~~ so that the ~~use of term crash~~ term crash is used as a cause of traffic accidents.

As shown in Fig. 1, an image pick-up device 21 is mounted at a front portion of an automobile 10 to pick up ever-changing images as analog image data. This image pick-up device 21 is any one of suitable devices such as a charge-coupled-device (CCD) camera. The image data are subject to sampling for a sampling range $_{\Delta}T$ ~~during~~ at a predetermined sampling ~~period~~ interval $_{\Delta}t$. The image data are collected up to crash. In this event, the image pick-up range of the image pick-up device 21 corresponds to a field of view observed through naked eyes.

The image pick-up device 21 is connected to an input interface 22. The analog image data obtained by the image pick-up device 21 are supplied to the input interface 22. The input interface 22 serves as an analog-to-digital converter for converting the analog image data into digital image data. More particularly, the picked up images are digitized by means of dividing the same into tiny pixels (data elements) isolated by grids. It is preferable to eliminate noises and distortions at this stage. The input interface 22 is also connected to a speed sensor 23, a steering gear ratio sensor 24 and a signal processor 30. The speed sensor 23 supplies velocity data to the signal processor 30 through the input interface 22. The velocity data represents an actual velocity of the automobile 10 at the time instant when the image pick-up device 21 picks up an image of a view. Likewise, the steering gear ratio sensor 24 supplies steering gear ratio data to the signal processor 30 through the input interface 22. The steering gear ratio data represents an actual steering gear ratio of the automobile 10.

The signal processor 30 comprises a central

processing unit (CPU) 31, a read-only memory (ROM) 32 and a random-access memory (RAM) 33. CPU 31, ROM 32 and RAM 33 are operatively connected to each other through a data bus 34. To evade potentially dangerous objects, CPU 31 carries out calculation operation in response to the image, velocity and steering gear ratio data given through the input interface 22. CPU 31 performs proper functions according to programs stored in ROM 32 and RAM 33. The outputs of the signal processor 30 is transmitted through an output interface 40. ROM 32 stores a table relating to numerical values required for the calculation. It also stores a table representing operational amount for a safety drive ensuring arrangement 50. On the other hand, RAM 33 stores programs for use in calculating an optimum operational amount for the safety drive ensuring arrangement 50. A program for this purpose is disclosed in, for example, Teruo Yatabe, Automation Technique: Intelligent Vehicle, pages 22-28.

The signal processor 30 first determines, according to the picked up image data, whether there is a space available on the roadway to pass through. When there is enough space to pass through and a potentially dangerous object is present on the roadway, the signal processor 30 calculates optimum operational amount for the safety drive for ensuring arrangement 50 to operate the same. In Fig. 1, the safety drive ensuring arrangement 50 consists of a steering actuator 51, a throttle actuator 52 and a brake actuator 53. If the signal processor 30 determines that it is necessary to operate these actuators, it produces steering gear ratio command, set velocity command, and brake operation command. The steering actuator 51, the throttle actuator 52 and the brake actuator 53 are operated depending on the condition in response to the steering gear ratio command, the set velocity command and the brake operation command, respectively.

The actuators are for use in actuating occupant protecting mechanism such as a brake device. Operation of these actuators is described now.

The steering actuator 51 is a hydraulic actuator for use in rotating steering wheel (not shown) in an emergency. In this event, the steering wheel is automatically rotated according to the steering gear ratio and rotational direction indicated by the steering gear ratio command. The operational amount of the steering or hydraulic actuator can be controlled in a well-known manner through a servo valve and a hydraulic pump, both of which are not shown in the figure.

The throttle actuator 52 acts to adjust opening amount of a throttle valve (not shown) to decrease speed while evading objects or so on.

The brake actuator 53 performs a function to gradually decrease speed of a vehicle in response to the brake operational command. The brake actuator 53 is also capable of achieving sudden brake operation, if necessary.

As mentioned above, CPU 31 carries out its operation with the tables and programs stored in ROM 32 and RAM 33, respectively, ~~for every one~~ calculating for all picked up image data. The conventional system is thus disadvantageous in that the calculation operation requires relatively long time interval as mentioned in the preamble of the instant specification.

On the contrary, a system according to the present invention uses image data representing ever-changing views picked up from a vehicle until it suffers from an accident. These image data are used for training a neural network implemented in the present system. After completion of the training, the neural network is implemented in a utility vehicle and serves as a decision making circuit for starting safety driving arrangements to evade crash, which otherwise will certainly ~~be~~ happen~~ed~~. The neural network predicts

crash and evades the same by means of properly starting an automatic steering system or a brake system.

A well-known neural network is described first to facilitate an understanding of the present invention and, following which preferred embodiments of the present invention will be described with reference to the drawing.

A neural network is the technological discipline concerned with information processing system, which ~~has been developed and~~ is still in a ~~their~~ development stage. Such artificial neural network structure is based on our present understanding of biological nervous systems. The artificial neural network is a parallel, distributed information processing structure consisting of processing elements interconnected unidirectional signal channels called connections. Each processing element has a single output connection that branches into as many collateral connections as desired.

A basic function of the processing elements is described below.

As shown in Fig. 2, each processing element can receive any number of incoming functions while it has a single output connection that can ~~be~~ fan out ~~into copies~~ to form multiple output connections. Thus the artificial neural network is by far more simple than the networks in a human brain. Each of the input data x1, x2, ..., xi is multiplied by its corresponding weight coefficient w1, w2, ..., wi, respectively, and the processing element sums the weighted inputs and passes the result through a nonlinearity. Each processing element is characterized by an internal threshold or offset and by the type of nonlinearity and processes a predetermined transfer function to produce an output f(X) corresponding to the sum ($X = \sum xi \cdot wi$). In Fig. 2, xi represents an output of an i-th processing element in an (s-1)-th layer and wi represents a connection strength or the weight from the (s-1)-th layer to the

s-th layer. The output f(X) represents energy condition of each processing element. Though the neural networks come in a variety of forms, they can be generally classified into feedforward and recurrent classes. In the latter, the output of each processing element is fed back to other processing elements via weights. As described above, the network has an energy or an energy function ~~associated with it~~ that will be minimum finally. In other words, the network is considered to have converged and stabilized when outputs no longer change on successive iteration. Means to stabilize the network depends on the algorithm used.

The back propagation neural network is one of the most important and common neural network architecture, which is applied to the present invention. In this embodiment, the neural network is used to determine if there is a possibility of crash. When the neural network detects the possibility of crash, it supplies an operational command to a safety ensuring unit in a manner described below. As well known in the art, the back propagation neural network is a hierarchical design consisting of fully interconnected layers of processing elements. More particularly, the network architecture comprises at least an input layer and an output layer. The network architecture may further comprise additional layer or N hidden layers between the input layer and the output layer where N represents an integer that is equal to or larger than zero. Each layer consists of one or more processing elements that are connected by links with variable weights. The net is trained by initially selecting small random weights and internal thresholds and then presenting all training data repeatedly. Weights are adjusted after every trial using information specifying the correct result until weights converge to an acceptable value. The neural network is thus trained to automatically generate and produce a desired output for an unknown input.

Basic learning operation of the back propagation neural network is as follows. First, input values are supplied to the neural network as the training data to produce output values, each of which is compared with a correct or desired output value (teacher data) to obtain information indicating a difference between the actual and desired outputs. The neural network adjusts the weights to reduce the difference between them. More particularly, the difference can be represented by a well-known mean square error. During training operation, the network adjusts all weights to minimize a cost function equal to the mean square error. Adjustment of the weights is achieved by means of back ~~propagating~~ propagation transferring the error from the output layer to the input layer. This process is continued until the network reaches a satisfactory level of performance. The neural network trained in the above mentioned manner can produce output data based on the input data even for an unknown input pattern.

The generalized delta rule derived with the steepest descent may be used to optimize the learning procedure that involves the presentation of a set of pairs of input and output patterns. The system first uses the input data to produce its own output data and then compares this with the desired output. If there is no difference, no learning takes place and otherwise the weights are changed to reduce the difference. As a result of this it becomes possible to converge the network after a relatively short cycle of training.

To train the net weights ~~on connections are first initialized randomly and~~ input data (training data) are successively supplied to the processing elements in the input layer. Each processing element is fully connected to other processing elements in the next layer where a predetermined calculation operation is carried out. In other words, the training input is fed through to the output. At the output layer the error is found using,

for example, a sigmoid function and is propagated back to modify the weight on a connection. The goal is to minimize the error so that the weights are repeatedly adjusted and updated until the network reaches a satisfactory level of performance. A graphical representation of sigmoid functions is shown in Fig. 3.

In this embodiment a sigmoid function as shown in Fig. 3 is applied as the transfer function for the network. The sigmoid function is a bounded differentiable real function that is defined for all real input values and that has a positive derivative everywhere. The central portion of the sigmoid (whether it is near 0 or displaced) is assumed to be roughly linear. With the sigmoid function it becomes possible to establish effective neural network models.

As a sigmoid function parameter in each layer, a y-directional scale and a y-coordinate offset are defined. The y-directional scale is defined for each layer to exhibit exponential variation. This results in improved convergence efficiency of the network.

It is readily understood that other functions may be used as the transfer function. For example, in a sinusoidal function a differential coefficient for the input sum in each processing element is within a range equal to that for the original function. To use the sinusoidal function results in extremely high convergence of training though the hardware for implementing the network may be rather complex in structure.

An embodiment of the present invention is described with reference to Figs. 4 through 9.

Fig. 4 is a block diagram of a system for predicting and evading crash of a vehicle using neural networks according to the first embodiment of the present invention. A system in Fig. 4 is similar in structure and operation to that illustrated in Fig. 1 other than a crash predicting circuit 60. Description

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of the similar components will thus be omitted by the consideration of evading redundancy. Fig. 5 is a schematic structural diagram of the crash predicting circuit 60 illustrated in Fig. 4 formed by a neural network of three layers.

The crash predicting circuit 60 in this embodiment is implemented by a neural network architecture of a hierarchical design with three layers as shown in Fig. 5(a). The input layer 61 consists of n processing elements 61-1 through 61-n arranged in parallel as a one-dimensional linear form. Each processing element in the input layer 61 is fully connected in series to the processing elements in a hidden layer 62 of the network. The hidden layer 62 is connected to an output layer 63 of a single processing element to produce an operational command described below. Fig. 5(b) shows an input layer consisting of a two-dimensional array of processing elements. In this event, the image data are supplied to the input layer as a two-dimensional data matrix of n divisions. Basically, the input and the hidden layers can have any geometrical form desired. With the two-dimensional array, the processing elements of each layer may share the same transfer function, and be updated together. At any rate, it should be considered that each processing element is fully interconnected to the other processing elements in the next layer though only a part of which are shown in Fig. 5(a) to evade complexity.

Referring now to Fig. 6 in addition to Fig. 5, illustrated are views picked up, as the image data for use in training the neural network. The image pick-up device 21 picks up ever-changing images as analog image data as described above in conjunction with the conventional system. This image pick-up device 21 is also any one of suitable devices such as a CCD camera. The image pick-up operation is carried out during running of a vehicle at higher speed than a

predetermined one. The image data are subject to sampling for a sampling range ΔT ~~during~~ a predetermined sampling ~~period~~ Δt. The image data are collected before and just after pseudo crash. The image pick-up range of the image pick-up device 21 corresponds to a field of view observed through naked eyes. A view shown in Fig. 6(a) is picked up when a station wagon (estate car) 80a on the opposite lane comes across the center line. A view shown in Fig. 6(b) is picked up when an automobile 80b suddenly appears from a blind corner of a cross-street. These ever-changing images are collected as the training data for the neural network.

The image data effectively used for the crash evasive purpose are those which allow continuous recognition of the ever-changing views before and just after pseudo crash. With this respect, the image pick-up device 21 picks up the images of a vehicle or other obstructions ~~located at~~ a relatively short ~~headway~~. In addition, the picked up images preferably are distinct reflections ~~of~~ the outside views.

The data elements consisting of one image are simultaneously supplied to the input layer 61 in parallel. In other words, each data element is supplied to the respective processing element of the input layer 61. The digital image data may be normalized before being supplied to the input layer 61 to increase a data processing speed. However, each processing element of the input layer 61 essentially receives the data element obtained by dividing the image data previously. The data elements are subjected to feature extraction when supplied to the hidden layer 62.

In typical image processing, feature extraction is carried out according to any one of various methods of pattern recognition to clearly identify shapes, forms or configurations of images. The feature-extracted data are quantized ~~for~~ to facilitate subsequent calculations. In this event, separate analytical procedure is used for

region partitioning or for extraction of configuration strokes. In other words, a particular program is necessary for each unit operation such as region partitioning, feature extraction, vectorization and so on. Compared with this, the prediction system according to the present invention requires no program based on each operation or procedure because a unique algorithm is established on completion of network training. This single algorithm allows to perform necessary functions without using separate algorithms or programs.

In a preferred embodiment, the feature extraction is directed to the configuration of an object defining the driving lanes such as shoulders, curbs, guard rails or the center line. The feature may also be extracted on regions such as carriageways. The neural network learns these configurations and regions during training process. This process is continued until the network reaches a satisfactory level of performance. The neural network is thus trained while carrying out feature extraction on the input image. Weights are adjusted after every trial on the quantized image data, so that the latest training data is weighted according to the latest result of adjustment and then supplied to the hidden layer 62. In addition, the neural network can be trained with image data including an object at time-varying positions. In this event, any one of suitable methods may be used for digital image processing.

In the present embodiment, each digital data indicative of a ~~ever-changing~~ view at a certain sampling time instance is divided into n data elements. A product of n represents a positive integer which is equal in number to the processing elements in the input layer 61. In other words, the series of time sequential data ~~is~~ are picked up as continuous n data elements to be supplied in parallel to the n by m processing elements in the input layer 61 as the training data. At the same

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time, an operational signal is supplied to the output layer 63 of the network as teacher data. The operational signal may be a logic "1" for representing crash of the automobile 10 after elapse of a predetermined time interval from the sampling time instant corresponding to the image data just having been supplied to the input layer 61.

In the same manner, the picked up image data and its corresponding teacher data are successively supplied to the crash predicting circuit 60. The crash predicting circuit 60 is continuously trained until the network reaches a satisfactory level of performance. After completion of training, the network is capable of matching the picked up image with the possibility of crash. The accuracy of prediction is improved by means of supplying images for a case of "safe" state to the neural network on learning.

The neural network thus learns the relative position between the vehicle on which it is mounted and objects at a short distance ahead of the vehicle ~~headway~~. As a result of this learning, the crash predicting circuit 60 enables ~~to~~ prediction of crash expected to ~~be~~ happen~~ed~~ a few seconds later according to this relative position. While outside views change every moment and a vehicle in practice encounters various objects and situations, a series of repeated training can yield stereotyped data patterns.

The neural network program that has already been trained can be memorized in a read only memory (ROM) as an application. In this event the network program is memorized after being compiled and translated into a machine language. The ROM is implemented in a predetermined IC chip or the like as an inherent circuit. The IC chip is mounted on a circuit for the air bag system in an automobile.

As mentioned above, the crash predicting circuit 60 supplies the operational signal to the safety drive

ensuring arrangement 50 when it predicts occurrence of crash. In response to this operational signal the safety drive ensuring arrangement 50 can perform proper function to evade crash.

For more clear understanding of the present invention, two cases where automobiles 80c, 80d running ~~are described those results~~ are explained in "safe" state ~~of the automobile 80c, 80d~~. Fig. 7 shows an exemplified image including an oncoming vehicle 80c running on the opposite lane. The situation being far from danger as shown in Fig. 7 may allow the system of the present invention to bypass the crash predicting circuit 60. Alternatively, the crash predicting circuit 60 may produce an operational signal of logic "0" to represent this "safe" condition.

A view shown in Fig. 8 represents a situation when a vehicle 80d on the opposite lane comes across the center line in the far distance ahead. The vehicle 80d is going to return to the lane where it ought to be. The subsequent image data indicate that the oncoming vehicle 80d takes an action to evade crash. In other words, the oncoming vehicle 80d is expected to return to the proper lane before the vehicle mounting the crash predicting circuit 60 passes by the vehicle 80d. Accordingly, the crash predicting circuit 60 determines that there are no hazardous objects ahead.

If a vehicle on the opposite lane comes across the center line or a vehicle suddenly appears from a blind corner of a cross-street as shown in Figs. 5(a) and 5(b), the crash predicting circuit 60 carries out prediction operation in accordance with the image data showing these situations. Expected hazards make the crash predicting circuit 60 actuate the safety drive ensuring arrangement 50 in the manner described above.

Another embodiment of the present invention will be described below in which the neural network comprises an intermediate layer having a self-organization function and a competitive learning function to positively

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respond to various unknown data with less training data. As well known in the art, in the self-organization a network modifies itself in response to inputs. Examples of the use of self-organizing training include the competitive learning law applied to the present embodiment.

As shown in Fig. 9 the neural network according to this embodiment comprises a two-dimensional self-organized competitive learning layer 64 interposed between the input layer 61 and the hidden layer 62. The two-dimensional self-organized competitive learning layer 64 is referred as to the two-dimensional Kohonen layers (2D-K layer) which in this embodiment comprises p by q layers consisting of a two-dimensional array of processing elements. The input layer 61 may consists of either one or two-dimensional array of processing elements. The 2D-K layer 64 can have any geometrical form desired. In this embodiment, it is also considered that each processing element is fully interconnected to the other processing elements in the next layer though only a part of which are shown in Fig. 9 to evade complexity.

The processing elements in the 2D-K layer 64 compete with one another to determine the "winner" on the basis of minimum distance. More particularly, a predetermined distance can be obtained by, in this embodiment, n processing elements for each set of the input data. The similarity for each of the n input data corresponds to the distance to select similar combination of processing elements. The selected processing elements becomes "winner" for facilitating determination on attributes of unknown data.

More particularly, the winning three Kohonen's processing elements are determined among the fourth processing elements to supply output data. Unknown data are preprocessed on the basis of classification for the input data due to the self-organization on learning.

The output value thereof is supplied to the subsequent hidden layer.

With an additional normalization layer 65 may be interposed between the input layer 61 and the 2D-K layer 64 as shown in Fig. 9. With this normalization layer 65, the learning efficiency in the 2D-K layer 64 will be sufficiently improved. Addition of the 2D-K layer 64 contributes to a surprising number of information processing capabilities for unknown data as well as a remarkably improved convergence efficiency on learning.

The neural network having the 2D-K layer can be completed by means of expanding the above mentioned back propagation method so that the learning procedure can be determined in a similar manner as in the back propagation method.

The self-organization requires that the system uses, during adaptation of initial several thousands times, no other information other than the incoming patterns and no data are fed back from the output layer. After completion of self-organization the network is trained according to the back propagation algorithm. The neural network having a structure according to this embodiment can be trained with less data for a shorter period of training cycle.

In the above mentioned second embodiment, the neural network already trained can be coded by using a programming language such as C-language. The network may be used as an imperative application system or packaged as a control microprocessor. In this event, the network can be memorized in a read only memory for every one type of commercial vehicles.

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A_3 ~~For the portion of algorithm that is established readily in logical~~, a well-known expert system may be applied to achieve a prediction system using a combination of logic circuit for the neural network and the expert system.

While the above embodiments have thus been

described in conjunction with automatic crash evasive operation, it is possible to give precedence to the driver's operation. For example, it is possible to issue appropriate warnings to the driver before actuation of the safety drive ensuring arrangement 50. For this purpose, an audible signal such as an alarm sound may be generated to alert the driver to potential hazards.

It should be understood that the present invention is not limited to the particular embodiments shown and described above, and various changes and modifications may be made without departing from the spirit and scope of the appended claims.

WHAT IS CLAIMED IS:

1. A system for predicting and evading crash of a vehicle comprising:

image pick-up means mounted on the vehicle for picking up images of actual ever-changing views when the vehicle is on running to produce actual image data;

crash predicting means associated with said image pick-up means, said crash predicting means being successively supplied with the actual image data for predicting occurrence of crash between the vehicle and potentially dangerous objects on the roadway to produce an operational signal when there is possibility of crash; and

safety drive ensuring means connected to said crash predicting means for actuating, in response to the operational signal, occupant protecting mechanism which is operatively connected thereto and equipped in the vehicle;

wherein said crash predicting means comprises a neural network which is previously trained with training data to predict the possibility of crash, the training data representing ever-changing views previously picked-up said image picking-up means during driving of the vehicle and just after actual crash.

2. A system as claimed in Claim 1, wherein the neural network comprises at least an input layer and an output layer, and

the training data are supplied to the input layer while the output layer is supplied with, as teacher data, flags representing expected and unexpected crash, respectively, of the vehicle.

3. A system as claimed in Claim 2, wherein the neural network comprises a two-dimensional self-organizing competitive learning layer as an intermediate layer.

4. A system as claimed in Claim 1, wherein the neural network is coded after completion of learning and

implemented in the vehicle.

5. A system as claimed in Claim 1, wherein said safety drive ensuring means is a steering actuator and the occupant protecting mechanism is a steering system of the vehicle.

6. A system as claimed in Claim 1, wherein said safety drive ensuring means is a throttle actuator and the occupant protecting mechanism is a throttle system of the vehicle.

7. A system as claimed in Claim 1, wherein said safety drive ensuring means is a brake actuator and the occupant protecting mechanism is a brake system of the vehicle.

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ABSTRACT OF THE DISCLOSURE

A system for predicting and evading crash of a vehicle includes an ~~comprising~~ image pick-up device ~~means~~ mounted on the vehicle for picking up images of actual ever-changing views when the vehicle is on running to produce actual image data, a crash predicting device ~~means~~ associated with said image pick-up device ~~means~~, said crash predicting device ~~means~~ being successively supplied with the actual image data for predicting occurrence of crash between the vehicle and potentially dangerous objects on the roadway to produce an operational signal when there is possibility of crash and a safety drive ensuring device ~~means~~ connected to said crash predicting device ~~means~~ for actuating, in response to the operational signal, an occupant protecting mechanism which is operatively connected thereto and equipped in the vehicle; The ~~wherein said~~ crash predicting device includes ~~means comprises~~ a neural network which is previously trained with training data to predict the possibility of crash, the training data representing ever-changing views previously picked-up from said image picking-up device ~~means~~ during driving of the vehicle for causing ~~and just after~~ actual crash.

