PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G08B 21/00	A1	(11) International Publication Number: WO 99/36893
		(43) International Publication Date: 22 July 1999 (22.07.99)

(21) International Application Number: PCT/EP99/00300

(22) International Filing Date: 15 January 1999 (15.01.99)

(30) Priority Data:

98/00378	15 January 1998 (15.01.98)	FR
PCT/EP98/05383	25 August 1998 (25.08.98)	EP

(63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Application

US	PCT/EP98/05383 (CIP)
Filed on	25 August 1998 (25.08.98)

(71) Applicant *(for all designated States except US)*: HOLDING B.E.V. S.A. [LU/LU]; 69, route d'Esch, L–Luxembourg (LU).

(71)(72) Applicants and Inventors: PIRIM, Patrick [FR/FR]; 56, rue Patay, F–75013 Paris (FR). BINFORD, Thomas [US/US]; 16012 Flintlock Road, Cupertino, CA 95014 (US).

(74) Agent: PHELIP, Bruno; Cabinet Harlé & Phélip, 7, rue de Madrid, F–75008 Paris (FR).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND APPARATUS FOR DETECTION OF DROWSINESS

(57) Abstract

In a process of detecting a person falling asleep, an image of the face of the person is acquired. Pixels of the image having characteristics corresponding to an eye of the person are selected and a histogram is formed of the selected pixels. The histogram is analyzed over time to identify each opening and closing of the eye, and characteristics indicative of the person falling asleep are determined. A sub–area of the image including the eye may be determined by identifying the head or a facial characteristic of the person, and then identifying the sub–area using an anthropomorphic model. To determine openings and closings of the eyes, histograms of shadowed pixels of the eye are analyzed to determine the width and height of the shadowing, or histograms of movement corresponding to blinking are analyzed. An apparatus for detecting a person falling asleep includes a sensor for acquiring an image of the face of the person, a controller, and a histogram formation unit for forming a histogram on pixels having selected characteristics. Also disclosed is a rear–view mirror assembly incorporating the apparatus.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

METHOD AND APPARATUS FOR DETECTION OF DROWSINESS

Binford

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention relates generally to an image processing system, and more particularly to the use of a generic image processing system to detect drowsiness.

2. Description of the Related Art.

It is well known that a significant number of highway accidents result from drivers becoming drowsy or falling asleep, which results in many deaths and injuries. Drowsiness is also a problem in other fields, such as for airline pilots and power plant operators, in which great damage may result from failure to stay alert.

A number of different physical criteria may be used to establish when a person is drowsy, including a change in the duration and interval of eye blinking. Normally, the duration of blinking is about 100 to 200 ms when awake and about 500 to 800 ms when drowsy. The time interval between successive blinks is generally constant while awake, but varies within a relatively broad range when drowsy.

Numerous devices have been proposed to detect drowsiness of drivers. Such devices are shown, for example, in U.S. Patent Nos. 5,841,354; 5,813,99; 5,689,241;5,684,461; 5,682,144; 5,469,143; 5,402,109; 5,353,013; 5,195,606; 4,928,090; 4,555,697; 4,485,375; and 4,259,665. In general, these devices fall into three categories: i) devices that detect movement of the head of the driver, e.g., tilting; ii) devices that detect a physiological change in the driver, e.g., altered heartbeat or breathing, and iii) devices that

detect a physical result of the driver falling asleep, e.g., a reduced grip on the steering wheel. None of these devices is believed to have met with commercial success.

Commonly-owned PCT Application Serial Nos. PCT/FR97/01354 and PCT/EP98/05383 disclose a generic image processing system that operates to localize objects in relative movement in an image and to determine the speed and direction of the objects in real-time. Each pixel of an image is smoothed using its own time constant. A binary value corresponding to the existence of a significant variation in the amplitude of the smoothed pixel from the prior frame, and the amplitude of the variation, are determined, and the time constant for the pixel is updated. For each particular pixel, two matrices are formed that include a subset of the pixels spatially related to the particular pixel. The first matrix contains the binary values of the subset of pixels. The second matrix contains the amplitude of the variation of the subset of pixels. In the first matrix, it is determined whether the pixels along an oriented direction relative to the particular pixel have binary values representative of significant variation, and, for such pixels, it is determined in the second matrix whether the amplitude of these pixels varies in a known manner indicating movement in the oriented direction. In domains that include luminance, hue, saturation, speed, oriented direction, time constant, and x and y position, a histogram is formed of the values in the first and second matrices falling in user selected combinations of such domains. Using the histograms, it is determined whether there is an area having the characteristics of the selected combinations of domains.

It would be desirable to apply such a generic image processing system to detect the drowsiness of a person.

SUMMARY OF THE INVENTION

The present invention is a process of detecting a driver falling asleep in which an image of the face of the driver is acquired. Pixels of the image having characteristics corresponding to characteristics of at least one eye of the driver are selected and a histogram is formed of the selected pixels. The histogram is analyzed over time to identify each opening and closing of the eye, and from the eye opening and closing information, characteristics indicative of a driver falling asleep are determined.

In one embodiment, a sub-area of the image comprising the eye is determined prior to the step of selecting pixels of the image having characteristics corresponding to characteristics of an eye. In this embodiment, the step of selecting pixels of the image having characteristics of an eye involves selecting pixels within the sub-area of the image. The step of identifying a sub-area of the image preferably involves identifying the head of the driver, or a facial characteristic of the driver, such as the driver's nostrils, and then identifying the sub-area of the image using an anthropomorphic model. The head of the driver may be identified by selecting pixels of the image having characteristics corresponding to edges of the head of the driver. Histograms of the selected pixels of the edges of the driver's head are projected onto orthogonal axes. These histograms are then analyzed to identify the edges of the driver's head.

The facial characteristic of the driver may be identified by selecting pixels of the image having characteristics corresponding to the facial characteristic. Histograms of the selected pixels of the facial characteristic are projected onto orthogonal axes. These histograms are then analyzed to identify the facial characteristic. If desired, the step of identifying the facial characteristic in the image involves searching sub-images of the image until the facial characteristic is found. In the case in which the facial characteristic is the

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.