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Attorney Docket No. K-1398

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS, the specification of which

(check one)
- [X] is attached hereto.
- [ ] was filed on _____ as Application Serial No. _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed
No. 229,201/92	Japan	August 4, 1992	[X] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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K-1398

COMBINED DECLARATION AND POWER OF ATTORNEY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

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POST OFFICE ADDRESS		

Full name of fourth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		

Full name of fifth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
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Full name of sixth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		

Full name of seventh joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		

Full name of eighth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
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Full name of ninth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
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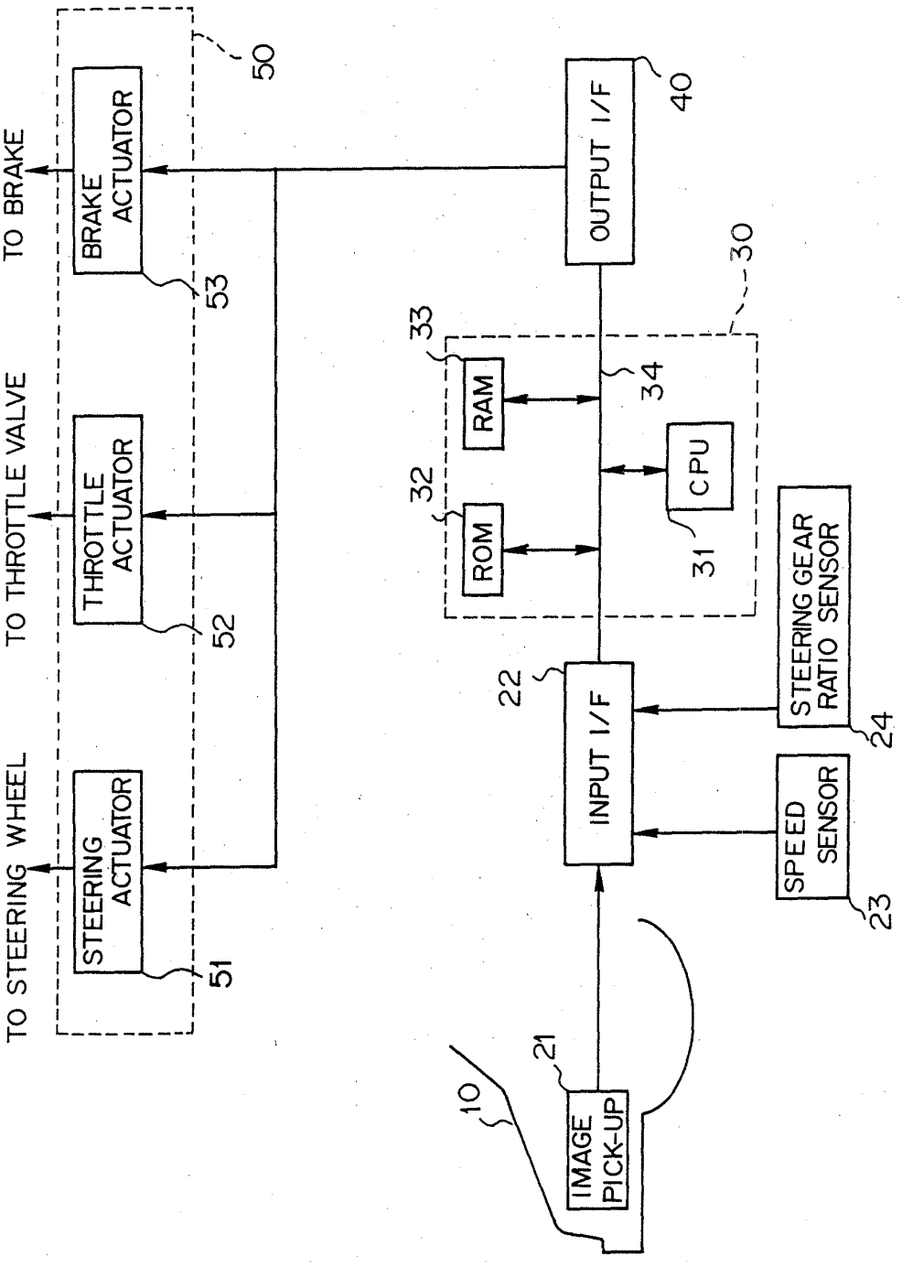

FIG. 1 PRIOR ART

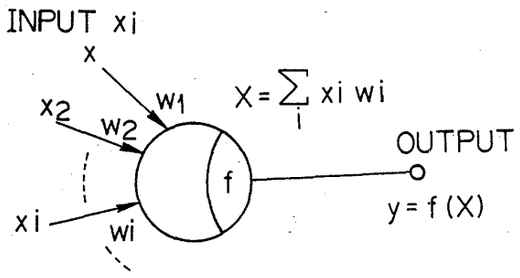

FIG. 2
PRIOR ART

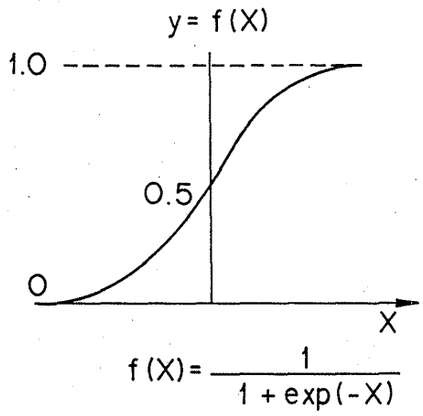

FIG. 3
PRIOR ART

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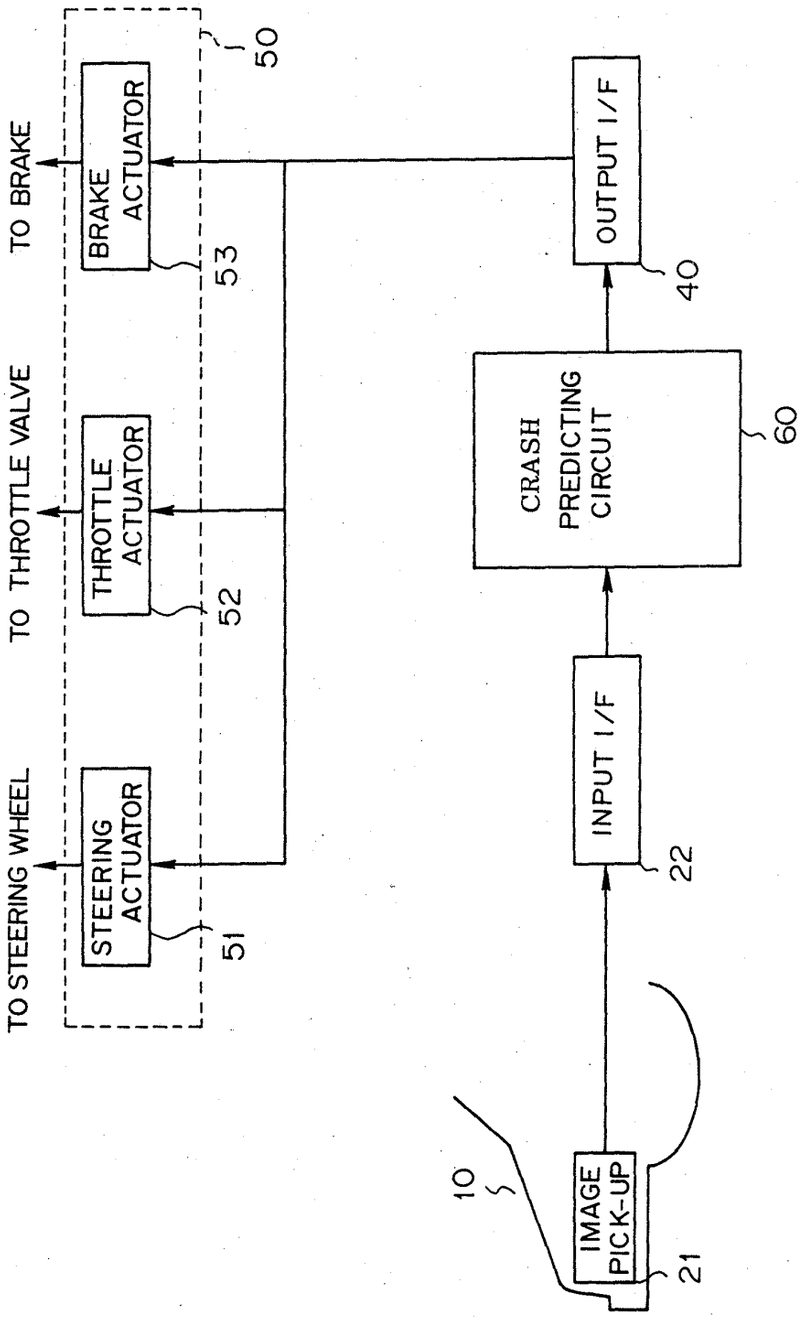

FIG. 4

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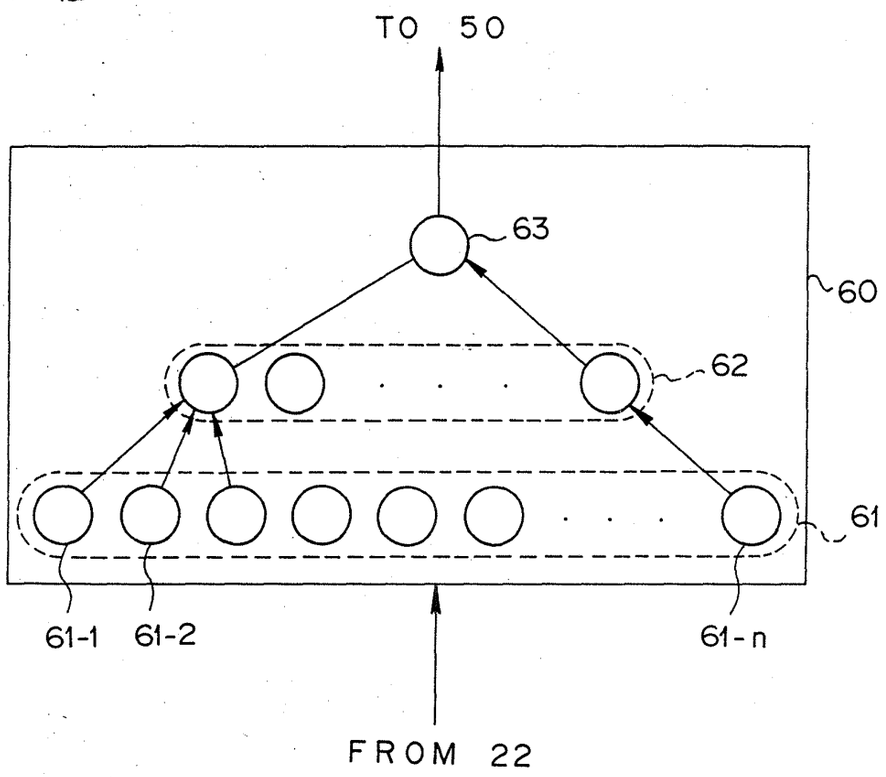

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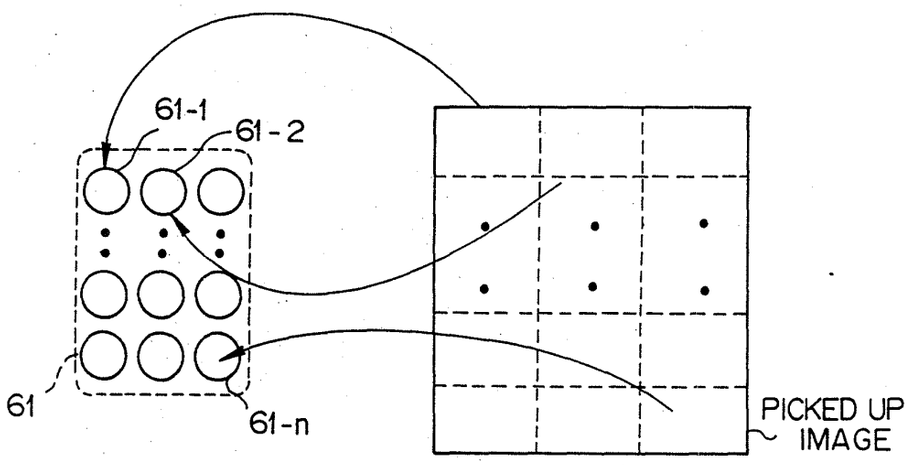

(b)

FIG. 5

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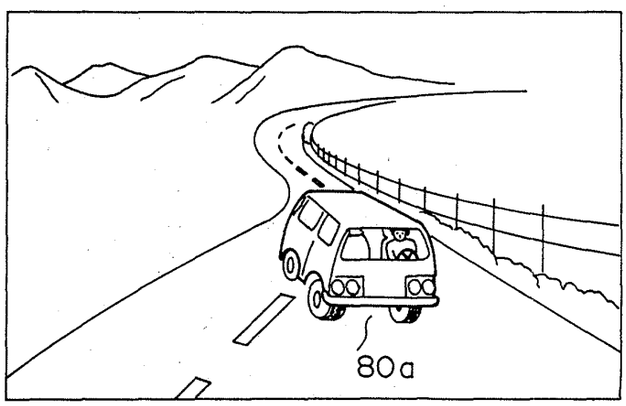

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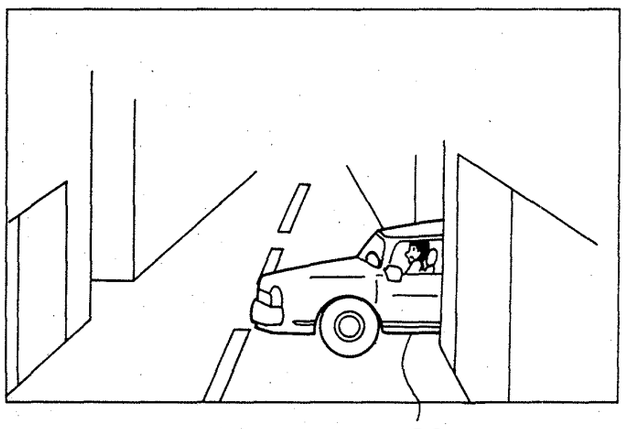

(b)

FIG. 6

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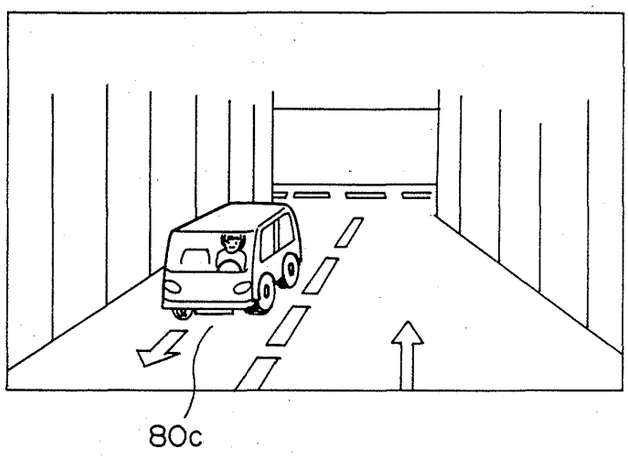


FIG. 7

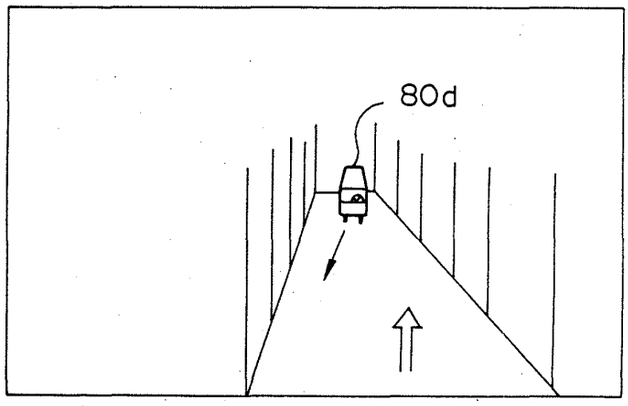


FIG. 8

PRINT OF DRAWINGS
AS ORIGINALLY FILED

K-138
7/7

08 097178

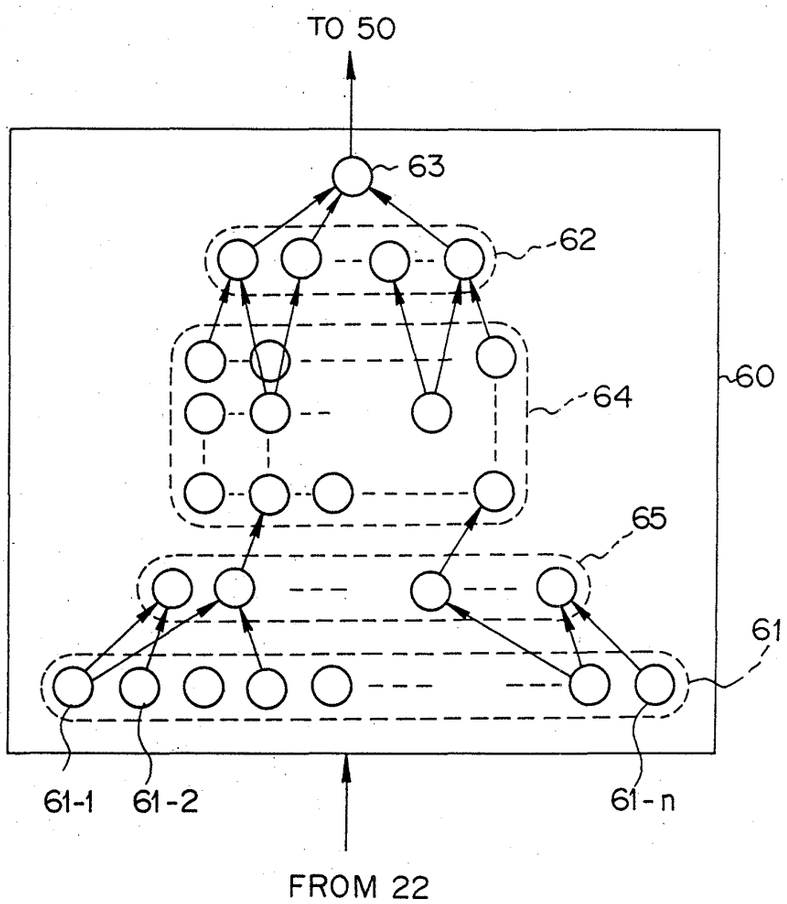


FIG. 9

#2/Sub. Declaration
R. Morgan
10/23/93

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1398

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 08/097,178

Filed : July 27, 1993

Group Art Unit : 2617

Examiner :

2617
2609
10/12

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

September 29, 1993

SUBMISSION OF DECLARATION

Sir:

Submitted herewith is a declaration signed by the inventor. In the original declaration, citizenship of the inventor was missing.

Please substitute the declaration herewith.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by _____
Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

727 Twenty-Third Street South
Arlington, Virginia 22202
(703) 521-3810

#2

(Page 1 of 2)

Attorney Docket No. K-1398

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS, the specification of which

(check one)
- ☐ is attached hereto.
- ☒ was filed on July 27, 1993 as Application Serial No. 08/097,178 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed	
No. 229,201/92	Japan	August 4, 1992	☒ Yes	☐ No
			☐ Yes	☐ No
			☐ Yes	☐ No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Yusuke Takeuchi Reg. No. 30,921
Manabu Kanesaka Reg. No. 31,467

Address all telephone calls to KANESAKA AND TAKEUCHI at telephone No. (703) 521-3810
Address all correspondence to KANESAKA AND TAKEUCHI, 727 Twenty-Third Street South Arlington, Virginia 22202.

COMBINED DECLARATION AND POWER OF ATTORNEY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF SOLE OR FIRST INVENTOR	INVENTOR'S SIGNATURE	DATE
Tomoyuki NISHIO	T Nishio	September 21, 1993
RESIDENCE		CITIZENSHIP
Kawasaki-shi, Japan		Japanese
POST OFFICE ADDRESS		
663-28, Ozenji, Asou-ku, Kawasaki-shi, Kanagawa-ken, Japan		

FULL NAME OF SECOND JOINT INVENTOR, IF ANY	INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		

FULL NAME OF THIRD JOINT INVENTOR, IF ANY	INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		

Full name of fourth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		

Full name of fifth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		

Full name of sixth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		

Full name of seventh joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		

Full name of eighth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		

Full name of ninth joint inventor	INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1398

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 097,178

Filed : July 27, 1993

Group Art Unit : 2617

Examiner :

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

January 18, 1994

SUBMISSION OF INFORMATION DISCLOSURE STATEMENT

Sir:

Submitted herewith are Information Disclosure Statement, EPC Search Report and five references.

It is certified that the Search Report and the references were cited on December 14, 1993 in a communication from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of the statement.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by _____
Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

727 Twenty-Third Street South
Arlington, Virginia 22202
(703) 521-3810

P.B.5818 - Patentlaan 2
2280 HV Rijswijk (ZH)
(070) 3 40 20 40
TX 31651 epo nl
FAX (070) 3 40 30 16

Ber. 091,178

Heim, Hans-Karl, Dipl.-Ing.
Weber & Heim
Patentanwälte
Hofbrunnstrasse 36
D-81479 München
ALLEMAGNE

Eingegangen
Weber & Heim
17. 12. 1993
Frist ca 30.7.94
Erledigt

RECEIVED
DEC. 29. 1993
SUNABA PATENT OFFICE

Datum/Date
14. 12. 93

Zeichen/Ref./Réf.	Anmeldung Nr./Application No./Demande n°.//Patent Nr No./Brevet n°.
T 191	93112302.0- -
Anmelder/Applicant/Demandeur//Patentinhaber/Propriétaire: TAKATA CORPORATION	

COMMUNICATION

貴社番号	TB-92-9-1
担 当	

The European Patent Office herewith transmits

- [x] the European search report
- [ ] the declaration under Rule 45 of the European Patent Convention
- [ ] the partial European search report under Rule 45 of the European Patent Convention
- [ ] the supplementary European search report concerning the international application number

relating to the above-identified European patent application; copies of the documents cited in the search report are enclosed.

The Search Division approved the following items, as submitted by the applicant:

- [ ] Abstract
- [x] Title
- [x] Figure

- [x] The abstract was modified by the Search Division and the definitive text is attached to the present communication.
- [ ] The following figure will be published with the abstract, since the Search Division considers that it better characterises the invention than the one indicated by the applicant.

Figure:

- [x] Additional copy(ies) of the documents cited in the European search report.

EUROPÄISCHES PATENTAMT - DEN HAAG - EUROPEAN PATENT OFFICE - THE HAGUE - OFFICE EUROPÉEN DES BREVETS - LA HAYE

REFUND OF THE SEARCH FEE

If applicable under Art.10 of the Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent to you later.

EPO Form 1507 07.90				

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 11 2302

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	DE-A-4 001 493 (IBP PIETZSCH) * column 3, line 10 - line 32 * * abstract *	1,5-7	B60R1/00 B60R21/00 B60K28/00
A		2,3	G05D1/02
Y	WO-A-9 002 985 (FREUND ET AL) * claim 1; figures 1,2 *	1,5-7	
A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 157 (M-1236)16 April 1992 & JP-A-04 008 639 (MITSUBISHI ELECTRIC CORP) 13 January 1992 * abstract *	1,6,7	
A	RUMELHART ET AL 'Parallel Distributed Processing, vol. 1: Foundations' 1986 , THE MIT PRESS , CAMBRIDGE, MASSACHUSETTS, USA * page 161, paragraph 3 * * page 162, paragraph 1 *	2-4	
A	EP-A-0 358 628 (TRANSITIONS RESEARCH CORPORATION) * column 4, line 12 - column 5, line 20 *	1,5-7	TECHNICAL FIELDS SEARCHED (Int. Cl.5) B60R B60K
A	DE-A-3 837 054 (MARINITSCH) * page 3, line 10 - line 26 *	1,6,7	G05D
A	FR-A-2 554 612 (ONERA ET AL) * the whole document *	1	

1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	18 NOVEMBER 1993	STANDRING M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 93 11 2302

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on 18/11/93
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-A-4001493	25-07-91	None		
WO-A-9002985	22-03-90	DE-A-	3830790	15-03-90
		EP-A-	0433351	26-06-91
EP-A-0358628	14-03-90	US-A-	4954962	04-09-90
		JP-A-	2170205	02-07-90
		US-A-	5040116	13-08-91
DE-A-3837054	22-06-89	EP-A-	0367034	09-05-90
FR-A-2554612	10-05-85	EP-A-	0146428	26-06-85

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

ABSTRACT / ZUSAMMENFASSUNG / ABREGE

93112302.0

A system for predicting and evading crash of a vehicle (10) comprising image pick-up means (21) mounted on the vehicle for picking up images of actual ever-changing views when the vehicle is on running to produce actual image data, crash predicting means (60) associated with said image pick-up means (21), said crash predicting means (60) being successively supplied with the actual image data for predicting occurrence of crash between the vehicle and potentially dangerous objects on the roadway to produce an operational signal when there is possibility of crash and safety drive ensuring means (50) connected to said crash predicting means for actuating, in response to the operational signal, occupant protecting mechanism (51,52,53) which is operatively connected thereto and equipped in the vehicle, wherein said crash predicting means (60) comprises a neural network which is previously trained with training data to predict the possibility of crash, the training data representing ever-changing views previously picked-up said image picking-up means (21) during driving of the vehicle and just after actual crash.

E U R O P E A N P A T E N T O F F I C E

Patent Abstracts of Japan

PUBLICATION NUMBER : JP4008639
PUBLICATION DATE : 13-01-92

ABSTRACT PUBLICATION DATE: 16-04-92
ABSTRACT VOLUME : 016157

APPLICATION DATE : 25-04-90
APPLICATION NUMBER : JP900109396

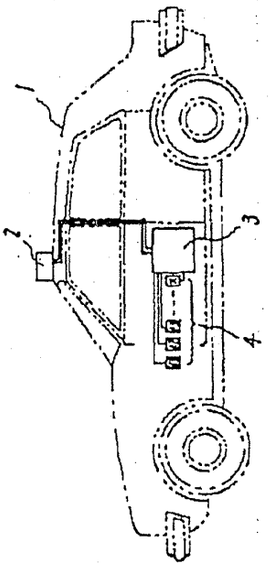
GROUP : M1236

APPLICANT : MITSUBISHI ELECTRIC CORP

INVENTOR : TAI SHUICHI; others: 04

INT.CL. : B60K28/06; B60K41/00;
G06F15/18

TITLE : CAR OPERATING DEVICE



ABSTRACT : PURPOSE:To enhance the safety by forming a car driving device from a neural network, which emits the study function upon information given from an information sensor, and a controller working in response to the output of this neural network, and thereby providing practicability of automated driving according to the situation with occurrence of accident.
CONSTITUTION:Information taken into an information sensor 2 installed on a car 1 is subjected to processing made by a neural network 3, and thereby the car is operated with automatic stop at red signal or speed control to generate optimum inter-car distance. The function of this neural network 3 is formed with studies, which are completed when desirable output is obtained abut all considerable pieces of input information. Use of such a neural network 3 with completed studies permits automated drive of the car even in case the driver falls asleep or out of capability of driving for ex. due to accident. Thus safe running is achieved.

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/097,178	07/27/93	NISHID	T K1398

EXAMINER
SWARTHOUT, B

ART UNIT	PAPER NUMBER
2617	3

26M1/0218

KANESAKA AND TAKEUCHI
727 TWENTY-THIRD STREET SOUTH
ARLINGTON, VA 22202

DATE MAILED: 02/18/94

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS

☑ This application has been examined ☑ Responsive to communication filed on 9-29-93 ☐ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), 0 days from the date of this letter. Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☑ Notice of References Cited by Examiner, PTO-892.
2. ☑ Notice of Draftsman's Patent Drawing Review, PTO-948.
3. ☑ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of Informal Patent Application, PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474.
6. ☐ _____.

Part II SUMMARY OF ACTION

1. ☑ Claims 1-7 are pending in the application.
   Of the above, claims _____ are withdrawn from consideration.
2. ☐ Claims _____ have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☑ Claims 1-7 are rejected.
5. ☐ Claims _____ are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☑ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable; ☐ not acceptable (see explanation or Notice of Draftsman's Patent Drawing Review, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____. has (have) been ☐ approved by the examiner; ☐ disapproved by the examiner (see explanation).
11. ☐ The proposed drawing correction, filed _____, has been ☐ approved; ☐ disapproved (see explanation).
12. ☑ Acknowledgement is made of the claim for priority under 35 U.S.C. 119. The certified copy has ☐ been received ☑ not been received ☐ been filed in parent application, serial no. _____ ; filed on _____.
13. ☐ Since this application apppears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

EXAMINER'S ACTION

PTOL-326 (Rev. 2/93)

1. This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

2. The disclosure is objected to because of the following informalities: The following language is not grammatically correct and should be rewritten: Page 1, lines 8-9; Page 3, line 29; Page 4, lines 21-22; Page 8, lines 23-24; Page 9, line 10; Page 11, lines 30-33; Page 14, lines 18-19; Page 17, line 6; Page 19, lines 32-33; and claim 1, line 5. Appropriate correction is required.

3. Claims 1-7 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 1, line 19 it is unclear how a network "is providing trained"; and on lines 21-22 "previously picked-up said image picking-up means" is unclear.

In claim 2 it is unclear what "an input layer and an output layer" are composed of, or how such a layer is supplied flags.

In claim 3 it is unclear what a "self-organizing competitive learning layer" is, or what an intermediate layer is.

In claim 4 it is unclear how a network is coded, how learning is accomplished or how completion of learning is sensed.

4. The following is a quotation of 35 U.S.C. § 103 which forms the basis for all obviousness rejections set forth in this Office

action:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.
>
> Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

Claims 1-4, 6 and 7 are rejected under 35 U.S.C. § 103 as being unpatentable over Adachi et al. in view of Yuhara et al.

Adachi discloses a vehicle crash predicting system comprising image pick-up means 30, crash prediction means 30, safety driver ensuring means 38-42, wherein the prediction means is trained previously to recognize potential crash using a fuzzy induction logic (cols. 4-6), except for specifically stating that a neural network is used.

Yuhara teaches use of neural network 12 to predict future conditions in a vehicle system in order to properly control a vehicle (abstract).

It would have been obvious to utilize neural network logic to predict crash in a system as set forth by Adachi, since such is well known in the art for predicting vehicle conditions and

provides an equivalent prediction technique to the fuzzy induction technique disclosed by Adachi, applicant citing no criticality for use of one prediction technique versus an equivalent technique.

With regard to claims 2-4, Yuhara discloses a neural network comprising 3-dimensional layers (col. 3), wherein the network is coded (col. 7).

With regard to claims 6-7, Adachi teaches adjusting throttle (40) and brake (42) responsive to Prediction results.

5. Claim 5 is rejected under 35 U.S.C. § 103 as being unpatentable over Adachi et al. in view of Yuhara et al. and Taylor.

Taylor teaches manipulation of a steering actuator 22 via a control unit if collision on a vehicle is predicted (abstract).

It would have been obvious to control a steering device as opposed to a brake or throttle means on predicted collision in a device as set forth by the combined teachings of Adachi and Yuhara, since this is one of various well known control parameters for avoiding collisions, applicant citing no criticality for use of steering versus other equivalent parameters.

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Kamishima, Asayama and Takahashi disclose vehicle control

and alarm systems.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brent Swarthout whose telephone number is (703) 305-4383.

Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 305-4750.

B.SWARTHOUT/TC
February 14, 1994

Brent A. Swarthout

BRENT SWARTHOUT
PATENT EXAMINER
GROUP 2600

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP–APART AND DISCARD CARBON

FORM PTO-892 (REV. 2-92)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	SERIAL NO.	GROUP ART UNIT	ATTACHMENT TO PAPER NUMBER	
NOTICE OF REFERENCES CITED		097,178	2617		3
		APPLICANT(S) Nishio			

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUB-CLASS	FILING DATE IF APPROPRIATE
	A	5270708	12-93	Kamishima	340	905	3-18-92
	B	5161632	11-92	Asayama	340	435	5-7-91
	C	5162997	11-92	Takahashi	364	424.1	1-22-91
	D	5249157	9-93	Taylor	340	903	8-22-90
	E	5200898	4-93	Yuhara et al	364	431.04	11-15-90
	F	5189619	2-93	Adachi et al.	340	903	8-2-90
	G						
	H						
	I						
	J						
	K						

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB-CLASS	PERTINENT SHTS. DWG	PERTINENT PP. SPEC.
	L								
	M								
	N								
	O								
	P								
	Q								

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

	R	
	S	
	T	
	U	

EXAMINER	DATE
Brent A. Swarthout	2-7-94

* A copy of this reference is not being furnished with this office action.
(See Manual of Patent Examining Procedure, section 707.05 (a).)

#21/2

Sheet 1 of 2

Form PTO-1449 (REV. 2-83)

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use several sheets if necessary)

ATTY. DOCKET NO.	SERIAL NO.
K-1398	08/097,178

APPLICANT: Tomoyuki Nishio

FILING DATE	GROUP
July 27, 1993	2617

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
BAS		DE-A-4001493	7/25/91	Germany				✓
BAS		WO-A-9002985	3/22/90	PCT			Abstract only ✓	
BAS		EP-A-0358628	3/14/90	Europe			✓	
BAS		DE-A-3837054	6/22/89	Germany				✓
BAS		FR-A-2554612	5/10/85	France				✓

OTHER DOCUMENTS *(Including Author, Title, Date, Pertinent Pages, Etc.)*

EXAMINER	DATE CONSIDERED
Brent A. Swarthout	2-7-94

*EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Form PTO-1449 (REV. 2-83)

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use several sheets if necessary)

ATTY. DOCKET NO.	SERIAL NO.
K-1398 GROUP 2600	097,178

APPLICANT: Tomoyuki Nishio

FILING DATE	GROUP
July 27, 1993	2617

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
BAS		JP-A-04008639	1/13/92	Japan			✓abstract only	

OTHER DOCUMENTS *(Including Author, Title, Date, Pertinent Pages, Etc.)*

BAS		Rumelhart et al "Parallel ~~Destruted~~ Distributed Processing, Vol. 1
		pages 161, 162, copyrighted 1986,

EXAMINER	DATE CONSIDERED
Brent A. Swarthout	2-7-94

*EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

PTO **FORM 948**
(REV. 7-92)

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

ATTACHMENT TO PAPER NUMBER
3
APPLICATION NUMBER
07/978

GROUP 2617

NOTICE OF DRAFTSPERSON'S PATENT DRAWING REVIEW

THE PTO DRAFTSMEN REVIEW ALL ORIGINALLY FILED DRAWINGS REGARDLESS OF WHETHER THEY WERE DESIGNATED AS INFORMAL OR FORMAL. ADDITIONALLY, THE PATENT EXAMINER WILL ALSO REVIEW THE DRAWINGS FOR COMPLIANCE WITH THE REGULATIONS.

The drawings filed 7/27/93

A. ☐ are approved by the draftsperson.

B. ☒ are objected to by the draftsperson under 37 CFR 1.84 for the reason(s) checked below. The examiner will require submission of new, corrected drawings at the appropriate time. Corrected drawings must be submitted according to the instructions listed on the back of this Notice.

1. Paper and ink. 37 CFR 1.84(a)

   ☐ Sheet(s)_____ Poor.

2. Size of Sheet and Margins. 37 CFR 1.84(b)

   Acceptable Paper Sizes and Margins

	Paper Size		
Margin	8 1/2 by 14 inches	8 1/2 by 13 inches	DIN size A4 21 by 29.7 cm.
Top	2 inches	1 inch	2.5 cm.
Left	1/4 inch	1/4 inch	2.5 cm.
Right	1/4 inch	1/4 inch	1.5 cm.
Bottom	1/4 inch	1/4 inch	1.0 cm.

   ☐ Proper Size Paper Required.
   All Sheets Must be Same Size.
   Sheet(s) _____

   ☐ Proper Margins Required.
   Sheet(s) _____

   ☐ TOP ☐ RIGHT

   ☐ LEFT ☐ BOTTOM

3. Character of Lines. 37 CFR 1.84(c)

   ☐ Lines Pale or Rough and Blurred.
   Fig(s)_____

   ☐ Solid Black Shading Not Allowed.
   Fig(s)_____

4. ☐ Photographs Not Approved.

   _____

   ☐ Comments;

5. Hatching and Shading. 37 CFR 1.84(d)

   ☐ Shade Lines are Required.
   Fig(s) _____

   ☐ Criss-Cross Hatching Not Allowed.
   Fig(s) _____

   ☐ Double Line Hatching Not Allowed.
   Fig(s) _____

   ☐ Parts in Section Must be Hatched.
   Fig(s) _____

6. Reference Characters. 37 CFR 1.84(f)

   ☐ Reference Characters Poor or Incorrectly Sized.
   Fig(s) _____

   ☐ Reference Characters Placed Incorrectly.
   Fig(s) _____

7. Views. 37 CFR 1.84(i) & (j)

   ☒ Figures Must be Numbered Properly. Fig. 5 & 6

   ☐ Figures Must Not be Connected.
   Fig(s) _____

8. ☐ Identification of Drawings. 37 CFR 1.84(1)
   Extraneous Matter or Copy Machine
   Marks Not Allowed. Fig(s) _____

9. ☐ Changes Not Completed from Prior
   PTO-948 dated _____

Telephone inquires concerning this review should be directed to the Chief Draftsperson at telephone number (703) 305-8404.

T. Rogers
Reviewing Draftsperson

8/25/93
Date

Note: Any objection to the drawings made by the examiner will be communicated separately in an office action.

PTO Copy

GP267

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1398

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 097,178

Filed : July 27, 1993

Group Art Unit : 2617

Examiner : Brent Swarthout

H/A
A. Brinkfield
5/20/94
Jee OK
R. Morgan
5/22/94

5/24/94

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

May 16, 1994

AMENDMENT

Sir:

In response to the Office Action of February 18, 1994, please amend the application, as follows:

IN THE SPECIFICATION

Page 1, line 7, delete ", which";

line 8, delete in its entirety, and add --in case of a situation that an accident may happen.--; A1

line 9, delete in its entirety, and add --In driving a car, a driver unconsciously senses--; A2

line 13, delete "of above their sense";

line 14, change "sometimes be the last one who", to --not properly handle--;

line 15, delete in its entirety;

line 16, delete "of";

line 18, after "is" add --physically--;

line 19, delete "by physical considerations".

23

Page 2, line 22, change "Ever-changing views spreading" to--The views--.

Page 3, lines 13 and 14, delete "dedicated";

line 28, change "collecting" to --collected--;

line 29, change "ever-changing vistas" to --scenes--, and change "travel" to --moving--.

Page 4, line 21, after "picked-up" add --from--;

OK line 33, change "detain" to --detail--.

Page 5, lines 20 and 22, delete "an".

Page 6, line 3, change "therefore" to --, so that--;

line 4, change "use of term crash" to --term crash is used--;

line 11, change "during" to --at--, and change "period" to --interval--.

Page 7, line 26, after "drive" add --for--.

Page 8, line 23, change "for every one" to --and calculating for all--.

Page 9, line 9, change "has" to --is--;

line 10, delete "been developed and", and change "their" to --a--;

line 23, delete "into copies".

Page 10, line 8, change "associated with it" to a comma.

Page 11, line 14, change "propagating" to --propagation transferring--;

lines 30-31, delete "on connections are first initialized randomly and".

Page 13, line 4, change "realized" to --formed--.

Page 14, line 2, change "during" to --at--;

line 3, change "period" to --interval--;

line 18, change "located at" to --from--;

line 19, change "headway" to --distance--;

line 20, change "of" to --from--.

Page 15, line 30, change "ever-changing" to --a--;

line 35, change "is" to --are--.

Page 16, line 20, change "headway" to --distance ahead of the vehicle--.

Page 17, line 6, change "are described those results" to--where automobiles 80c, 80d running--;

line 7, change "of the automobile 80c, 80d" to--are explained--.

Page 19, line 32, delete in its entirety, and add --For algorithm that can be logically established easily--;

line 33, delete "readily in logical".

IN THE CLAIMS

Please cancel claims 1-7, and file new claims 8-11, as follows:

~~8. A system for predicting and evading crash of a vehicle~~ comprising:

image pick-up means mounted on the vehicle for picking up images of actual views in a direction of running of the vehicle while running of the vehicle,

crush predicting means having a neural network, said neural network containing previously taken image data formed of successive scenes to become accidents and being trained for realizing conditions of causing said accidents, said neural network having an input layer continuously receiving actual image data obtained from the image pick-up means, said neural network watching the actual image data obtained from the image pick-up ~~means while running of the vehicle with reference to said~~

previously taken image data to become the accidents, judging if the vehicle collides with an object noticed in the actual image data of the image pick-up means, and outputting an operational signal in case of prediction of occurrence of a crush with said object, and

safety drive ensuring means connected to said crash predicting means, said safety drive ensuring means, in response to the operational signal, outputting a signal for evading the crush between the vehicle and the object and for protecting an occupant of the vehicle.

9. A system as claimed in claim 8, wherein said neural network has a laminated structure having said input layer and an output layer, said input layer instantaneous receiving said actual image data as one-dimensional form from the image pick-up means having two dimensional data, and said output layer outputting a binary signal for indicating if said crush occurs in response to the actual image data inputted to the input layer.

10. A system as claimed in claim 9, wherein in a training of the neural network, said input layer receives the previously taken image data formed of successive scenes to become the accidents and receives said binary signal from said output layer indicating that the accidents occurred in said successive scenes so that during the driving of the vehicle, the neural network determines if said actual image data obtained from the image pick-up means belong to the previously taken image data of the accidents.

11. A system as claimed in claim 10, wherein said neural network containing the trained data is programed and is memorized in a

A4 cont. ~~ROM for constituting the crush predicting means, said ROM being included in a circuit for the safety drive ensuring means.~~

IN THE ABSTRACT

Line 2, change "comprising" to --includes an--, and change "means" to --device--;

BAS Line 5, before "crash" add --a--, and change "means" to--device--;

Line 6, change "means" to --device--(both occurrences);

Line 11, after "and" add --a--, and change "means" to--device--;

Line 12, change "means" to --device--;

Line 13, before "occupant" add --an--;

Line 15, change ", wherein said" to --. The--, and change "means comprises" to --device includes--;

Line 19, before "said" add --from--, and change "means" to--device--;

Line 20, change "and just after" to --for causing--.

IN THE DRAWINGS

In Fig. 5, change "Fig. 5(a), (b)" to --Fig. 5(a)-- and--Fig. 5(b)--, as shown in red in the attached copy thereof.

In Fig. 6, change "Fig. 6(a), (b)" to --Fig. 6(a)-- and--Fig. 6(b)--, as shown in red in the attached copy thereof.

REMARKS

This is a response to the Office Action of February 18, 1994.

In paragraph 2 of the Action, the disclosure was objected to. In view of the objection, the specification has been

reviewed, and clerical and grammatical errors of the specification have been amended.

In paragraph 3 of the Action, claims 1-7 were rejected under 35 USC 112, second paragraph. Claims 1-7 have been cancelled, and new claims 8-11 have been filed. New claims have been prepared to obviate the rejection under 35 USC 112.

In paragraph 4 of the Action, claims 1-4, 6 and 7 were rejected under 35 USC 103 as being unpatentable over Adachi et al. in view of Yuhara et al. In paragraph 5 of the Action, claim 5 was rejected under 35 USC 103 as being unpatentable over Adachi et al. in view of Yuhara et al. and Taylor.

As clearly recited in the new claims, the system for predicting and evading crash of a vehicle of the invention is formed of image pick-up means, crush predicting means and safety drive ensuring means actuated by the crush predicting means. The image pick-up means is mounted on the vehicle for picking up images of actual views in a direction of running of the vehicle while running of the vehicle.

The crush predicting means is connected to the image pick-up means and includes a neural network. The neural network contains previously taken image data formed of continuous scenes to become accidents and is in advance trained for realizing conditions of causing the accidents. The neural network has an input layer successively receiving actual image data obtained from the image pick-up means.

The neural network watches the actual image data obtained from the image pick-up means while running of the vehicle with reference to the previously taken image data to become the accident, and judges if the vehicle collides with an object noticed in the actual image data of the image pick-up means. In

case the neural network predicts a crush with the object, the network output an operational signal.

The safety drive ensuring means is connected to the crash predicting means, and in response to the operational signal, output a signal for evading the collision between the vehicle and the object and for protecting an occupant of the vehicle.

In the training of the neural network, the input layer receives the previously taken image data formed of successive scenes to become the accidents and receives a binary signal indicating that the accidents occurred in the successive scenes. During the driving, the neural network determines if the actual image data obtained from the image pick-up means belongs to the previously taken image data of the accidents.

Adachi et al. relates to a vehicle control system, which includes a laser radar apparatus 30 to detect a distance relative to a front car, a speed sensor 32 for the front car, and danger index calculating means 34 which receives data from the laser radar apparatus 30 and the speed sensor 32 and is operated under fuzzy induction. The data from the apparatus 30 and the sensor 32 are classified as index information into a table and formula to judge a possibility of a crush. The index information is prepared by the fuzzy induction, which is determined by an operator. The car is controlled by the calculating means 34.

In the present invention, the system includes the neural network, which was trained to judge possibility of accidents based on various image data inputted before. When the vehicle is in driving, the actual image data are supplied to the neural network, and watched with reference to the trained data. Based on the previously obtained image data, the neural network judges the possibility of accident. In the invention, the actual image

data are not compared with all the trained data one by one. The neural network trained before judges the possibility of an accident.

In Adachi et al., fuzzy induction is used to judge the prediction of an accident, but all the data are supplied to the calculating means and compared with the previous data. In the present invention, the neural network was trained before to judge occurrence of an accident, and the actual image data are used to judge the prediction of the accident by the neural network. However, in Adachi et al., the data of distance and the speed of the front car are obtained and are judged based on the fuzzy induction. Adachi et al. does not use the image obtained from the image pick-up means as disclosed in the present invention.

Thus, Adachi et al. does not disclose or even suggest the system of the present invention.

Yuhara et al. relates to a method of controlling of a motor vehicle by a neural network, wherein a present value of a throttle valve opening and a rate of change of the present value of the throttle valve opening are supplied and trained in the neural network. The neural network is controlled to learn the present value of the throttle valve opening when the rate of change of the present value of the throttle valve opening becomes zero so that a predicted value of the throttle valve opening approaches the actual valve of the throttle valve opening at the time the rate of change thereof becomes zero.

In the present invention, the neural network receives the previously taken image data for causing accidents and the signal of accidents to learn the image data of the accident. While the vehicle is running, actual image data are supplied to the neural

network and are watched by the previously taken accident data in the neural network to predict an accident.

In Yuhara et al., the neural network is used for controlling the vehicle, but the neural network controls the throttle valve to predict the next movement of the throttle valve. In the invention, the neural network is used to learn the image data of the previously taken accidents, and watches the actual data with reference to the learned accident data to predict an accident. In case of a prediction of the crush, the safety drive ensuring means is actuated by the neural network. The features of the present invention is not disclosed or even suggested in Yuhara et al.

Taylor relates to a collision avoidance system including an electro-optical rangefinder scanner, retroreflectors on target vehicles and a processing unit. The system senses data of speed, position, acceleration and so on of the target vehicle and issues a warning signal if a predicted value is below a minimum value.

The subject of Taylor is the same as that of the present invention. However, Taylor does not use the image data nor the neural network to predict the collision, as in the present invention. Thus, Taylor does not disclose or suggest the present invention.

As explained above, the cited references do not disclose or even suggest the features of the present invention. Especially, the cited references do not disclose or suggest the use of the image data to predict an accident, particularly the combination of the image data and the neural network. Thus, even if the cited references are combined, the present invention is not obvious from the cited references.

Reconsideration and allowance are earnestly solicited.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by _____
Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

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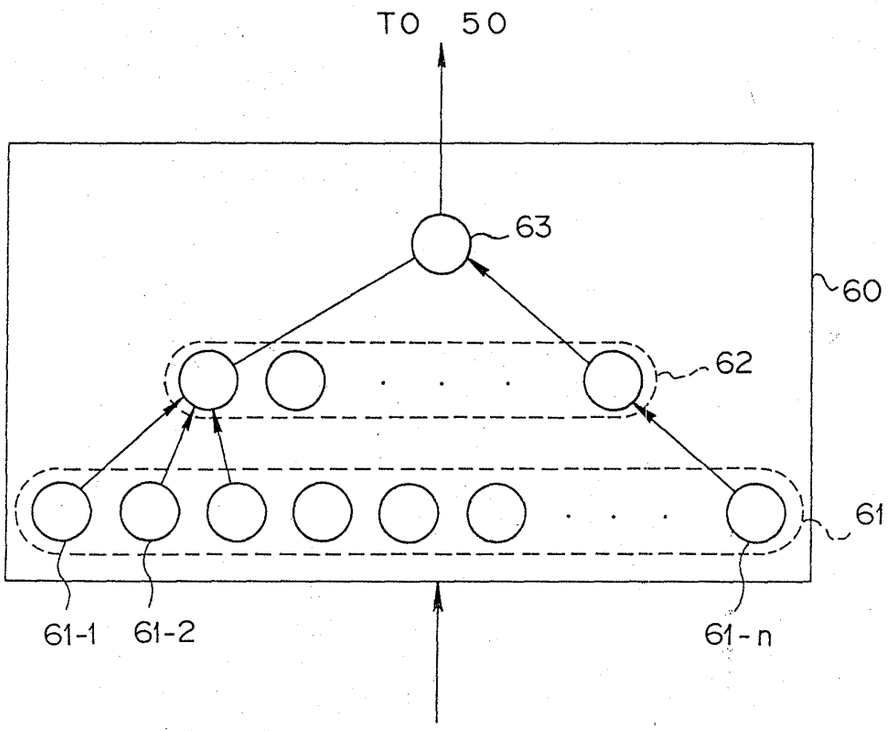
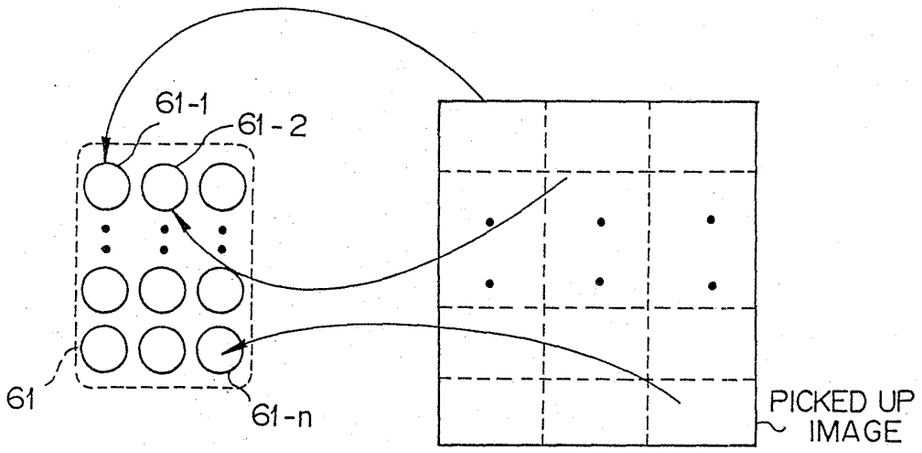
Ser. 07/7,178
#4



~~(a)~~ Fig. 5 (a)

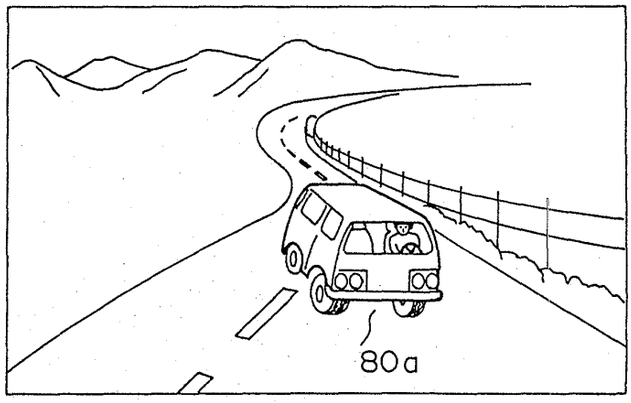


~~(b)~~ Fig. 5 (b)

~~FIG. 5~~

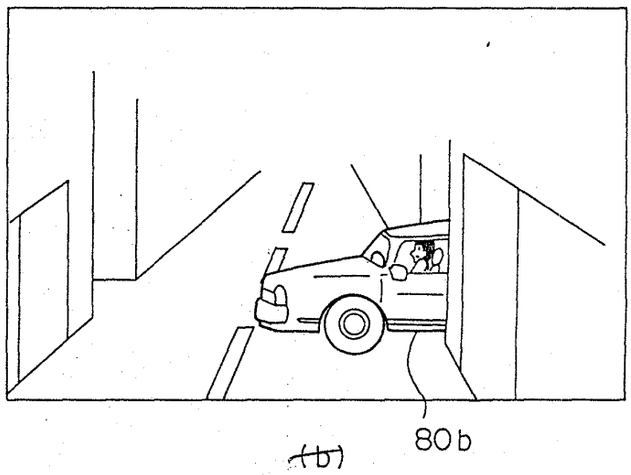
Approved
BAS 7/2-94

Sh. 6



~~(a)~~

Fig. 6(a)



~~(b)~~

Fig. 6(b)

~~FIG. 6~~

Sig Hahn
Roddy
Appl

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/097,178	07/27/93	NISHIO T	K1398

EXAMINER
SWARTHOUT, B

26M1/0726

KANESAKA AND TAKEUCHI
727 TWENTY-THIRD STREET SOUTH
ARLINGTON, VA 22202

ART UNIT	PAPER NUMBER
2617	5

DATE MAILED: 07/26/94

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS

☑ This application has been examined ☑ Responsive to communication filed on 5-16-94 ☑ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), 0 days from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133.

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☑ Notice of References Cited by Examiner, PTO-892.
2. ☐ Notice re Patent Drawing, PTO-948.
3. ☐ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of informal Patent Application, Form PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474.
6. ☐ _____

Part II SUMMARY OF ACTION

1. ☑ Claims 8-11 are pending in the application.
   Of the above, claims _____ are withdrawn from consideration.
2. ☑ Claims 1-7 have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☑ Claims 8-11 are rejected.
5. ☐ Claims _____ are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☑ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable. ☐ not acceptable (see explanation or Notice re Patent Drawing, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____ has (have) been ☐ approved by the examiner. ☐ disapproved by the examiner (see explanation).
11. ☑ The proposed drawing correction, filed on 5-16-94, has been ☑ approved. ☐ disapproved (see explanation).
12. ☑ Acknowledgment is made of the claim for priority under U.S.C. 119. The certified copy has ☐ been received ☑ not been received ☐ been filed in parent application, serial no. _____; filed on _____.
13. ☐ Since this application appears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

EXAMINER'S ACTION

PTOL-326 (Rev. 9-89)

1. This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

2. The following is a quotation of the first paragraph of 35 U.S.C. § 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification is objected to under 35 U.S.C. § 112, first paragraph, as failing to provide an enabling disclosure.

In claim 8 it is unclear how a network is trained for realizing conditions; it is unclear what "an input layer" is; it is unclear how a network watches the actual image data; it is unclear how vehicle collision with an object is judged; and it is unclear how a signal evades a crush and protects occupants.

In claim 9 it is unclear what "a laminated structure" or "an output layer" are.

In claim 10 it is unclear how a network is trained; and it is unclear how a network determines if data belongs to a previous image.

In claim 11 it is unclear how a network is programmed to predict crush.

3. Claims 8-11 are rejected under 35 U.S.C. § 112, first paragraph, for the reasons set forth in the objection to the specification.

4. Claims 8-11 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claims 8, 9 and 11 it is unclear what "crush" is.

In claim 8 "scenes to become accidents" and "data to become the accidents" is unclear.

In claim 9 it is unclear how data is received in "one-dimensional form".

In claim 10 "scenes to become the accidents" is unclear.

In claim 11 "the trained data" has no antecedent basis.

In claim 8 "said crash predicting means" has no antecedent basis.

5. The disclosure is objected to because of the following informalities: in claim 9 "instantaneous receiving" is not grammatically correct; and in claim 11 "programmed" is misspelled. Appropriate correction is required.

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Nabet, Schweizer, Gioutsos and Takahashi disclose neural network systems.

7. Applicant's amendment necessitated the new grounds of rejection. Accordingly, **THIS ACTION IS MADE FINAL.** See M.P.E.P. § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 C.F.R. § 1.136(a).

A SHORTENED STATUTORY PERIOD FOR RESPONSE TO THIS FINAL ACTION IS SET TO EXPIRE THREE MONTHS FROM THE DATE OF THIS ACTION. IN THE EVENT A FIRST RESPONSE IS FILED WITHIN TWO MONTHS OF THE MAILING DATE OF THIS FINAL ACTION AND THE ADVISORY ACTION IS NOT MAILED UNTIL AFTER THE END OF THE THREE-MONTH SHORTENED STATUTORY PERIOD, THEN THE SHORTENED STATUTORY PERIOD WILL EXPIRE ON THE DATE THE ADVISORY ACTION IS MAILED, AND ANY EXTENSION FEE PURSUANT TO 37 C.F.R. § 1.136(a) WILL BE CALCULATED FROM THE MAILING DATE OF THE ADVISORY ACTION. IN NO EVENT WILL THE STATUTORY PERIOD FOR RESPONSE EXPIRE LATER THAN SIX MONTHS FROM THE DATE OF THIS FINAL ACTION.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brent Swarthout whose telephone number is (703) 305-4383.

Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 305-4750.

Brent Swarthout/skf

July 22, 1994

Brent A. Swarthout

BRENT SWARTHOUT
PATENT EXAMINER
GROUP 2600

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP–APART AND DISCARD CARBON

FORM PTO-892 (REV. 2-92)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	SERIAL NO.	GROUP ART UNIT	ATTACHMENT TO PAPER NUMBER	
NOTICE OF REFERENCES CITED		097,178	2617		5
		APPLICANT(S) Nishio			

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUB-CLASS	FILING DATE IF APPROPRIATE
	A	5285523	2-94	Takahashi	364	424.01	9-24-91
	B	5282134	1-94	Gioutsos et al.	364	424.01	8-19-91
	C	5214744	5-93	Schweizer et al.	364	807	12-14-90
	D	5130563	7-92	Nabet et al.	364	807	
	E						
	F						
	G						
	H						
	I						
	J						
	K						

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB-CLASS	PERTINENT SHTS. DWG	PERTINENT PP. SPEC.
	L								
	M								
	N								
	O								
	P								
	Q								

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

	R	
	S	
	T	
	U	

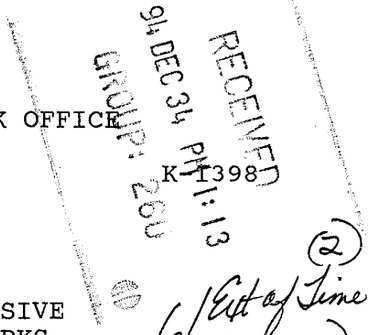
EXAMINER	DATE
Brent A. Swarthout	7-19-94

* A copy of this reference is not being furnished with this office action.
(See Manual of Patent Examining Procedure, section 707.05 (a).)

#370.00-116-Rg2617

AF

Corres. and Mail
BOX AF



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-I398

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 097,178

Filed : July 27, 1993

Group Art Unit : 2617

Examiner : Brent Swarthout

(2) 6/Ext of Time B (NE) A. Brunsfeld 1/3/95 Jeeok

2602 11-5

1/3/95 1m

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

December 22, 1994

AMENDMENT AFTER FINAL ACTION

Sir:

In response to the final Action of July 26, 1994, please amend the application, as follows:

Do Not Enter BAS 1-4-95

IN THE CLAIMS

Please amend claims 8-11, as follows:

8.(amended) A system for predicting and evading crash of a vehicle comprising:

image pick-up means mounted on the vehicle for picking up images of actual views in a direction of running of the vehicle while running of the vehicle,

[crush] crash predicting means having a neural network, said neural network containing previously taken image data formed of successive scenes [to become] for causing accidents and being

trained by a back propagation method for realizing conditions of causing said accidents, said neural network having an input layer formed of processing elements arranged parallel to each other, said input layer continuously receiving actual image data obtained from the image pick-up means, said neural network [watching] receiving the actual image data obtained from the image pick-up means while running of the vehicle, evaluating the actual image data by itself trained by [with reference to] said previously taken image data for causing [to become] the accidents, judging if the vehicle collides with an object noticed in the actual image data of the image pick-up means, and outputting an operational signal in case of prediction of occurrence of a [crush] crash with said object, and

safety drive ensuring means connected to said crash predicting means, said safety drive ensuring means, in response to the operational signal, [outputting a signal for evading] operating to evade the [crush] crash between the vehicle and the object [and] for protecting an occupant of the vehicle.

9.(amended) A system as claimed in claim 8, wherein said neural network [has a laminated structure having said input layer and] further includes an output layer formed of a single processing element and connected to the processing elements of the input layer in series, said input layer [instantaneous] instantaneously receiving said actual image data [as one-dimensional form] from the image pick-up means [having two dimensional data], and said output layer outputting a binary signal for indicating if said [crush] crash occurs in response to the actual image data inputted to the input layer.

10.(amended) A system as claimed in claim 9, wherein in a training of the neural network by the back propagation method, said input layer receives the previously taken image data formed of successive scenes [to become] for causing the accidents and receives said binary signal from said output layer indicating that the accidents occurred in said successive scenes, said neural network, [so that] during the driving of the vehicle after the training, evaluating[, the neural network determines if] said actual image data obtained from the image pick-up means [belong to the previously taken image data of the accidents].

11.(amended) A system as claimed in claim 10, wherein said neural network containing [the] trained data [is programed and] is memorized in a ROM for constituting the [crush] crash predicting means, said ROM being included in a circuit for the safety drive ensuring means.

REMARKS

This is a response to the final Action of July 26, 1994.

In paragraph 2 of the final Action, the specification was objected to under 35 USC 112, first paragraph, wherein explanations or recitations of the claims were referred to and deemed to be unclear. In view of the portions of the claims pointed out by the Examiner, claims have been amended.

In particular, the neural network is trained by a back propagation method as explained from page 10, line 13 to page 12, line 6 of the specification. The input layer is formed of processing elements as explained on page 13, lines 6-28.

In the neural network, the network is at first trained by

images causing the accidents to understand by itself the pattern of the accidents or changes of the images, i.e. views. The pattern of the accident is memorized in the neural network. In use, while the car is driving, the actual image is continuously supplied to the trained neural network, wherein the neural network evaluates and judges the actual image based on the training if the image supplied to the neural network causes an accident. If the network judges that the actual image causes an accident, an operation signal is outputted from the neural network, so that safety drive ensuring means, such as a steering actuator, throttle actuator or brake actuator, is actuated to avoid or minimize the accident.

In paragraph 3 of the final Action, claims 8-11 were rejected under 35 USC 112 for the reasons set forth in the objection to the specification. As explained above, claims 8-11 have been amended to obviate the rejection.

In paragraph 4 of the final Action, claims 8-11 were rejected under 35 USC 112, second paragraph. In paragraph 5 of the Action, the disclosure was objected to. In view of the rejection and the objection, claims 8-11 have been amended.

As explained above, claims 8-11 have been amended to obviate the rejections and the objection. It is believed that claims 8-11 are clear and are patentable over the prior art of record. However, if it is required to further amend the claims, please contact the undersigned agent. The agent is willing to amend the claims as required.

Reconsideration and allowance are earnestly solicited.

A two month extension of time is hereby requested. A check in the amount of $370.00 is attached herewith for the two month extension of time.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by _____
Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

727 Twenty-Third Street South
Arlington, Virginia 22202
(703) 521-3810

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
08/357,178	07/07/93	NISHIO	T K1356

E6M1/0105

KANESAKA AND TAKEUCHI
727 TWENTY-THIRD STREET SOUTH
ARLINGTON, VA 22202

EXAMINER	
SWARTHOUT, B	
ART UNIT	PAPER NUMBER
2617	7

DATE MAILED: 01/05/95

Below is a communication from the EXAMINER in charge of this application

COMMISSIONER OF PATENTS AND TRADEMARKS

ADVISORY ACTION

☑ THE PERIOD FOR RESPONSE:

a) ☑ is extended to run 5 mos or continues to run _____ from the date of the final rejection

b) ☐ expires three months from the date of the final rejection or as of the mailing date of this Advisory Action, whichever is later. In no event however, will the statutory period for the response expire later than six months from the date of the final rejection.

Any extension of time must be obtained by filing a petition under 37 CFR 1.136(a), the proposed response and the appropriate fee. The date on which the response, the petition , and the fee have been filed is the date of the response and also the date for the purposes of determining the period of extension and the corresponding amount of the fee. Any extension fee pursuant to 37 CFR 1.17 will be calculated from the date of the originally set shortened statutory period for response or as set forth in b) above.

☐ Appellant's Brief is due in accordance with 37 CFR 1.192(a).

☑ Applicant's response to the final rejection, filed 12-22-94 has been considered with the following effect, but it is not deemed to place the application in condition for allowance:

1. ☑ The proposed amendments to the claim and /or specification will not be entered and the final rejection stands because:

   a. ☐ There is no convincing showing under 37 CFR 1.116(b) why the proposed amendment is necessary and was not earlier presented.

   b. ☑ They raise new issues that would require further consideration and/or search. (See Note).

   c. ☐ They raise the issue of new matter. (See Note).

   d. ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal.

   e. ☐ They present additional claims without cancelling a corresponding number of finally rejected claims.

   NOTE: Additional limitations to claims 8-10 and change to claim 11 would require further consideration.

2. ☐ Newly proposed or amended claims _____ would be allowed if submitted in a separately filed amendment cancelling the non-allowable claims.

3. ☑ Upon the filing an appeal, the proposed amendment ☐ will be entered ☑ will not be entered and the status of the claims will be as follows:

   Claims allowed: _____
   Claims objected to: _____
   Claims rejected: 8-11

   However;

   ☐ Applicant's response has overcome the following rejection(s): _____

4. ☐ The affidavit, exhibit or request for reconsideration has been considered but does not overcome the rejection because _____

5. ☐ The affidavit or exhibit will not be considered because applicant has not shown good and sufficent reasons why it was not earlier presented.

☐ The proposed drawing correction ☐ has ☐ has not been approved by the examiner.

☐ Other

Brent Swarthout

BRENT SWARTHOUT
PATENT EXAMINER
GROUP 2600

703-305-4383

PTOL-303 (REV. 5-89)

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address : COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT		ATTORNEY DOCKET NO.
08/097,178	07/27/93	NISHIO	T	K1398

E6M1/0310

KANESAKA AND TAKEUCHI
727 TWENTY-THIRD STREET SOUTH
ARLINGTON, VA 22202

EXAMINER	
SWARTHOUT	
ART UNIT	PAPER NUMBER
2617	8

DATE MAILED: 03/10/95

NOTICE OF ABANDONMENT

This application is abandoned in view of:

1. ☒ Applicant's failure to respond to the Office letter, mailed 7-26-94.
2. ☐ Applicant's letter of express abandonment which is in compliance with 37 C.F.R. 1.138.
3. ☐ Applicant's failure to timely file the response received _____ within the period set in the Office letter.
4. ☐ Applicant's failure to pay the required issue fee within the statutory period of 3 months from the mailing date of _____ of the Notice of Allowance.
   - ☐ The issue fee was received on _____.
   - ☐ The issue fee has not been received in Allowed Files Branch as of _____.

   In accordance with 35 U.S.C. 151, and under the provisions of 37 C.F.R. 1.316(b), applicant(s) may petition the Commissioner to accept the delayed payment of the issue fee if the delay in payment was unavoidable. The petition must be accompanied by the issue fee, unless it has been previously submitted, in the amount specified by 37 C.F.R. 1.17 (l), and a verified showing as to the causes of the delay.

   If applicant(s) never received the Notice of Allowance, a petition for a new Notice of Allowance and withdrawal of the holding of abandonment may be appropriate in view of Delgar Inc. v. Schuyler, 172 U.S.P.Q. 513.
5. ☐ Applicant's failure to timely correct the drawings and/or submit new or substitute formal drawings by _____ as required in the last Office action.
   - ☐ The corrected and/or substitute drawings were received on _____.
6. ☐ The reason(s) below.

Brent Swarthout

BRENT SWARTHOUT
PATENT EXAMINER
GROUP 2600

703-305-4383

PTO-1432 (REV. 5-83)

3000-117

9/Ext of time

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1398

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 08/097,178

Filed : July 27, 1993

Group Art Unit : 2617

Examiner : Brent Swarthout

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

March 20, 1995

9200

EXTENSION OF TIME

Sir:

In the above application, a File Wrapper Continuation application was filed on January 19, 1995, and serial number was assigned as 08/375,249. At the time of the application, a third month extension of time was requested and the extension fee of $500.00 was payed (two month extension with the fee of $370.00 was filed on December 22, 1994). A copy of the request for the extension of time in the File Wrapper Continuation application is attached herewith.

However, $500.00 was returned with the notice attached herewith. It is thought that the third month extension is required for the File Wrapper Continuation. Therefore, a check in the amount of $500.00 is paid again.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by 

Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

727 Twenty-Third Street South
Arlington, Virginia 22202
(703) 521-3810

NOTICE TO CHECK RECIPIENT — TREASURY-FINANCIAL MANAGEMENT SERVICE — TFS FORM 3039 (Rev.)

VENDOR NAME: MANABU KANESAKA

VENDOR I.D. NUMBER: MISC 0

AGENCY NAME AND BILLING ADDRESS:
PATENT & TRADEMARK OFFICE
2011 CRYSTAL DRIVE
CRYSTAL PARK 1, SUITE 802
ARLINGTON VA 22202

U.S. TREASURY REG. FINANCIAL CENTER: PHILADELPHIA, PA

CHECK NUMBER	CHECK AMOUNT	CHECK DATE
2038-03838137	$****500*00	03-14-95

NON NEGOTIABLE

AGENCY SCHEDULE NUMBER: M000000108

AGENCY TELEPHONE NUMBER: 703-305-8083

PAYMENT IDENTIFICATION DATA

DATE DEPOSITED 01/19/95
FOR SERIAL NUMBER 08375249
DOC.NUMBER/ MARK
AMT REFUNDED $500.00
REMARKS ABANDONED FILING FEE $130.00
FFS INDENTIFICATION MAR95-00075
ANY QUESTION CONTACT FRANK LEBRON 703 305-4229
03/03/95

PLEASE DIRECT ANY INQUIRIES CONCERNING THIS PAYMENT TO THE AGENCY AT THE ADDRESS (OR TELEPHONE NUMBER) INDICATED ABOVE.

United States Treasury 15-51 000 M 071,268,394

Check No.

03 14 95 05 PHILADELPHIA, PA 2038 03838137

MISC 0 M2 PTO M000000108 13100001

Pay to the order of

MANABU KANESAKA
C/O KANESAKA AND TAKEUCHI
727 23RD STREET SOUTH
ARLINGTON VA 22202

$****500*00

VOID AFTER ONE YEAR

006
REGIONAL DISBURSING OFFICER

PER ENCLOSED MAILING NOTICE

⑈20383⑈ ⑆000000518⑆ 038381376⑈ 010395

1230-101

Request Form for File Upper Continuing Application under 37 CFR 1.62

08/375249

DOCKET NUMBER	ANTICIPATED CLASSIFICATION OF THIS APPLICATION: CLASS	SUBCLASS	PRIOR APPLICATION: EXAMINER	ART UNIT
K-1518			Brent Swarthout	2617

10/C

Address to:

Commissioner of Patents and Trademarks
Box FWC
Washington, D.C. 20231

This is a Request for filing a ☐ continuation-in-part ☒ continuation ☐ divisional application under 37 CFR 1.62 of prior application Serial No. 08/097,178, filed on 07/27/1993 entitled

VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

by the following named inventor(s).

FULL NAME OF INVENTOR	FAMILY NAME: Nishio	FIRST GIVEN NAME: Tomoyuki	SECOND GIVEN NAME:
RESIDENCE & CITIZENSHIP	CITY: Kawasaki	STATE OR FOREIGN COUNTRY: Japan JPX	COUNTRY OF CITIZENSHIP: Japanese
POST OFFICE ADDRESS	POST OFFICE ADDRESS: 663-28, Ozenji, Asou-ku	CITY: Kawasaki-shi	STATE & ZIP CODE/COUNTRY: Kanagawa-ken, Japan
FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

The above identified prior application in which no payment of the issue fee, abandonment of ,or termination of proceedings has occurred, is hereby expressly abandoned as of the filing date of this new application. Please use all the contents of the prior application file wrapper, including the drawings, as the basic papers for the new application. (note: 37 CFR 1.60 may be used for applications where the prior application is not to be abandoned.)

1. ☒ Enter the amendment previously filed on December 22, 1994 under 37 CFR 1.116 but unentered, in the prior application .

2. ☐ A preliminary amendment is enclosed.

The filing fee is calculated on the basis of the claims existing in the prior application as amended at 1 and 2 above.

CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS	4 -20=		×$	$
	INDEPENDENT CLAIMS	1 -3=		×$	
	MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+$	
			BASIC FEE		+ $730.00
			Total of above Calculations =		
	Reduction by ½ for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28). If applicable, verified statement must be attached.				-
			TOTAL =		$730.00

(page 1 of 2)

ATTORNEYS DOCKET NUMBER
K-1518

3. ☐ The Commisioner is hereby authorized to charge fees under 37 CFR 1.16 and 1.17 which may be required, or credit any overpayment to Deposit Account No. _____.

4. ☐ A check in the amount of $ _____ is enclosed.

5. ☐ A new oath or declaration is included since this application is a continuation-in-part which discloses and claims additional matter.

6. ☒ Amend the specification by inserting ~~before~~ after the ~~third~~ line the sentence:

This application is a ☐ continuation-in-part, ☒ continuation, ☐ division, of application Serial No. 08/097,178, filed 07/27/1993 now abandoned.

7. ☐ A verified statement claiming small entity status is enclosed.

8. ☒ Priority of application Serial No. 229201/92 filed on 08/04/1992 in Japan is claimed under 35 U.S.C. 119.

9. ☒ The prior application is assigned of record to Takata Corporation.

10. ☒ The power of attorney in the prior application is to: Manabu Kanesaka Reg. No. 31,467, Yusuke Takeuchi Reg. No. 30,921

11. ☒ Third month extension of time is requested for Patent Application Serial No. 08/097,178 filed on July 27, 1993. The extension fee ($500.00) is added to the filing fee ($730.00) and a check in the amount of $1,230.00 is enclosed.

Address all future communications to : (May only be completed by applicant, or attorney or agent of record)

Manabu Kanesaka c/o Kanesaka and Takeuchi
727 Twenty-Third Street South
Arlington, Virginia 22202

It is understood that secrecy under 35 U.S.C. 122 is hereby waived to the extent that if information or access is available to any one of the applications in the file wrapper of a 37 CFR 1.62 application, be it either this application or a prior application in the same file wrapper, the Patent and Trademark Office may provide similar information or access to all the other applications in the same file wrapper.

1/19/95
Date

Manabu Kanesaka
Signature

727 Twenty-Third Street South
Arlingto, Virginia 22202
(703) 521-3810

☐ Inventor(s) ☒ attorney or agent of record
☐ assignee of complete interest ☐ filed under § 1.34(a)

(page 2 of 2)

#370.00-116-K1398
AF

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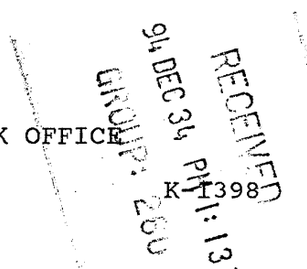


IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1398

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 097,178

Filed : July 27, 1993

Group Art Unit : 2617

Examiner : Brent Swarthout

2602
11-5

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

December 22, 1994

AMENDMENT AFTER FINAL ACTION

Sir:

In response to the final Action of July 26, 1994, please amend the application, as follows:

IN THE CLAIMS

Please amend claims 8-11, as follows:

~~8.(amended) A system for predicting and evading crash of a~~ vehicle comprising:

image pick-up means mounted on the vehicle for picking up images of actual views in a direction of running of the vehicle while running of the vehicle,

[crush] crash predicting means having a neural network, said neural network containing previously taken image data formed of ~~successive~~ scenes ~~[to become]~~ for causing accidents and ~~being~~

090 BA 12/29/94 08097178 1 116 370.00 CK

~~trained by a back propagation method for realizing conditions~~ of causing said accidents, said neural network having an input layer formed of processing elements arranged parallel to each other, said input layer continuously receiving actual image data obtained from the image pick-up means, said neural network [watching] receiving the actual image data obtained from the image pick-up means while running of the vehicle, evaluating the actual image data by itself trained by [with reference to] said previously taken image data for causing [to become] the accidents, judging if the vehicle collides with an object noticed in the actual image data of the image pick-up means, and outputting an operational signal in case of prediction of occurrence of a [crush] crash with said object, and

safety drive ensuring means connected to said crash predicting means, said safety drive ensuring means, in response to the operational signal, [outputting a signal for evading] operating to evade the [crush] crash between the vehicle and the object [and] for protecting an occupant of the vehicle.

9.(amended) A system as claimed in claim 8, wherein said neural network [has a laminated structure having said input layer and] further includes an output layer formed of a single processing element and connected to the processing elements of the input layer in series, said input layer [instantaneous] instantaneously receiving said actual image data [as one-dimensional form] from the image pick-up means [having two dimensional data], and said output layer outputting a binary signal for indicating if said [crush] crash occurs in response to the actual image data ~~inputted to the input layer.~~

~~10.(amended) A system as claimed in claim 9, wherein in a~~ training of the neural network by the back propagation method, said input layer receives the previously taken image data formed of successive scenes [to become] for causing the accidents and receives said binary signal from said output layer indicating that the accidents occurred in said successive scenes, said neural network, [so that] during the driving of the vehicle after the training, evaluating[, the neural network determines if] said actual image data obtained from the image pick-up means ~~[belong to the previously taken image data of the accidents].~~

~~11~~.(amended) A system as claimed in claim ~~10~~, wherein said neural network containing [the] trained data [is programed and] is memorized in a ROM for constituting the [crush] crash predicting means, said ROM being included in a circuit for the safety drive ensuring means.

REMARKS

This is a response to the final Action of July 26, 1994.

In paragraph 2 of the final Action, the specification was objected to under 35 USC 112, first paragraph, wherein explanations or recitations of the claims were referred to and deemed to be unclear. In view of the portions of the claims pointed out by the Examiner, claims have been amended.

In particular, the neural network is trained by a back propagation method as explained from page 10, line 13 to page 12, line 6 of the specification. The input layer is formed of processing elements as explained on page 13, lines 6-28.

In the neural network, the network is at first trained by

images causing the accidents to understand by itself the pattern of the accidents or changes of the images, i.e. views. The pattern of the accident is memorized in the neural network. In use, while the car is driving, the actual image is continuously supplied to the trained neural network, wherein the neural network evaluates and judges the actual image based on the training if the image supplied to the neural network causes an accident. If the network judges that the actual image causes an accident, an operation signal is outputted from the neural network, so that safety drive ensuring means, such as a steering actuator, throttle actuator or brake actuator, is actuated to avoid or minimize the accident.

In paragraph 3 of the final Action, claims 8-11 were rejected under 35 USC 112 for the reasons set forth in the objection to the specification. As explained above, claims 8-11 have been amended to obviate the rejection.

In paragraph 4 of the final Action, claims 8-11 were rejected under 35 USC 112, second paragraph. In paragraph 5 of the Action, the disclosure was objected to. In view of the rejection and the objection, claims 8-11 have been amended.

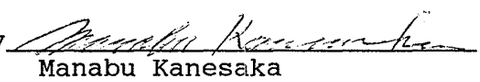
As explained above, claims 8-11 have been amended to obviate the rejections and the objection. It is believed that claims 8-11 are clear and are patentable over the prior art of record. However, if it is required to further amend the claims, please contact the undersigned agent. The agent is willing to amend the claims as required.

Reconsideration and allowance are earnestly solicited.

A two month extension of time is hereby requested. A check in the amount of $370.00 is attached herewith for the two month extension of time.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by 

Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

727 Twenty-Third Street South
Arlington, Virginia 22202
(703) 521-3810

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/375,240	01/19/95	NISHIO	T K-1518

EXAMINER	
SWARTHOUT, B	
ART UNIT	**PAPER NUMBER**
2617	12

E6M1/0628

MANABU KANESAKA
KANESAKA AND TAKEUCHI
727 23RD STREET SOUTH
ARLINGTON VA 22202

DATE MAILED: 06/28/95

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS

☑ This application has been examined ☑ Responsive to communication filed on 1-19-95 ☐ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), 0 days from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☑ Notice of References Cited by Examiner, PTO-892.
2. ☐ Notice of Draftsman's Patent Drawing Review, PTO-948.
3. ☐ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of Informal Patent Application, PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474.
6. ☐ _____.

Part II SUMMARY OF ACTION

1. ☑ Claims 8-11 are pending in the application.
   Of the above, claims _____ are withdrawn from consideration.
2. ☑ Claims 1-7 have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☐ Claims _____ are rejected.
5. ☐ Claims _____ are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☑ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable; ☐ not acceptable (see explanation or Notice of Draftsman's Patent Drawing Review, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____. has (have) been ☐ approved by the examiner; ☐ disapproved by the examiner (see explanation).
11. ☑ The proposed drawing correction, filed 5-16-94, has been ☑ approved; ☐ disapproved (see explanation).
12. ☑ Acknowledgement is made of the claim for priority under 35 U.S.C. 119. The certified copy has ☐ been received ☑ not been received ☐ been filed in parent application, serial no. _____; filed on _____.
13. ☐ Since this application apppears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

EXAMINER'S ACTION

PTOL-326 (Rev. 2/93)

1. This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

2. Claims 8-11 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 8, lines 9-10 "realizing conditions of causing" is indefinite, but "recognizing conditions in image data which cause" would have been more proper;

on line 16 "data by itself trained by" is indefinite, but "data by comparing it to" would have been more proper;

on line 18 "judging if the vehicle collides" is indefinite, since the device only judges if a crash is predicted, but -- judging if the vehicle is predicted to crash based on the comparison of said previous taken image data" would have been more proper.

In claim 9, line 9 "crash occurs" is indefinite but "crash is predicted to occur" would have been more proper.

In claim 10, lines 8-9 "evaluating said actual image data obtained from the image pick-up means" is indefinite as to what it is being evaluated for, but "evaluating said actual image data obtained from the image pick-up means to determine if it corresponds to said previously taken image data for causing accidents" would have been more proper.

3. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Pearson and Nishio disclose neural network systems.

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brent Swarthout whose telephone number is (703) 305-4383. The examiner can normally be reached on M-F from 6:30 a.m. to 4:00 p.m. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Peng, can be reached on (703) 305-4392. The fax phone number for this Group is (703) 305-9508.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 305-8576.

Brent Swarthout

BRENT A. SWARTHOUT
PRIMARY EXAMINER
GROUP 2600

Swarthout/mh
June 14, 1995

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP–APART AND DISCARD CARBON

FORM PTO-892 (REV. 2-92)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	SERIAL NO. 375,249 ~~08/477,178~~	GROUP ART UNIT 2617	ATTACHMENT TO PAPER NUMBER 12
NOTICE OF REFERENCES CITED		APPLICANT(S) Nishio		

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUB-CLASS	FILING DATE IF APPROPRIATE
	A	5161014	11-92	Pearson et al.	395	11	
	B	5377108	12-94	Nishio	364	424.05	
	C						
	D						
	E						
	F						
	G						
	H						
	I						
	J						
	K						

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB-CLASS	PERTINENT SHTS. DWG	PERTINENT PP. SPEC.
	L								
	M								
	N								
	O								
	P								
	Q								

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

	R	
	S	
	T	
	U	

EXAMINER	DATE
B. Swarthout	6-13-95

* A copy of this reference is not being furnished with this office action.
(See Manual of Patent Examining Procedure, section 707.05 (a).)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1518

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 08/375,249

Filed : January 19, 1995

Group Art Unit : 2617

Examiner : Brent A. Swarthout

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

July 5, 1995

AMENDMENT

Sir:

In response to the Office Action of June 28, 1995, please amend the application as follows:

IN THE CLAIMS

Please amend claims 8-10 as follows:

18. (twice amended) A system for predicting and evading crash of a vehicle comprising:

image pick-up means mounted on the vehicle for picking up images of actual views in a direction of running of the vehicle while running of the vehicle,

crash predicting means having a neural network, said neural network containing previously taken image data formed of successive scenes for causing accidents and being trained by a back propagation method for [realizing conditions of causing] recognizing conditions in image data which cause said accidents,

said neural network having an input layer formed of processing elements arranged parallel to each other, said input layer continuously receiving actual image data obtained from the image pick-up means, said neural network receiving the actual image data obtained from the image pick-up means while running of the vehicle, evaluating the actual image data by [itself trained by] comparing it to said previously taken image data for causing the accidents, judging if the vehicle [collides] is predicted to crash based on the comparison of said previously taken image data with an object noticed in the actual image data of the image pick-up means, and outputting an operational signal in case of prediction of occurrence of a crash with said object, and

safety drive ensuring means connected to said crash predicting means, said safety drive ensuring means, in response to the operational signal, operating to evade the crash between the vehicle and the object for protecting an occupant of the vehicle.

2~~9~~. (twice amended) A system as claimed in claim 1~~8~~, wherein said neural network further includes an output layer formed of a single processing element and connected to the processing elements of the input layer in series, said input layer instantaneously receiving said actual image data from the image pick-up means, and said output layer outputting a binary signal for indicating if said crash [occurs] is predicted to occur in response to the actual image data inputted to the input layer.

3~~10~~. (twice amended) A system as claimed in claim 2~~9~~, wherein in a training of the neural network by the back propagation method, said input layer receives the previously taken image data formed of successive scenes for causing the accidents and receives said binary signal from said output layer indicating that the accidents occurred in said successive scenes, said neural network, during the

driving of the vehicle after the training, evaluating said actual image data obtained from the image pick-up means to determine if it corresponds to said previously taken image data for causing accidents.

REMARKS

This is a response to the Office Action of June 28, 1995.

In paragraph 1 of the Action, formal drawings were required when the application is allowed. The formal drawings will be submitted as required when the application is allowed.

In paragraph 2 of the Action, claims 8-11 were rejected under 35 U.S.C. Section 112, second paragraph. In view of paragraph 2 of the Action, claims have been reviewed and amended as suggested by the Examiner. Therefore, it is believed that the rejection under 35 U.S.C. Section 112 is obviated and the application is now in condition for allowance.

Reconsideration and allowance are earnestly solicited.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by _____
Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

727 Twenty-Third Street South
Arlington, Virginia 22202
(703) 521-3810

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/375,249	01/19/95	NISHIO	T K-1518

SWARTHOUT, R EXAMINER

E6M1/0915

ART UNIT	PAPER NUMBER
2617	14

MANABU KANESAKA
KANESAKA AND TAKEUCHI
727 23RD STREET SOUTH
ARLINGTON VA 22202

DATE MAILED: 09/15/95

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS

☑ This application has been examined ☑ Responsive to communication filed on 7-5-95 ☐ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), 0 days from the date of this letter. Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☑ Notice of References Cited by Examiner, PTO-892.
2. ☐ Notice of Draftsman's Patent Drawing Review, PTO-948.
3. ☐ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of Informal Patent Application, PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474.
6. ☐ _____.

Part II SUMMARY OF ACTION

1. ☑ Claims 8-11 are pending in the application.
   Of the above, claims _____ are withdrawn from consideration.
2. ☐ Claims _____ have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☑ Claims 8-11 are rejected.
5. ☐ Claims _____ are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☑ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable; ☐ not acceptable (see explanation or Notice of Draftsman's Patent Drawing Review, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____. has (have) been ☐ approved by the examiner; ☐ disapproved by the examiner (see explanation).
11. ☑ The proposed drawing correction, filed 5-16-94, has been ☑ approved; ☐ disapproved (see explanation).
12. ☑ Acknowledgement is made of the claim for priority under 35 U.S.C. 119. The certified copy has ☐ been received ☑ not been received ☐ been filed in parent application, serial no. _____; filed on _____.
13. ☐ Since this application apppears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

EXAMINER'S ACTION

PTOL-326 (Rev. 2/93)

1. This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

2. Claims 8-11 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-6 of U.S. patent no. 5,377,108 (Nishio) in view of Kamishima and Lammen (WO 90/02985).

Nishio discloses a vehicle crash predictive system comprising vehicle data sensing means neural network crash prediction means containing prior data used for learning using a back propagation technique, the network comparing received data to prior crash data in a first layer to predict a crash except for use of crash evasion means, and image data comparing.

Kamishima teaches the concept of comparing current sensed conditions to preset accident data in order to generate an alarm to evade a crash (abstract).

Lammen teaches use in a vehicle anti-collision system of cameras to detect a scene around a vehicle in order to compare with data to predict collision using a hierarchically-structured process (pages 3, 7).

It would have been obvious to use image sensing and crash evasion means in conjunction with a neural network crash predictive system as disclosed by Nishio, in order that more comprehensive crash protection could have been provided by

indicating more types of potential crashes and by providing crash evasion warnings to prevent injuries.

With regard to claims 9 and 10, Nishio teaches a single output layer 6 connected in series to an input layer, and use of a back propagation method.

With regard to claim 11, a ROM would have been a conventional memory element in which predetermined crash data in the Nishio device could have been stored, applicant citing no criticality for use of a well known ROM versus the inherent storage means of Nishio.

3. The obviousness-type double patenting rejection is a judicially established doctrine based upon public policy and is primarily intended to prevent prolongation of the patent term by prohibiting claims in a second patent not patentably distinct from claims in a first. In re Vogel, 164 USPQ 619 (CCPA 1970). A timely filed terminal disclaimer in compliance with 37 CFR 1.321 (b) would overcome an actual or provisional rejection on this ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.78(d).

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Gayer and Brady disclose vehice monitoring systems.

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brent

Swarthout whose telephone number is (703) 305-4383. The examiner can normally be reached on M-F from 6:30 a.m. to 4:00 p.m. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Peng, can be reached on (703) 305-4392. The fax phone number for this Group is (703) 308-5397.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 305-8576.

Brent Swarthout

Swarthout/mh
Sept. 12, 1995

BRENT A. SWARTHOUT
PRIMARY EXAMINER
GROUP 2600

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP–APART AND DISCARD CARBON

FORM PTO-892 (REV. 2-92)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	SERIAL NO.	GROUP ART UNIT	ATTACHMENT TO PAPER NUMBER	
NOTICE OF REFERENCES CITED		375,249	2617		14
		APPLICANT(S)			

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUB-CLASS	FILING DATE IF APPROPRIATE
	A	5434927	7-95	Brady et al.	348	148	
	B						
	C						
	D						
	E						
	F						
	G						
	H						
	I						
	J						
	K						

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB-CLASS	PERTINENT SHTS. DWG	PERTINENT PP. SPEC.
	L	4001493	7-91	Germany	Gayer et al.	—	—		
	M	9002985	3-90	WIPO	Lammen	—	—		
	N								
	O								
	P								
	Q								

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

	R	
	S	
	T	
	U	

EXAMINER	DATE
Brent Swarthout	9-7-95

* A copy of this reference is not being furnished with this office action.
(See Manual of Patent Examining Procedure, section 707.05 (a).)

IW 148 GP 2617

PTO/SB/26 (10-94)
Approved for use through 07/31/96. OMB 0651-0031
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A PRIOR PATENT

Docket Number (Optional): K-1518

In re Application of:

Application No. 08/375,249

Filed: January 19, 1995

For: VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

C 2 12/14/95 9/18/95

The owner, Takata Corporation of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application, which would extend beyond the expiration date of the full statutory term defined in 35 U.S.C. 154 to 156 and 173, as presently shortened by any terminal disclaimer, of prior Patent No. 5,377,108 . The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 to 156 and 173 of the prior patent, as presently shortened by any terminal disclaimer, in the event that it later: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims cancelled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. [ ] For submissions on behalf of an organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. [X] The undersigned is an agent of record.

12/14/95
Date

Manabu Kanesaka
Signature

Manabu Kanesaka (REG. No.31467)
Typed or printed name

[X] Terminal disclaimer fee under 37 CFR 1.20(d) included.

[X] PTO suggested wording for terminal disclaimer was

240 AM 12/09/95 08375249
1 148 110.00 CK 5-1518

[X] unchanged. [ ] changed (if changed, an explanation should be supplied).

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1518

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 08/375,249

Filed : January 29, 1995

Group Art Unit : 2617

Examiner : Brent A. Swarthout

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

December 15, 1995

RESPONSE

Sir:

This is a response to the Office Action of September 15, 1995.

In paragraph 2 of the Action, claims 8-11 were rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-6 of U.S. Patent No. 5,377,108 in view of Kamishima and Lammen.

In view of the obviousness-type double patenting rejection, a terminal disclaimer signed by the undersigned agent has been filed, as agreed by the assignee. A check in the amount of $110.00 is attached herewith for the terminal disclaimer.

It is believed that the application is now in condition for allowance.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by _____
Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

727 Twenty-Third Street South
Arlington, Virginia 22202
(703) 521-3810

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
08/375,249	01/19/95	NISHIO T	K-1518

EXAMINER
SWARTHOUT, B

E6M1/0213

MANABU KANESAKA
KANESAKA AND TAKEUCHI
727 23RD STREET SOUTH
ARLINGTON VA 22202

ART UNIT	PAPER NUMBER
2617	16

DATE MAILED: 02/13/96

NOTICE OF ALLOWABILITY

PART I.

1. ☑ This communication is responsive to terminal disclaimer filed 12-14-95
2. ☑ All the claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice Of Allowance And Issue Fee Due or other appropriate communication will be sent in due course.
3. ☑ The allowed claims are 8-11, now 1-4.
4. ☐ The drawings filed on _____ are acceptable.
5. ☑ Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has [_] been received. [1] not been received. [_] been filed in parent application Serial No. _____, filed on _____.
6. ☐ Note the attached Examiner's Amendment.
7. ☐ Note the attached Examiner Interview Summary Record, PTOL-413.
8. ☐ Note the attached Examiner's Statement of Reasons for Allowance.
9. ☐ Note the attached NOTICE OF REFERENCES CITED, PTO-892.
10. ☐ Note the attached INFORMATION DISCLOSURE CITATION, PTO-1449.

PART II.

A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE THREE MONTHS FROM THE "DATE MAILED" indicated on this form. Failure to timely comply will result in the ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

1. ☐ Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION, PTO-152, which discloses that the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.
2. ☑ APPLICANT MUST MAKE THE DRAWING CHANGES INDICATED BELOW IN THE MANNER SET FORTH ON THE REVERSE SIDE OF THIS PAPER.
   a. ☑ Drawing informalities are indicated on the NOTICE RE PATENT DRAWINGS, PTO-948, attached hereto or to Paper No. 3. CORRECTION IS REQUIRED.
   b. ☑ The proposed drawing correction filed on 5-16-94 has been approved by the examiner. CORRECTION IS REQUIRED.
   c. ☐ Approved drawing corrections are described by the examiner in the attached EXAMINER'S AMENDMENT. CORRECTION IS REQUIRED.
   d. ☑ Formal drawings are now REQUIRED.

Any response to this letter should include in the upper right hand corner, the following information from the NOTICE OF ALLOWANCE AND ISSUE FEE DUE: ISSUE BATCH NUMBER, DATE OF THE NOTICE OF ALLOWANCE, AND SERIAL NUMBER.

Attachments:

- _ Examiner's Amendment
- _ Examiner Interview Summary Record, PTOL-413
- _ Reasons for Allowance
- _ Notice of References Cited, PTO-892
- _ Information Disclosure Citation, PTO-1449
- _ Notice of Informal Application, PTO-152
- _ Notice re Patent Drawings, PTO-948
- _ Listing of Bonded Draftsmen
- _ Other

Brent Swarthout

BRENT A. SWARTHOUT
PRIMARY EXAMINER
GROUP 2600

703-305-4383

PTOL-37 (REV. 4-89) *

USCOMM-DC 89-3789

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: Box ISSUE FEE
COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

E6M1/0213

MANABU KANESAKA
KANESAKA AND TAKEUCHI
727 23RD STREET SOUTH
ARLINGTON VA 22202

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

☐ Note attached communication from the Examiner
☐ This notice is issued in view of applicant's communication filed _____

SERIES CODE/SERIAL NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT		DATE MAILED
08/375,249	01/19/95	004	SWARTHOUT, B	2617	02/13/96

First Named Applicant: NISHIO, TOMOYUKI

TITLE OF INVENTION: VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

	ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2	K-1518	340-903.000	T67	UTILITY	NO	$1250.00	05/13/96

THE APPLICATION IDENTIFIES ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

I. Review the SMALL ENTITY Status shown above.
If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is changed, pay twice the amount of the FEE DUE shown above and notify the patent and Trademark Office of the change in status, or
B. If the Status is the same, pay the FEE DUE shown above.

If the SMALL ENTITY is shown as NO:
A. Pay FEE DUE shown above, or
B. File verified statement of Small Entity Status before, or with, pay of 1/2 the FEE DUE shown above.

II. Part B of this notice should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B should be completed and returned. If you are charging the ISSUE FEE to your deposit account, Part C of this notice should also be completed and returned.

III. All communications regarding this application must give series code (or filing date), serial number and batch number. Please direct all communication prior to issuance to Box ISSUE FEE unless advised to contrary.

IMPORTANT REMINDER: Patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (REV. 12-93) (0651-0033) 4. PATENT AND TRADEMARK OFFICE COPY

038 3-10-96
093

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1518

Applicant : Tomoyuki Nishio

Title : VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

Serial No. : 08/375,249

Filed : January 19, 1995

Batch No. : T67

Group Art Unit : 2617

Examiner : Brent A. Swarthout

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

March 7, 1996

SUBMISSION OF PRIORITY DOCUMENT

Sir:

Submitted herewith is a certified copy of Japanese Patent Application No. 4-229201 filed on August 4, 1992.

Priority of the above application is claimed under 35 USC 119.

KANESAKA AND TAKEUCHI

by _____
Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

727 Twenty-Third Street South
Arlington, Virginia 22202
(703) 521-3810

日本国特許庁
PATENT OFFICE
JAPANESE GOVERNMENT

別紙添付の書類に記載されている事項は下記の出願書類に記載されて
る事項と同一であることを証明する。
his is to certify that the annexed is a true copy of the following application as filed
this Office.

願年月日
e of Application: １９９２年　８月　４日

願番号
cation Number: 平成　４年特許願第２２９２０１号

願人
ant (s): タカタ株式会社

１９９３年　６月１１日

特許庁長官
Commissioner,
Patent Office 麻生渡

出証平　０５－０２８２８２

０４－２２９２０１

【書類名】　特許願
【整理番号】　J43179
【提出日】　平成 4年 8月 4日
【あて先】　特許庁長官殿
【国際特許分類】　B60R 21/16
　　G06F 15/18
【発明の名称】　神経回路網による衝突予防予測システム
【請求項の数】　4
【発明者】
　【住所又は居所】　神奈川県川崎市麻生区王禅寺６６３－２８
　【氏名】　西尾　友之
【特許出願人】
　【識別番号】　000108591
　【氏名又は名称】　タカタ株式会社
　【代表者】　代表者　高田　重一郎
【代理人】
　【識別番号】　100097685
　【弁理士】
　【氏名又は名称】　市村　健夫
【手数料の表示】
　【納付方法】　予納
　【予納台帳番号】　024981
　【納付金額】　14,000円
【提出物件の目録】
　【物件名】　明細書　1
　【物件名】　図面　1
　【物件名】　要約書　1
　【包括委任状番号】　9202012

０４－２２９２０１

【書類名】　　明細書

【発明の名称】　神経回路網による衝突予防予測システム

【特許請求の範囲】

【請求項１】

自車からの視認可能範囲の景色を衝突直前まで撮像した画像を学習データ群として中間層を有する神経回路網に入力して学習演算により前記神経回路網を学習させた衝突予測回路を有する認識部に、走行時にリアルタイムで車載撮像手段により収集した実画像データを所定幅のデータセットとして逐次入力し、予想される衝突画像の特徴に一致するか否かを前記神経回路網の学習結果に基づき前記衝突予測回路で予測し、衝突画像特徴を示すことが予測された場合に車両走行安全保持手段の動作開始を指令するようにしたことを特徴とする神経回路網による衝突予防予測システム。

【請求項２】

前記神経回路網は、２次元自己組織化競合学習層を前記中間層に構築したことを特徴とする請求項１記載の神経回路網による衝突予防予測システム。

【請求項３】

前記学習画像データは、衝突前から衝突に至るまでの実写画像からなり、衝突直前までの前記実写画像を画像パターンとし、この画像パターンを前記神経回路網の入力層に入力し、前記実写画像に基づく衝突有無のフラグを前記神経回路網の出力層に付与する希望出力データとしたことを特徴とする請求項１または請求項２のいずれかに記載の神経回路網による衝突予防予測システム。

【請求項４】

前記神経回路網は学習完了状態でコード化され、前記車両走行安全保持手段の制御回路内に組み込まれたことを特徴とする請求項１または請求項２のいずれかに記載の神経回路網による衝突予防予測システム。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】

本発明は神経回路網による衝突予防予測システムに係り、特に自動車の衝突等

の衝突遭遇の臨界状態を車両から見た走行方向の画像の変化としてあらかじめ神経回路網に学習させ、その学習結果に基づき衝突を予測するとともに、必要に応じて車両走行安全保持手段を動作させて衝突の発生を防止できるようにした神経回路網による衝突予防予測システムに関する。

【０００２】

【従来の技術】

自動車を運転する際、ドライバーはほとんど無意識に多くの状況を瞬時に判断して衝突を回避するようないろいな動作を取っている。

しかし、一般のドライバーはその判断能力を越えるような緊急事態に遭遇すると往々にパニック状態に陥り、車両を安全な状態に導くための手段をとれなくなってしまうことがある。また、人間の動作として生理的に反応遅れがあるので、物理的に衝突等を回避できない場合もある。

そこで、衝突をあらかじめ機械あるいは電気的に検知できるような装置を自動車に搭載して衝突予防を図ろうという技術も種々開発されている。

【０００３】

図８は衝突防止用レーダを搭載した自動車の制御ブロックを模式的に示した自動車のモデルを示したものである。

この自動車５０は前面に小型のレーダ発信部５１及びアンテナ５２を装着して前方に向けてマイクロ波を出射して前方を走行する車両や障害物等の物標からの反射波を受信し、搭載した信号処理部５３等でこれらの物標との相対速度や相対距離を検知して衝突の危険性を判別して、必要に応じて所定の安全動作をとれるようになっている。

【０００４】

また、実際の景色を撮影してその画像をパターン認識して前方の道路を２次元的に認識し、道路の通過可能状態を判定しながら走行する自動車も提案されている。この自動車は通常走行する道路の環境を複数のカテゴリーに分類し、そのカテゴリーにおける標準パターンとの照合をしながら走行でき、障害物が画像内に存在するような場合にはその障害物を回避するようにハンドルを自動操作できるようになっている。

【０００５】

【発明が解決しようとする課題】

しかしながら、上述のレーダを搭載した自動車では、図９に示したように自動車が大きくカーブした山道等を走行する場合に前方位置する路側や隣接車線を先行する他の自動車等の物標を正確に認識できない。このため装置に誤動作が発生し易いという問題がある。また複雑な物標の分離識別能力がないため、種々の緊急状況を認識できず、技術的に不十分な点が多い。

【０００６】

また、画像パターンを認識して安全走行の標準パターンと照合しながら走行する自動車では、衝突予防を目的とした場合、認識のために用意すべき標準パターンは膨大なものとなり、認識動作に非常に多くの演算時間を必要とし、衝突予測のように瞬時の判断を要する状況では実用的でない。またこの演算速度を早めるには高速演算可能な専用の画像処理プロセッサを必要とし、搭載機器が大型化してしまうので、実際の車載部品として使用することも難しい。そのため道路の状況の変化の比較的少ない通常走行の補助的なナビゲーション程度にしか使用できない。

【０００７】

そこで、本発明の目的は上述した従来の技術が有する問題点を解消し、自動車の衝突直前に至るまでの種々の状態を捉えた画像データをあらかじめ神経回路網有するシステム内に取り込み、神経回路網での並列処理による自己組織化・学習により学習させ、走行中に得られたデータをもとに、衝突の発生ををを予測し、搭乗者を保護するための車両走行安全保持手段を的確に動作させることにより衝突を予防することのできる神経回路網による衝突予防予測システムを提供することにある。

【０００８】

【課題を解決するための手段】

上記目的を達成するために、本発明は自車からの視認可能範囲の景色を衝突直前まで撮像した画像を学習データ群として中間層を有する神経回路網に入力して学習演算により前記神経回路網を学習させた衝突予測回路を有する認識部に、走

行時にリアルタイムで車載撮像手段により収集した実画像データを所定幅のデータセットとして逐次入力し、予想される衝突画像の特徴に一致するか否かを前記神経回路網の学習結果に基づき前記衝突予測回路で予測し、衝突画像特徴を示すことが予測された場合に車両走行安全保持手段の動作開始を指令するようにしたことを特徴とするものである。

【０００９】

このとき前記神経回路網は、２次元自己組織化競合学習層を前記中間層に構築することが好ましい。

【００１０】

また、前記学習画像データは、衝突前から衝突に至るまでの実写画像からなり、衝突直前までの前記実写画像を画像パターンとし、この画像パターンを前記神経回路網の入力層に入力し、前記実写画像に基づく衝突有無のフラグを前記神経回路網の出力層に付与する希望出力データとすることが好ましい。

【００１１】

さらに、前記神経回路網は学習完了状態でコード化され、前記車両走行安全保持手段の制御回路内に組み込むことが好ましい。

【００１２】

【作用】

本発明によれば、自車からの視認可能範囲の景色を衝突直前まで撮像した画像を並列学習データ群として中間層を有する神経回路網に入力して学習演算により前記神経回路網を学習させた衝突予測回路を有する認識部に、走行時にリアルタイムで車載撮像手段により収集した実画像データを所定のデータセットとして逐次前記神経回路網に入力し、あらかじめ学習された衝突画像特徴に一致するか否かを前記神経回路網の学習結果に基づき前記衝突予測回路で予測し、前記衝突しきい値を越えることが予測された場合に車両走行安全保持手段の動作開始を指令するようにしたので、前記神経回路網内において多数の画像データを用いて前記神経回路網を学習させることにより前記中間層に適正重み係数を設定しておき、この学習済みデータ神経回路網に実際に走行時に得られた画像データをそのまま所定サンプリング間隔で前記認識部に入力し、引き続き生じる状態が衝突である

のか否かを特徴抽出により得られた衝突画像との照合により衝突の予測を行い、衝突が予測される場合には直ちに衝突の警報を発したり、車両走行の安全手段を講じることができる。

【００１３】

このとき前記神経回路網は、２次元自己組織化競合学習層を前記中間層に構築することにより未学習データに対する精度を著しく向上させることができる。

【００１４】

また、前記学習画像データは、衝突前から衝突に至るまでの実写画像からなり、衝突直前までを撮像した画像であり、この画像を前記神経回路網の入力層に入力し、前記連続画像に基づく衝突有無のフラグを前記神経回路網の出力層に付与する希望出力データとしたことにより、前記神経回路網での特徴抽出自己組織化を可能にして神経回路網での計算効率を著しく向上させるとともに、データハンドリングの負荷を大幅に軽減させることができる。

【００１５】

さらに、前記神経回路網は学習完了状態でコード化され、前記車両走行安全保持手段の制御回路内に組み込むことで、小型で高性能の自動操舵、自動制動手段の制御回路を構築できるとともに、その製造コストを大幅に低減できる。

【００１６】

【実施例】

本発明は、自動車衝突等の事故発生に至るまでの画像データを学習データとして神経回路網に取り入れ、学習後の神経回路網を衝突予防のための走行安全保持手段の判定回路として利用し、実車の衝突等の衝突をあらかじめ予測し、適正なタイミングで必要な自動操舵あるいは制動動作を行い、衝突を防止しようというものである。

以下において、公知の一般的な神経回路網を概説し、さらに本発明による神経回路網による衝突状態予測システムの実施例について添付図面を参照して説明する。

【００１７】

［神経回路網（ニューラルネットワーク）］

神経回路網（ニューラルネットワーク）はその名の示すとおり、脳神経回路網（ニューロネットワーク）の情報処理メカニズムを模して開発された情報処理システムであり、脳神経細胞（ニューロン）に相当する多数のプロセッシングエレメント（Processing Elements 、以下ＰＥと記す。）が同時に動作する並列処理システムである。

また、その構造は各ＰＥが相互に結合された階層的構造をなし、各階層を通じて並列分散処理を実現できるようになっている。

なお、現在までに発表された神経回路網を用いた応用システムでの成果によると、脳神経細胞の数との比較において、その解析モデルは本体の機能をかなりのレベルで抽出しているとの実績を得ている。

【００１８】

ここでこのＰＥの機能について簡単に説明する。

ＰＥは図２に示したように多入力一出力素子からなり、実際の脳の内部のニューロンに比べ、相当簡略された構造になっている。すなわち複数の入力ｘｉ に対して重み係数ｗｉ がかけられ、その総和（Ｘ＝Σｘｉ ・ｗｉ ）がとられ、その総和に対して所定の伝達関数ｆ（Ｘ）が出力される。この出力値は各ＰＥの状態を示しており、各々入力された値に対する出力値を再び入力側にフィードバックし、全体の系としての安定状態を形成していくようになっている。この安定化手法は、系のエネルギの最小化に依存している。

ここでは２種類の異なる学習アルゴリズムによる予測システムの実施例について説明する。

【００１９】

［第１の実施例］

以下に示す第１の実施例では、入力値と別に神経回路網の出力側に学習希望出力（教師信号）を与え、学習を行うバックプロパゲーション（Back Propagation 、以下ＢＰと記す。）手法を利用して自動車衝突の発生予測を行う。

ここで、簡単にＢＰ手法の概念について説明する。

ＢＰ手法は階層構造のネットワークにおいて、入力層、出力層を構成するＰＥの他に中間層としての隠れ層を構成するＰＥを介在させた多層ネットワークであ

る。

【００２０】

学習アルゴリズムとしては、希望出力信号（教師信号）により入力値（学習データ）にフィードバックをかける際に伝達関数の微分係数を各ＰＥの実出力値と希望出力値との差（誤差）に乗じ、上述の重み係数ｗｉ を次々と更新して希望出力と実際の出力との誤差関数を極小化させるようになっている。すなわち、系のエネルギ減少方向に向け誤差が極小となるように状態変化を起こすことにより最終的に系が平衡状態になるように学習を繰り返す方法をとっている。

具体的には出力誤差が十分小さくなり、入力値と出力値との境界近傍でのデータ群の連続性が確保されればその学習は完了したといえる。

この学習を進めるための最適化手法としては一般化δルール、最急降下法等を用いることができる。これらの手法では初期において乱数を発生させて入力する学習データを決定し、その後は系のエネルギの定状態化した以外の部分に対して学習を行うことで早期に系を収束させることができる。

【００２１】

実際のＢＰ手法による学習では、所定の入力学習データを入力層のＰＥに入力して、以後ネットワークを動作させ、出力ＰＥ値と教師信号とを比較し、そのときの誤差を収束するまで修正を行う。これを１サイクルとして、各入力データを初期においてランダムに設定して所定回数の学習を繰り返し実行する。そして所定誤差内のしきい値を得たら各ＰＥの重み係数を求めて学習を完了させる。

【００２２】

本実施例では、自車からの視認可能な範囲の景色の変化を自動車前部に搭載したＣＣＤビデオカメラ等の撮像手段により衝突等の衝突前から衝突継続中まで撮影した画像を入力データとしてそのまま前記神経回路網に入力し、この神経回路網内で各画像データの特徴抽出を行って学習を進める方法を例に説明する。

【００２３】

（衝突予防予測回路の学習計画）

上述のＢＰ手法を適用した衝突予防予測回路の学習計画を説明する。

(1)　神経回路網の構造

本実施例における衝突予防予測回路の神経回路網は図１（ａ）に示したような３層の階層構造からなる。

入力層１はｎ×ｍ個の２次元グリッド状のＰＥを１次元配列とした構造であり、この入力層１からの出力値は同様に１次元横並びのＢＰ隠れ層２を経て、衝突判定を示す１個のＰＥからなる衝突予測回路の出力層３に出力される。

なお、入力層の構造としては図１（ａ）に示したように１次元配列とした場合、前記２次元入力データはｍ行に分割され、１本の帯状のデータとして取り扱うことができ、データの取扱いを容易に行えるようになる。

また、入力層１、隠れ層２、出力層３の各層において重み係数ｗｉ を介してすべてのＰＥ同士が結合されネットワークが構成されている。

【００２４】

(2)　学習画像データの収集

自動車の前部に搭載したＣＣＤビデオカメラにより衝突のわずか前から衝突直前まで経過時間に相当するサンプリング範囲（ΔＴ）において、所定のサンプリング間隔（Δｔ）で自車の視認範囲の画像データを収集する。

図４は走行時に連続的に撮像された画像データの一例を示したものであり、同図（ａ）はワゴン車１０Ａがセンターラインを越えて自車のレーンの前方に進入してきたあるサンプリング時刻での状態を示している。

また、同図（ｂ）は見通しの悪い交差点で前方に横断車１０Ｂが急に現れたあるサンプリング時刻での状態を示している。そして各画像データの前後には刻々と変化する前方の状況が記録されている。

【００２５】

またそのサンプル範囲としては、ドライバーが自車が危険な状態になると認識できるような距離範囲内で対向車等を視認し、かつその衝突を回避できず、衝突に至るまでの状況を包含するような時間的範囲が設定されている。

【００２６】

(3)　神経回路網における画像データの前処理及び特徴抽出

ＣＣＤカメラ等の撮像素子により得られた画像情報は、信号処理部において、アナログ信号を量子化してディジタル変換する。そして画像前処理として雑音除

去、ひずみ補正等を行い、信号を成形する。

【００２７】

次いで、神経回路網にそのまま画像データを次々に入力する。画像データは処理の便宜のために正規化して神経回路網に入力されることもあるが、基本的にはそのままの画像を神経回路網に取り込む。そして隠れ層に入力される前に画像データの特徴抽出を行う。

【００２８】

特徴抽出では神経回路網の学習データとしてその学習効果が十分得られるように、対象となる画像データの輪郭や領域を際立たせるように解析データの特徴抽出を行い、種々のパターン認識の手法により画像データは以後の演算の容易化のために量子化される。このパターン認識の手法としては通常のコンピュータではあらかじめプログラム化されている画像認識での領域化、輪郭線図の抽出等の公知の方法をセットする必要はなく、神経回路網自らがこれらの手法に類似するアルゴリズムを内部に構築いけることがこの神経回路網の最大の利点である。

【００２９】

本実施例において、着目すべき画像の輪郭としては例えば　路肩、縁石、センターライン等のように自車あるいは対向車等の走行範囲を規制する部分がこれに相当し、領域としては、例えば自車の走行路面、対向車線の路面等がこれに相当する。神経回路網はこれらを自ら認識しながら学習を進めていく。

この特徴抽出を行いながら、学習を重ねることにより入力データは量子化された状態で異なる重み付けがされ、１個１個の隠れ層に入力される。

また、学習過程において、画像中で急激に移動したりする対象を抽出することで対向車や危険な飛来物のように自車にとって危険度の高い対象の動きが特に抜き出され学習される。

【００３０】

(4)　伝達関数の設定

本実施例では各ＰＥの伝達関数として図３に示したシグモイド関数を採用している。このシグモイド関数は準線形の飽和型の伝達特性をもつ関数で、この関数により計算効率の良い神経回路網モデルを設定することができる。

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このとき各層におけるシグモイド関数のパラメータとして相対値で与えるｙ方向スケールとｙ座標オフセットとをユーザ設定値としている。関数のｙ方向スケールについては各層間において所定の指数変化を定義することで収束効率の向上を図ることができる。

なお、伝達関数としては他の種々の関数も適用でき、たとえば正弦関数は各ＰＥでの入力緩和に対する微係数が原関数と同等の広い変化範囲を有するという特徴がある。この正弦関数を利用するとハードウェア構成上は若干複雑になるが、学習収束性は抜群に良く、本実施例にも有効に適用することができる。

【００３１】

(5)　学習の手法

本実施例では一連の連続した画像のうち、各サンプリング時刻での画像データを神経回路網の入力層のＰＥの数（ｎ×ｍ）に等しく画面分割して、この２次元グリッドデータを１次元配列に組み直し、１組のデータセットとして、ある時刻の状況データとして神経回路網の入力層に一度に入力する。これと同時にこの画像が経時的に変化し、衝突に至ったというデータを希望出力データとしてフラグ「１」を出力層に入力しながら学習する。この学習では神経回路網は入力画像の各コマを希望出力に合致させるように各ＰＥに入力される重みを変えながら学習を繰り返し、学習がうまくいけば、全部の画像のコマを認識する。このとき学習時には衝突なしの画像も含めて学習を行うようにする。

このように衝突に至るまでの自車及び対向車両や障害物との関係を画像入力し、その像の形成された所定時間後に衝突が起こるというデータを学習させる。このとき景色は刻々と変化する上、対象物が接近する状況も様々であるが、学習を重ねることにより予測精度を向上させることができる。

また、学習データ数、学習回数は個々の学習効果との兼ね合いで適宜設定できる。

【００３２】

（実車での予測動作）

本実施例による神経回路網による衝突予防予測システムを実車に適用した実施例について簡単に説明する。

学習が完了した神経回路網プログラムはマシン語に変換することでアプリケーションとしてＲＯＭ化し、所定のＩＣチップ等に組み込むことができる。そしてこのチップは実車の緊急時に作動するステアリングサーボモータやブレーキ用アクチュエータの制御回路内に搭載される。

【００３３】

ここで、車両の安全走行を保持するための装備について簡単に説明する。

前述のステアリングサーボモータは緊急時にステアリングホイールを所定の操舵角だけ回転させるように作動するモータで、衝突を回避するために操舵角は対向車の進行方向と自車の進行方向とが車幅の１／２以上のオフセットを設定した状態でほぼ平行になるように設定される。これにより対向車等との１次衝突は回避されるが、その後の路肩、ガードレールへの接近に対しても所定の操舵角が設定され、２次衝突も未然に防ぐことができる。

ブレーキ用アクチュエータは、自動車の速度を徐々に減速させる機能とともに、必要に応じて急制動させることもできる。

これらの装備は、衝突予測回路からの衝突発生フラグがたって動作指令が出力されると即座に作動するように設計されている。

なお、以上の動作をとる前に単に警報ブザー

【００３４】

これらの装備と前述のように進行方向前方を連続して撮像できる撮像手段と神経回路網を備えた識別部を有する自動車では、走行して車速が所定速度に達すると、ＣＣＤ等の車載撮像装置による連続撮像が開始される。そして各映像データは所定の２次元グリッドを構成するデータセットに逐次変換され、神経回路網の入力層にデータセットごとに所定の間隔をあけて次々と連続的に入力される。そして、自車が走行していく過程で次々と発生する状況に対して学習済みデータとの照合が行われる。

【００３５】

例えば、図５は、対向車線をすれ違う自動車１０が視野内に捉えられた状態を示している。このようにまったく衝突の危険がない状態では衝突予測回路を経由しないようにすることもできる。

また、図６には進行方向の遠方に車線を越えて自車のレーンに進入してきた自動車１０が認識されている。このときこの自動車１０は対向車のレーンに戻る動作をとっており、引き続きこの画面以後のサンプリング画像を認識することで対向車の衝突回避行動を判定でき、自車がその地点に到達するまでに対象となる対向車との衝突ないと判定される。

【００３６】

そして走行中のある時点で図４の画像のように走行している自車が衝突しそうになった場合に、その画像をもとに学習済み神経回路網で所定の重み計算が行われ、出力層からその状況が継続して衝突が起こるかどうかのフラグが出力される。このフラグが衝突有りとの判定であれば、ただちに前述の車両安全保持手段が作動する。

【００３７】

また、この判定は、多くの学習データを入力して自己組織化された神経回路網により行われるので、簡易なアルゴリズムにより学習を積ませることで一層正確な判断を行わせることも可能である。

【００３８】

［第２の実施例］

次に、少ない学習データで、多くの未学習データに正確に応答させるために自己組織化機能と競合学習機能とを神経回路網内の中間層に取り入れた実施例について説明する。

本実施例では図７に示したように２次元の自己組織化・競合学習層２０を隠れ層３、５の前に設けている。この２次元の自己組織化・競合学習層２０は２次元-Kohonen層（以下、２Ｄ－Ｋ層と記す）と呼ばれ、本実施例ではｐ×ｑ層の２次元グリッドから構成されている。

このとき入力層１は図７のように第１の実施例に示した１次元配列としているが、ｎ×ｍ個の２次元グリッド層のままでも良い。

【００３９】

この２Ｄ－Ｋ層２０では各入力データセットは入力層１に対してすべてのＰＥが相互結合されており、各ＰＥ間において所定の幾何学的距離が算定される。こ

のとき２Ｄ－Ｋ層２０では、競合学習として、入力されたｎ×ｍ個のパターンの類似性がその距離関係に写し出され、類似性の高いＰＥが選択され、このＰＥに対して優位な重み付けがなされる。これにより未学習データに対する属性判定がより明確になる。

【００４０】

未学習データに対しては学習時の自己組織化による入力データの区分けに従った重み付けが施され、次の隠れ層に出力値が引き渡される。

なお、２Ｄ－Ｋ層２０の直前に付加的に規格化層２１を挿入することにより入力パターンが所定の規格化されたベクトルとして表される。これにより２Ｄ－Ｋ層２０での学習効率を向上させることができる。

このように２Ｄ－Ｋ層２０を設けることにより学習時の収束効率を大幅に向上できるとともに、未学習データに対する正解率もきわめて良くなることが明らかにされている。

【００４１】

この２Ｄ－Ｋ層を備えた神経回路網は、上述のＢＰ手法を拡張することで完成させることができる。したがって学習計画等はＢＰ手法に準じて決定できる。

この神経回路網では学習開始直後の数千回の繰り返し学習状態では内部の自己組織化学習のために出力側からのフィードバックは行われない。そして自己組織化が完了後所定のＢＰ手法の学習が行われる。この結果早い収束回数で学習を完了することができる。

【００４２】

なお、前述の実施例において、学習完了した神経回路網についてはＣ言語等によりコード化したり、コンパイル、リンクにより実行形アプリケーションとしたり、制御マイコンとしてパッケージ化することもできる。このとき対応車種ごとにＲＯＭ化すれば、コンパクトな神経回路網を設定でき、システムのコストダウンを図ることも可能である。

【００４３】

また、論理構築の容易なアルゴリズム部分に対してはエキスパート・システムを適用し、神経回路網とエキスパート・システムとの混成論理回路による予測シ

ステムを構築することも可能である。

なお、自動車の事故には自動車同士や対壁等の衝突の他に、転覆や転落等も含まれる。しかし、これらの事故のプロセスには何らかの形で衝突という現象が関与していると考えられる。このため、ここでは衝突を広く定義し、事故は衝突により起こるとして取り扱う。

【００４４】

【発明の効果】

以上の説明から明らかなように、本発明によれば自動車が衝突する場合等に直面するビジュアルな情報をデータ処理して、迅速に演算を行える並列処理アルゴリズムを適用して入力されたデータをもとに衝突の有無を予測するので、衝突が起こる前に車両を安全に保持する手段を講じることができ、搭乗者の安全の確保を迅速かつ確実に行うことができるという効果を奏する。

【図面の簡単な説明】

【図１】

本発明による神経回路網による衝突予防予測システムの第１の実施例の神経回路網の一例を示した神経回路網構成図。

【図２】

本発明に適用した神経回路網の一素子を模式的に示した概念図。

【図３】

本発明における学習演算に使用された伝達関数の一例を示した特性曲線図。

【図４】

走行時に撮像された学習画像データのあるサンプリング時刻での景色の一例を示した説明図。

【図５】

実車走行での画像認識における画像データの一例を示した説明図。

【図６】

実車走行での画像認識における画像データの一例を示した説明図。

【図７】

本発明による神経回路網による衝突状態予測システムの第２の実施例の神経回

路網の一例を示した神経回路網構成図。

【図８】

従来の衝突防止用レーダを搭載した自動車の構成の一例を示した模式ブロック図。

【図９】

図８に示した自動車がカーブを走行する際の状況を示した説明図。

【符号の説明】

１　入力層

２　隠れ層

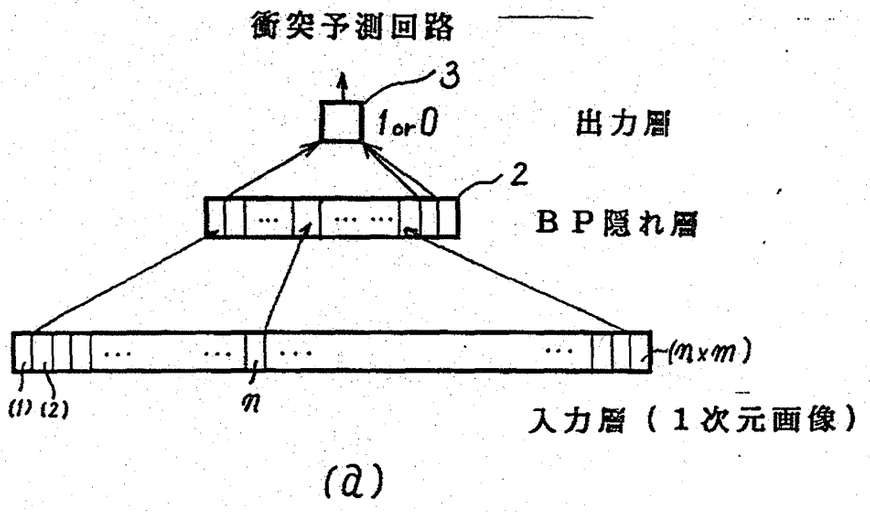
３　出力層

２０　２次元自己組織化・競合学習層（２Ｄ－Ｋ層）

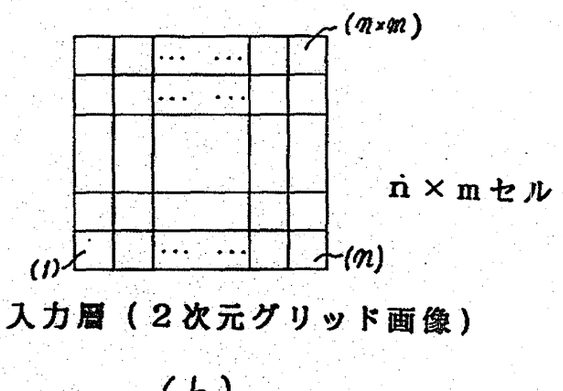
２１　規格化層

【書類名】　図面

【図１】

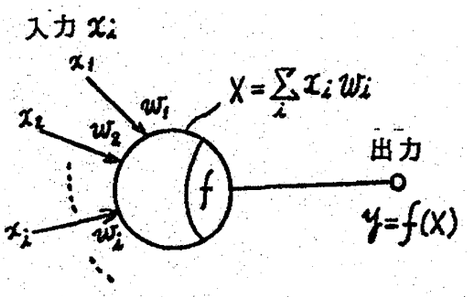

衝突予測回路
3
1 or 0
出力層
2
ＢＰ隠れ層
(n×m)
(1) (2)
n
入力層（１次元画像）

(a)

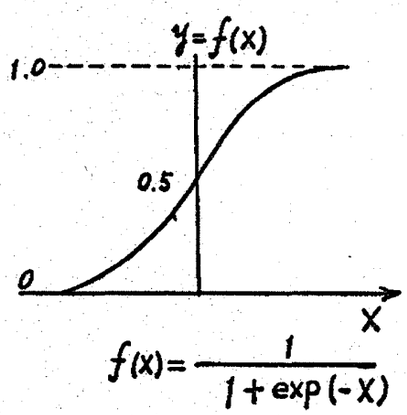

(n×m)
ｎ×ｍセル
(1)
(n)
入力層（２次元グリッド画像）

(b)

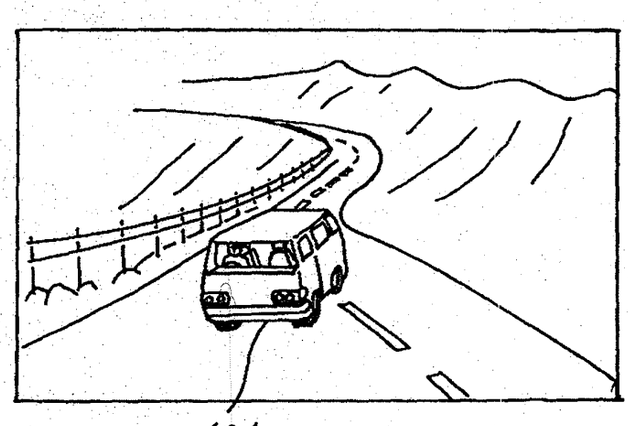
【図２】


入力 x_i
x_1
x_2
x_i
w_1
w_2
w_i
$X=\sum_i x_i w_i$
f
出力
$y=f(X)$

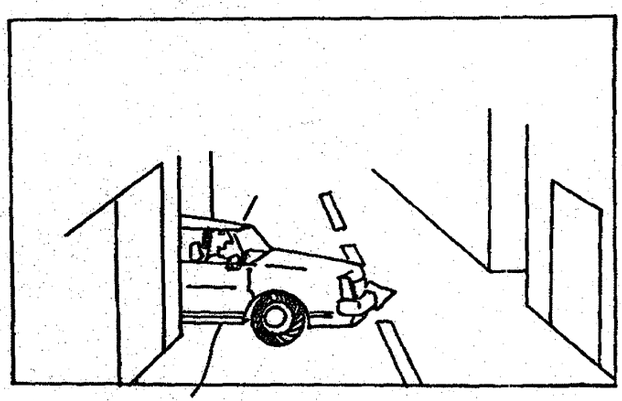
【図３】


$y=f(X)$
1.0
0.5
0
X
$f(X)=\frac{1}{1+\exp(-X)}$

【図4】

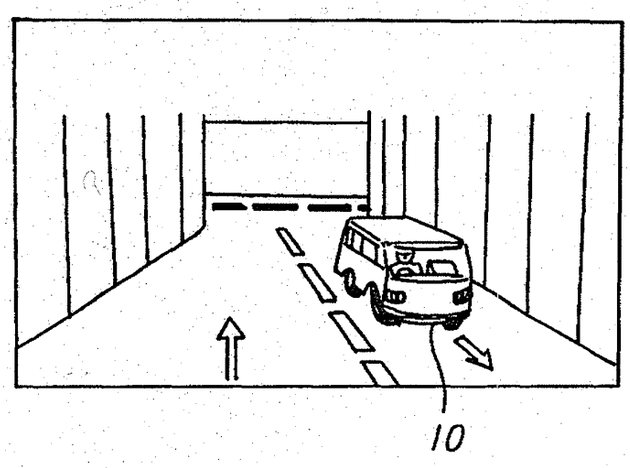


(a)

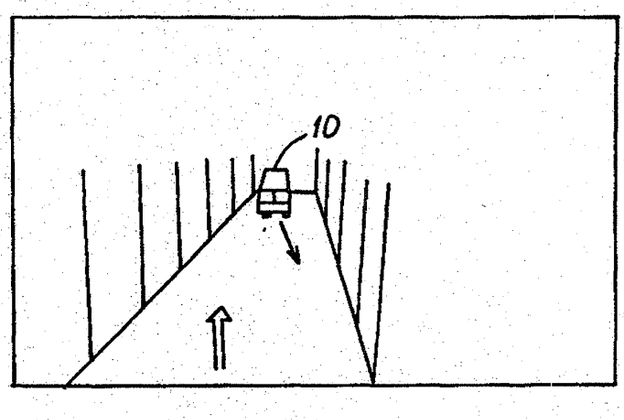


(b)

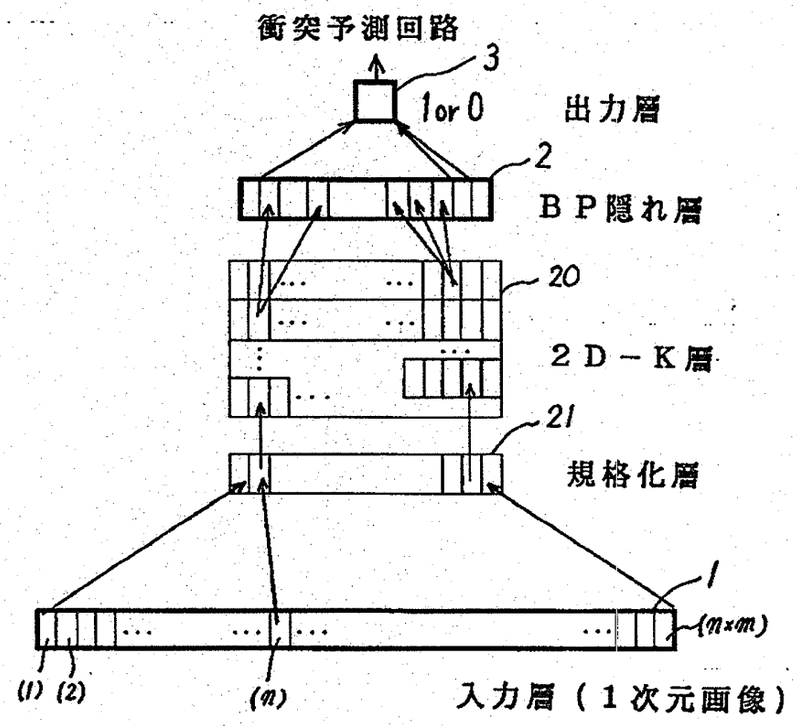
【図５】



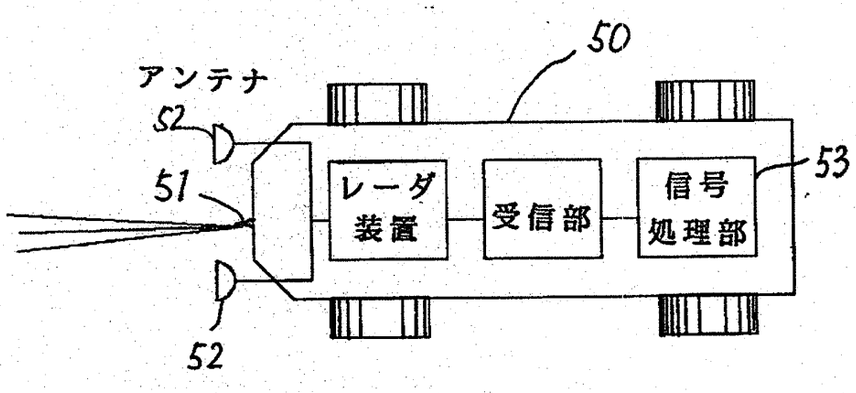
【図６】



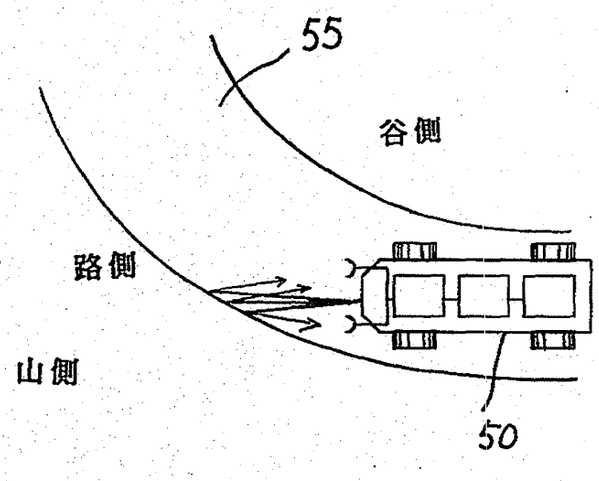
【図７】


衝突予測回路
3
1or 0
出力層
2
ＢＰ隠れ層
20
２Ｄ－Ｋ層
21
規格化層
1
(n×m)
(1)
(2)
(n)
入力層（１次元画像）

【図８】


50
アンテナ
52
51
レーダ装置
受信部
信号処理部
53
52

【図９】



０４－２２９２０１

【書類名】　　要約書

【要約】

【目的】　自動車の衝突臨界状態を予測して、所定の安全措置をとり、衝突を予防する。

【構成】　自車からの視認可能範囲の景色を衝突直前まで撮像した画像を学習データ群として隠れ層２を有する神経回路網の入力層１に入力し、特徴抽出して学習する。　学習済み神経回路網を有する衝突予測回路を有する認識部に、走行時にリアルタイムで車載撮像手段により収集した実画像データをデータセットとして逐次入力する。このときその後の画像が衝突に至ることが判定された場合に出力層３の出力値に衝突フラグを出力する。これを受け、直ちに車両走行安全保持手段の動作開始を指令する。

【選択図】　図１

０４－２２９２０１

【書類名】　職権訂正データ
【訂正書類】　特許願

＜認定情報・付加情報＞
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出 願 人 履 歴 情 報

識別番号　〔０００１０８５９１〕

１．変更年月日　１９９０年　８月　７日
［変更理由］　新規登録
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氏　名　タカタ株式会社

０５－０２８２８２

#17
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

K-1518

Applicant	:	Tomoyuki Nishio
Title	:	VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS
Serial No.	:	08/375,249
Filed	:	January 19, 1995
Batch No.	:	T67
Group Art Unit	:	2617
Examiner	:	Brent A. Swarthout

Hon. Commissioner of Patents and Trademarks
Washington, D. C. 20231

April 29, 1996

SUBMISSION OF FORMAL DRAWINGS

Sir:

Submitted herewith are formal drawings (Figs. 5(a), 5(b), 6(a) and 6(b)) in the above identified patent application.

Respectfully submitted,

KANESAKA AND TAKEUCHI

by _____
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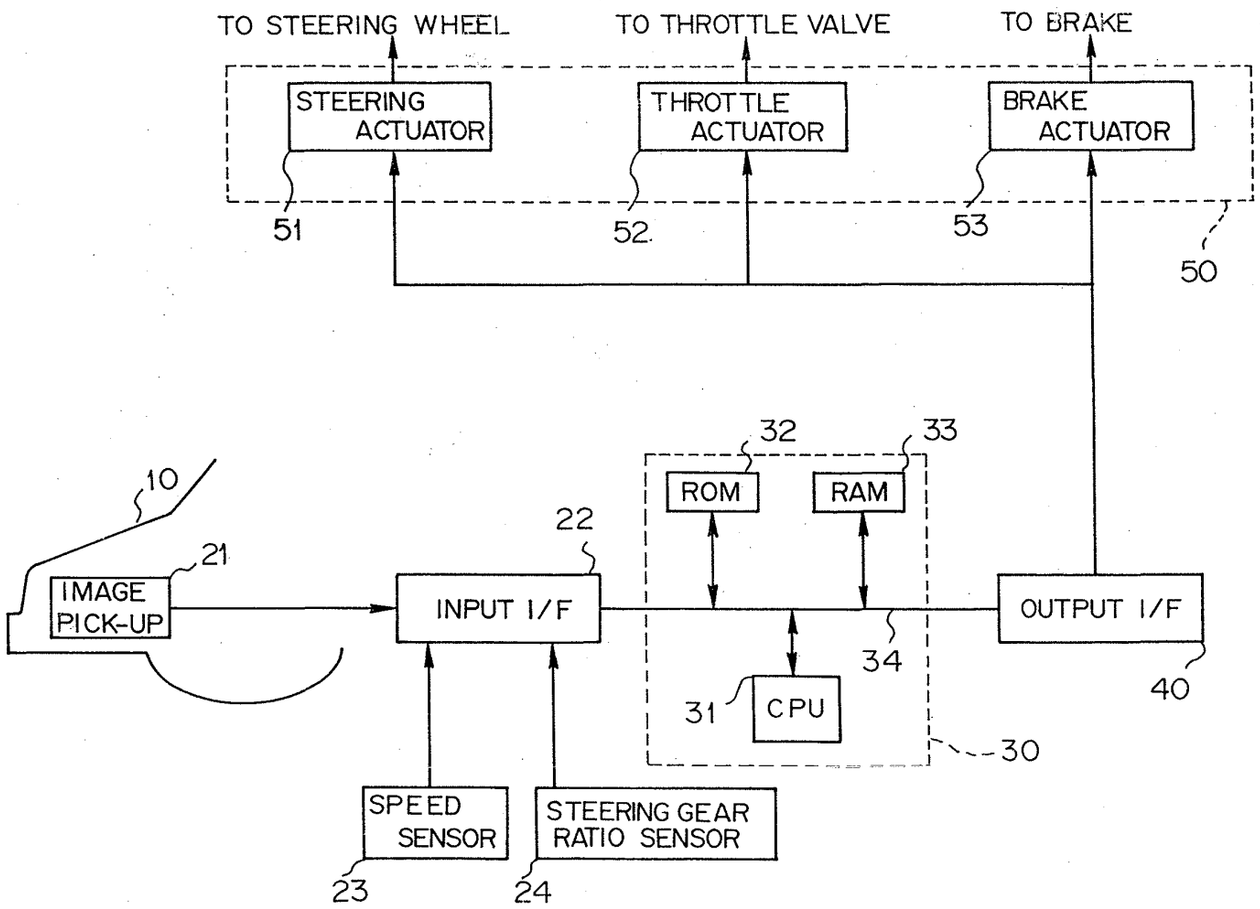


FIG. 1 PRIOR ART

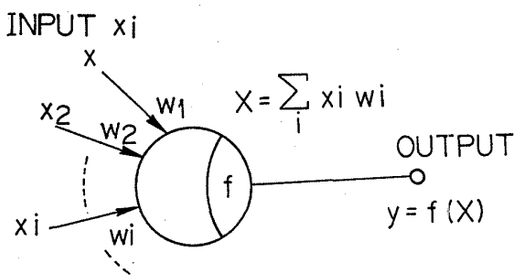


FIG. 2
PRIOR ART

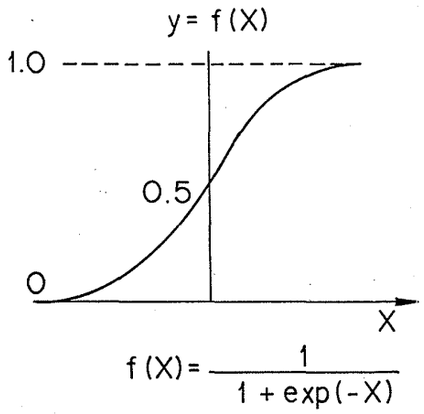


FIG. 3
PRIOR ART

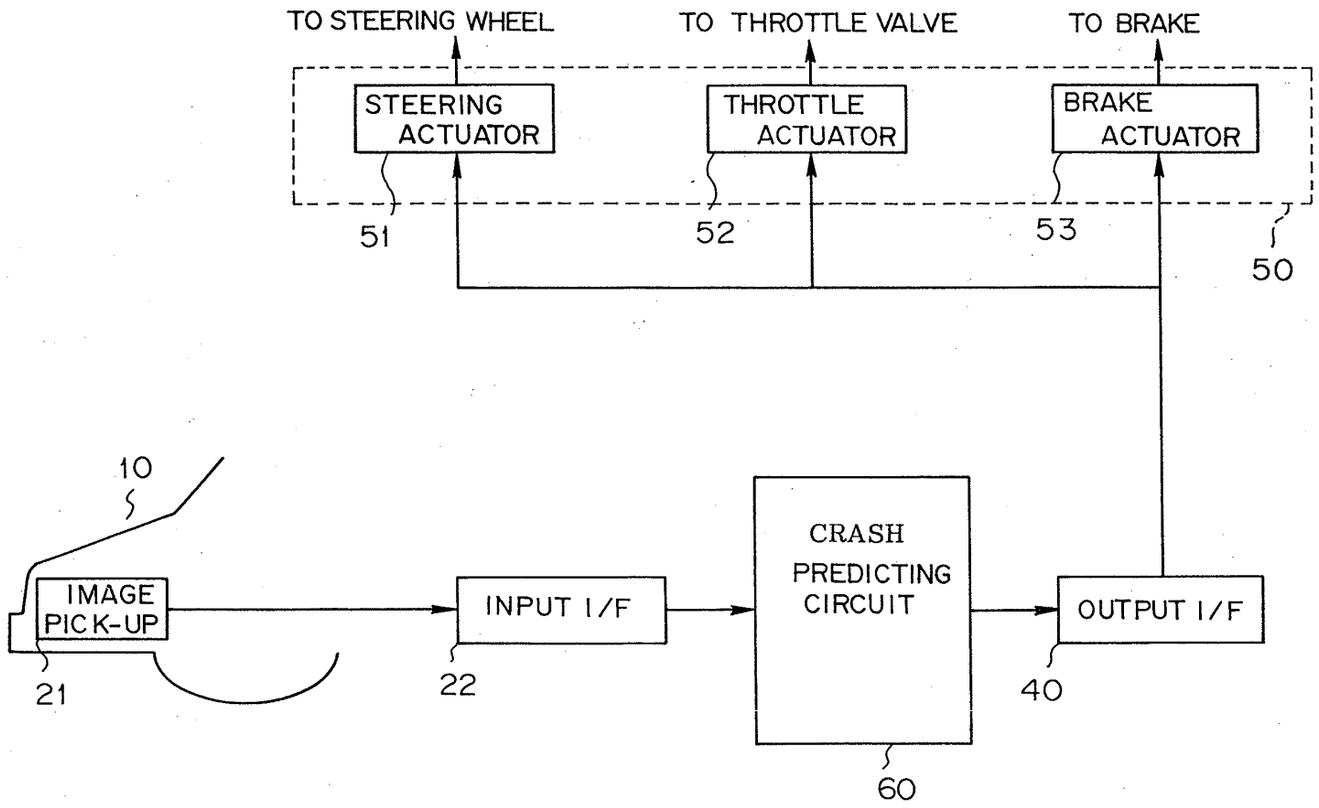
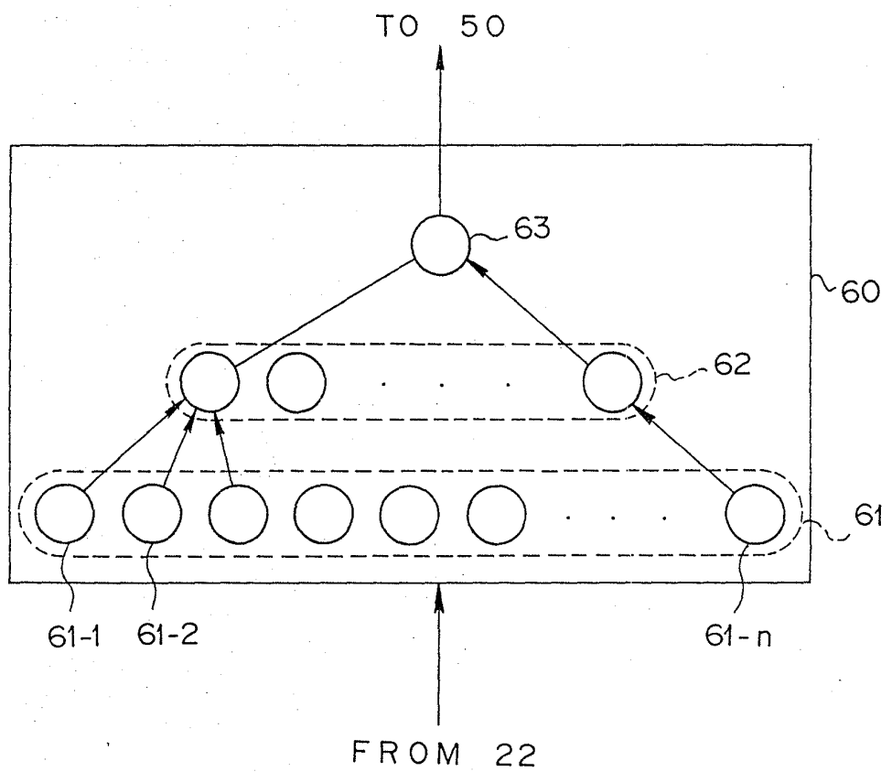


FIG. 4


TO 50
63
60
62
61
61-1
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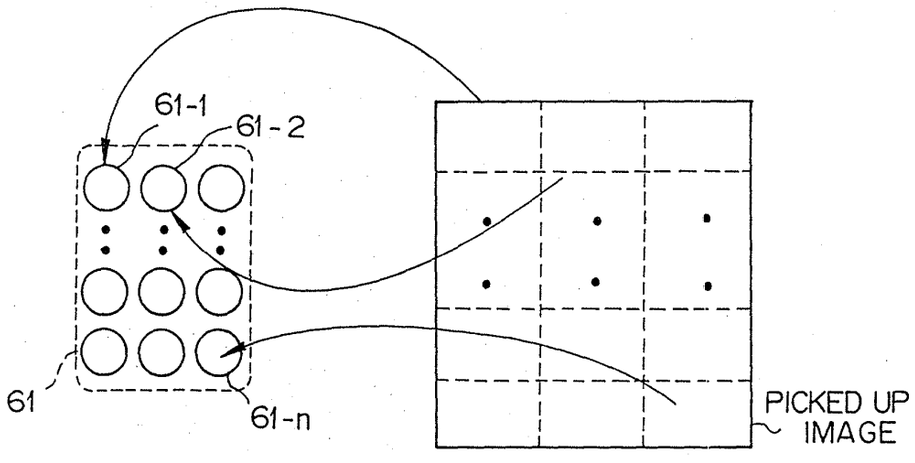
FROM 22

FIG. 5(a)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PICKED UP IMAGE

FIG. 5(b)

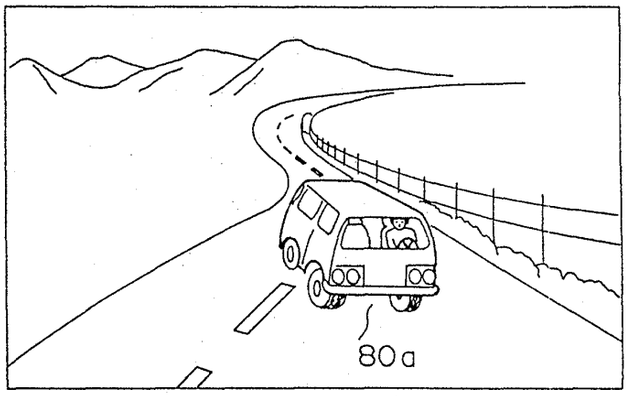

FIG. 6(a)

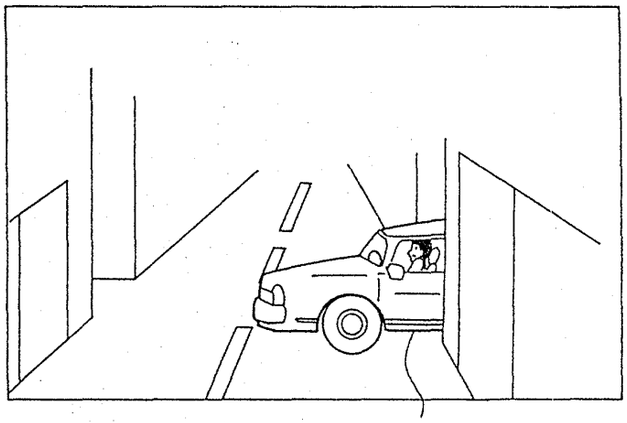

FIG. 6(b)

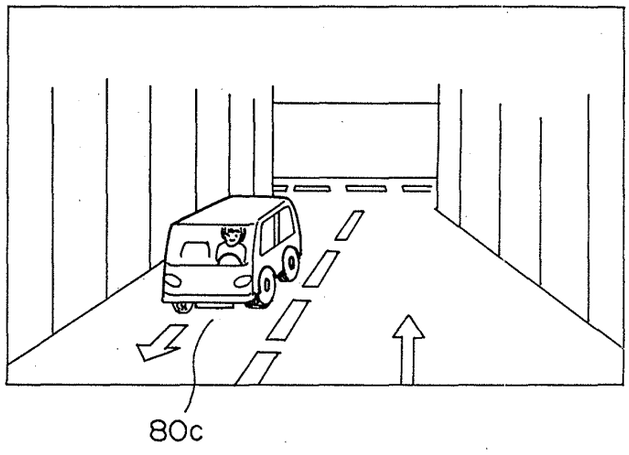

FIG. 7

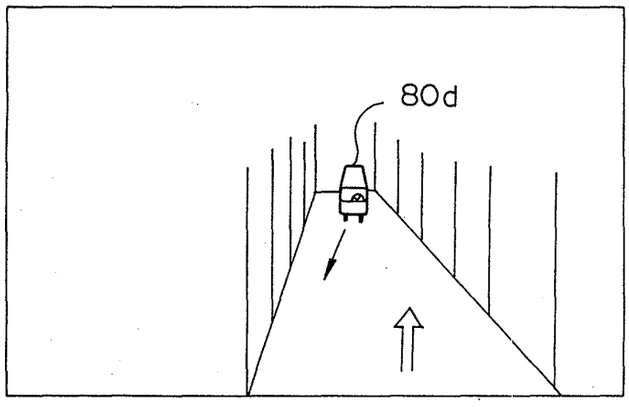

FIG. 8

K-1398
7/9

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375249

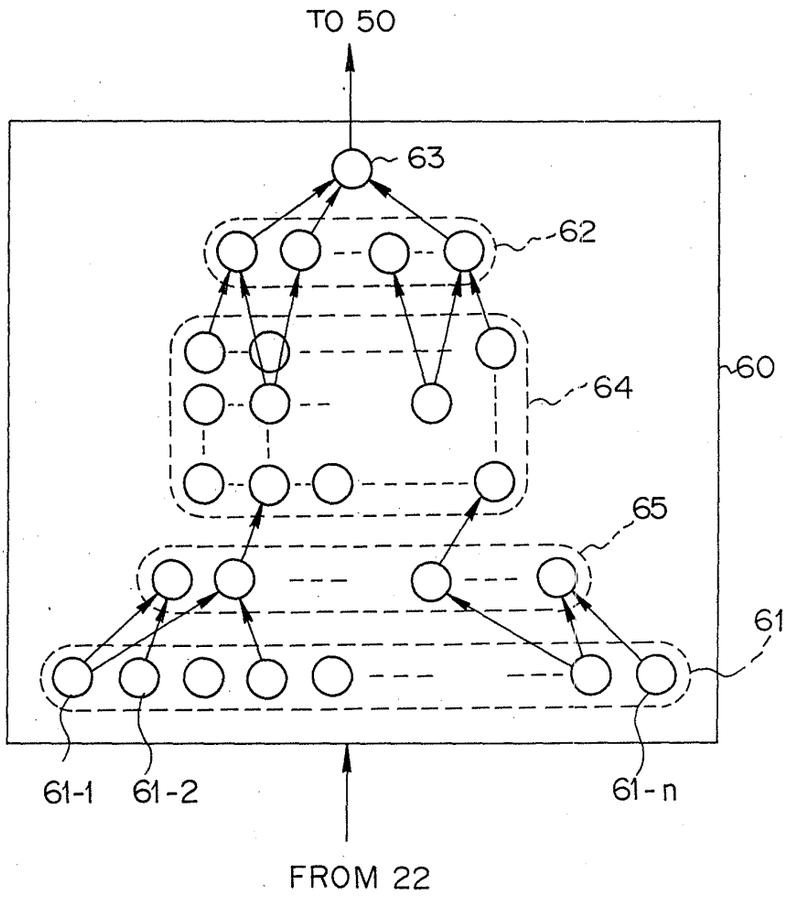

FIG. 9

142-1250

PART B—ISSUE FEE TRANSMITTAL

MAILING INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE. Blocks 2 through 6 should be completed where appropriate. All further correspondence including the Issue Fee Receipt, the Patent, advance orders and notification of maintenance fees will be mailed to addressee entered in Block 1 unless you direct otherwise, by: (a) specifying a new correspondence address in Block 3 below; or (b) providing the PTO with a separate "FEE ADDRESS" for maintenance fee notifications with the payment of Issue Fee or thereafter. **See reverse for Certificate of Mailing.**

1. CORRESPONDENCE ADDRESS	2. INVENTOR(S) ADDRESS CHANGE (Complete only if there is a change)
E6M1/0213 MANABU KANESAKA KANESAKA AND TAKEUCHI 727 23RD STREET SOUTH ARLINGTON VA 22202	INVENTOR'S NAME Street Address City, State and ZIP Code CO-INVENTOR'S NAME Street Address City, State and ZIP Code ☐ Check if additional changes are on reverse side

RECEIVED Publishing Division APR 5 U 1996

4/30/96

GP

SERIES CODE/SERIAL NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT	DATE MAILED
08/375,249	01/19/95	004	SWARTHOUT, B 2617	02/13/96

First Named Applicant NISHIO, TOMOYUKI

TITLE OF INVENTION: VEHICLE CRASH PREDICTIVE AND EVASIVE OPERATION SYSTEM BY NEURAL NETWORKS

	ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2	K-1518	340-903.000	167	UTILITY	NO	$1250.00	05/13/96

3. Correspondence address change (Complete only if there is a change)	4. For printing on the patent front page, list the names of not more than 3 registered patent attorneys or agents OR, alternatively, the name of a firm having as a member a registered attorney or agent. If no name is listed, no name will be printed.
	1 KANESAKA & TAKEUCHI 2 3

DO NOT USE THIS SPACE

810 BL 05/13/96 08375249
1 142 1,250.00 CK

5. ASSIGNMENT DATA TO BE PRINTED ON THE PATENT (print or type)

(1) NAME OF ASSIGNEE: Takata Corporation

(2) ADDRESS: (CITY & STATE OR COUNTRY) Tokyo, Japan

A. ☐ This application is NOT assigned.

☒ Assignment previously submitted to the Patent and Trademark Office.

☐ Assignment is being submitted under separate cover. Assignments should be directed to Box ASSIGNMENTS.

PLEASE NOTE: Unless an assignee is identified in Block 5, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the PTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

6a. The following fees are enclosed:

☒ Issue Fee ☐ Advance Order - # of Copies

6b. The following fees should be charged to:

DEPOSIT ACCOUNT NUMBER

(ENCLOSE PART C)

☐ Issue Fee ☐ Advance Order - # of Copies

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The COMMISSIONER OF PATENTS AND TRADEMARKS is requested to apply the Issue Fee to the application identified above.

(Authorized Signature)	(Date)
Manabu Kanesaka	4/29/96

NOTE; The Issue Fee will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the Patent and Trademark Office.

1. TRANSMIT THIS FORM WITH FEE-CERTIFICATE OF MAILING ON REVERSE

PTOL-85B (REV.12-93)(0651-0033)

UNITED STAT DEPARTMENT OF COMMERCE
Patent and Trademark Office

ASSISTANT SECRETARY AND COMMISSIONER
OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

PAYOR NUMBER
0 0 4 4 4 1

P75M

MANABU KANESAKA
KANESAKA AND TAKEUCHI
1423 POWHATAN STREET
ALEXANDRIA VA 22314

DATE PRINTED
9/ 5/00

NOTICE OF PATENT EXPIRATION

According to the records of the Patent and Trademark Office, payment of the maintenance fee for the patents listed below has not been timely received prior to the end of the six-month grace period in accordance with 37 CFR 1.362(e). THE PATENT(S) LISTED BELOW HAS THEREFORE EXPIRED AS OF THE END OF THE GRACE PERIOD. 35 U.S.C. 41(b).

Expired patents may be reinstated in accordance with 37 CFR 1.378 if upon petition, the maintenance fee and the surcharge set forth in 37 CFR 1.20(m) are paid, AND THE DELAY IN PAYMENT OF THE MAINTENANCE FEE IS SHOWN TO THE SATISFACTION OF THE COMMISSIONER TO HAVE BEEN UNAVOIDABLE. 35 U.S.C. 41(c)(1).

IF THE COMMISSIONER ACCEPTS PAYMENT OF THE MAINTENANCE FEE UPON PETITION, THE PATENT SHALL BE CONSIDERED AS NOT HAVING EXPIRED, BUT WOULD BE SUBJECT TO THE INTERVENING RIGHTS AND CONDITIONS SET FORTH IN 35 U.S.C. 41(c)(2).

NOTICE OF THE EXPIRATION WILL BE PUBLISHED IN THE **OFFICIAL GAZETTE**.

PATENT NUMBER	U.S. SERIAL NUMBER	PATENT DATE	APPLICATION FILING DATE	EXPIRATION DATE	ATTORNEY DOCKET NUMBER
5541590	08375249	7/30/96	1/19/95	7/30/00	K-1518

PTOL-441
MB441A

PART B - FILE COPY

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
08/375,249	5541590	2617	9200

Change of Address/Power of Attorney

The following fields have been set to Customer Number 32628 on

- Correspondence Address
- Power of Attorney
- Maintenance Fee Address

The address of record for Customer Number 32628 is:
HAUPTMAN KANESAKA BERNER PATENT AGENTS
SUITE 300, 1700 DIAGONAL RD
ALEXANDRIA, VA 22314-2848

The Practitioners of record for Customer Number 32628 are:

PTO INSTRUCTIONS:

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1) Add 'ADDRESS CHANGE TO CUSTOMER NUMBER' on the next available content line of the File Jacket.
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3) File this Notice in the File Jacket.

Please take the following action when the correspondence address has NOT been changed:
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08/375249

PATENT APPLICATION SERIAL NO._____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

$ 504.00 REFUND SCHEDULED

FEB 2 4 1995

By Treasury Clerk in approximately ten (10) days from above date.
CHIEF ACCOUNTING OFFICER
PATENT TRADEMARK OFFICE

080 KJ 02/03/95 08375249 1 101 1.230.00 OP [illegible]

PTO-1556
(5/87)

08 097178

PATENT APPLICATION SERIAL NO._____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

040 TD 08/12/93 08097178 1 101 710.00 CK K-1398

PTO-1556
(5/87)

UNITED STATES PATENT & TRADEMARK OFFICE
Washington, D.C. 20231

3/10/95

REQUEST FOR **PATENT** FEE REFUND Mar95-00075 SE

1 Date of Request: 2/15	2 Serial/Patent # 375 249

3 Please refund the following fee(s):		4 PAPER NUMBER	5 DATE FILED	6 AMOUNT
✓	Filing	~~Ab Stmt~~	1/9/95	$ 500.00
	Amendment			$
	Extension of Time			$
	Notice of Appeal/Appeal			$
	Petition			$
	Issue			$
	Cert of Correction/Terminal Disc.			$
	Maintenance			$
	Assignment			$
	Other			$
		7 TOTAL AMOUNT OF REFUND		$ 500.00

3/13/95 SE

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Credit Deposit A/C #:

9 [ ][ ]--[ ][ ][ ][ ]

10 REASON:

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Duplicate Payment

✓ No Fee Due (Explanation):

ABANDONED

11 REFUND REQUESTED BY:

TYPED/PRINTED NAME: C Barnes TITLE: Ex.

SIGNATURE: C. B PHONE: 308-1102

OFFICE: Special Projects

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APPROVED: _____ DATE: 2/24/95

Instructions for completion of this form appear on the back. After completion, attach white and yellow copies to the official file and mail or hand-carry to:

Office of Finance
Refund Branch
Crystal Park One, Room 802B

FORM PTO 1577
(01/90)

Form PTO 1130
(REV 2/94)

PACE DATA ENTRY CODING SHEET

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

1ST EXAMINER	DATE 2-9-95
2ND EXAMINER	DATE

APPLICATION NUMBER	TYPE APPL	FILING DATE MONTH	DAY	YEAR	SPECIAL HANDLING	GROUP ART UNIT	CLASS	SHEETS OF DRAWING
08/375249	2	01	19	95	Ø	2617	340	7

TOTAL CLAIMS	INDEPENDENT CLAIMS	SMALL ENTITY?	FILING FEE	FOREIGN LICENSE	ATTORNEY DOCKET NUMBER
04	01	Ø	730	Y	K-1518

CONTINUITY DATA

CONT CODE	STATUS CODE	PARENT APPLICATION SERIAL NUMBER	PCT APPLICATION SERIAL NUMBER	PARENT PATENT NUMBER	PARENT FILING DATE MONTH	DAY	YEAR
Ø2	3	Ø8Ø97178			Ø7	27	93
			PCT/				
			PCT/				
			PCT/				
			PCT/				
			PCT/				

PCT/FOREIGN APPLICATION DATA

FOREIGN PRIORITY CLAIMED	COUNTRY CODE	PCT/FOREIGN APPLICATION SERIAL NUMBER	FOREIGN FILING DATE MONTH	DAY	YEAR
Y	JPX	229,201/92	Ø8	Ø4	92

163

U.S.G.P.O.: 1994 - 384-4

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 1994

Application or Docket Number: 08/375,249

CLAIMS AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE	SMALL ENTITY FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY FEE
BASIC FEE				365.00	OR		730.00
TOTAL CLAIMS	4 minus 20 =	*	x$11=		OR	x$22=	
INDEPENDENT CLAIMS	1 minus 3 =	*	x38=		OR	x76=	
MULTIPLE DEPENDENT CLAIM PRESENT			+120=		OR	+240=	
			TOTAL		OR	TOTAL	730

* If the difference in column 1 is less than zero, enter "0" in column 2

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 4	Minus	** 20	= —
Independent	* 1	Minus	*** 3	= —
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
x$11=		OR	x$22=	
x38=		OR	x76=	
+120=		OR	+240=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
x$11=		OR	x$22=	
x38=		OR	x76=	
+120=		OR	+240=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
x$11=		OR	x$22=	
x38=		OR	x76=	
+120=		OR	+240=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 1992

Application or Docket Number: 07178

CLAIMS AS FILED - PART I

	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE	SMALL ENTITY FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY FEE
FOR							
BASIC FEE				$355.00	OR		$710.00
TOTAL CLAIMS	4 minus 20 =	*	x$11=		OR	x$22=	
INDEPENDENT CLAIMS	1 minus 3 =	*	x 37=		OR	x 74=	
MULTIPLE DEPENDENT CLAIM PRESENT			+115=		OR	+230=	
			TOTAL		OR	TOTAL	710

* If the difference in column 1 is less than zero, enter "0" in column 2

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
Total	* 4	Minus	** 20	=	x$11=		OR	x$22=	
Independent	* 1	Minus	*** 3	=	x 37=		OR	x 74=	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					+115=		OR	+230=	
					TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
Total	* 4	Minus	** 20	=	x$11=		OR	x$22=	
Independent	* 1	Minus	*** 3	=	x 37=		OR	x 74=	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					+115=		OR	+230=	
					TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
Total	*	Minus	**	=	x$11=		OR	x$22=	
Independent	*	Minus	***	=	x 37=		OR	x 74=	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					+115=		OR	+230=	
					TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875
(Rev. 10-92)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

PTO 1130 (REV 11/91)

U.S. DEPARTMENT OF COMMERCE– PATENT & TRADEMARK OFFICE

PACE DATA ENTRY CODING SHEET

1ST EXAMINER: B. Chase — DATE: 8-23-93

2ND EXAMINER: — DATE:

APPLICATION NUMBER	TYPE APPL	FILING DATE MONTH	DAY	YEAR	SPECIAL HANDLING	GROUP ART UNIT	CLASS	SHEETS OF DRAWING
08 097178	1	07	27	93	0	2617	340	7

TOTAL CLAIMS	INDEPENDENT CLAIMS	SMALL ENTITY?	FILING FEE	FOREIGN LICENSE	ATTORNEY DOCKET NUMBER
7	1	0	710	Y	K1398

CONTINUITY DATA

CONTINUITY CODE	STATUS CODE	PARENT APPPLICATION SERIAL NUMBER	PARENT PATENT NUMBER	PARENT FILING DATE MONTH	DAY	YEAR
		0				
		0				
		0				
		0				
		0				

PCT/FOREIGN APPLICATION DATA

FOREIGN PRIORITY CLAIMED	COUNTRY CODE	PCT/FOREIGN APPLICATION SERIAL NUMBER	FOREIGN FILING DATE MONTH	DAY	YEAR
Y	JPX	229,201/92	08	04	92

Staple Issue Slip Here

POSITION		ID NO.	DATE
CLASSIFIER		8	8-17-93
EXAMINER		36	8-23-93
TYPIST		329	8-23-93
VERIFIER		350	08/24/93
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SPEC. HAND			
FILE MAINT.			
DRAFTING			

INDEX OF CLAIMS

Claim Final	Claim Original	Date							
	1	7-7-94	7-19-94						
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SYMBOLS

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-	(Through numberal) Canceled
+	Restricted
N	Non-elected
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A	Appeal
O	Objected

Claim Final	Claim Original	Date							
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POSITION		ID NO.	DATE
CLASSIFIER			
EXAMINER		412	2-7-95
TYPIST		659	3-31-95
VERIFIER		314	3-31-95
CORPS CORR.			
SPEC. HAND			
FILE MAINT.			
DRAFTING			

INDEX OF CLAIMS

Claim Final	Claim Original	Date 6-8-95	Date 9-7-95	Date 2-1-96
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SYMBOLS

✓	Rejected
=	Allowed
- (Through numberal)	Canceled
+	Restricted
N	Non-elected
I	Interference
A	Appeal
O	Objected

Claim Final	Claim Original	Date
	51	
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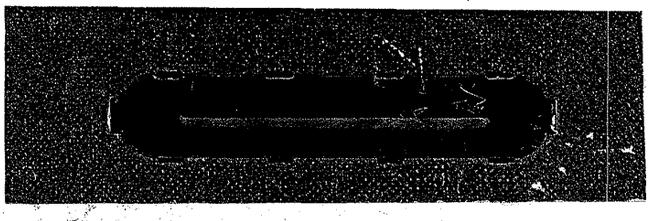

SEARCHED

Class	Sub.	Date	Exmr.
340	435, 995 903, 905	6-13-95	BAS
348	170, 113 148, 149		
364	424.01 424.04 424.05		
395	905, 22 11, 21 23		
	updated	9-7-95	BAS
382	104 157		
	updated	2-1-96	BAS

SEARCH NOTES

	Date	Exmr.
checked w/ Y. Couso	9-7-95	BAS

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
340	435, 903	2-1-96	BAS
348	148		
364	424.04		
395	905, 23		

(RIGHT OUTSIDE)

[redacted]

SEARCHED

Class	Sub.	Date	Exmr.
340	435, 995 903, 905	2-7-94	BAS
358	103		
364	424.01		
348	updated 149, 170	7-19-94	BAS

SEARCH NOTES

	Date	Exmr.
Class 358 is now 348		

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.

(RIGHT OUTSIDE)