[0048] Trigger events are divided into two groups: those requiring immediate action and those not requiring immediate action, but necessary for proper billing of insurance. Those required for proper billing of insurance will be recorded in the same file with all the other recorded vehicle sensor information. Those trigger events requiring action will be uploaded to a central control center which can take action depending on the trigger event. Some trigger events will require dispatch of emergency services, such as police or EMS, and others will require the dispatch of claims representatives from the insurance company.

[0049] The following comprises an exemplary of some, but not all, trigger events:

Need for Assistance:

[0050] These events would require immediate notification of the central control center.

1. Accident Occurrence. An accident could be determined through the use of a single sensor, such as the deployment of an airbag. It could also be determined through the combination of sensors, such as a sudden deceleration of the vehicle without the application of the brakes.
2. Roadside assistance needed. This could be through the pressing of a "panic button" in the vehicle or through the reading of a sensor, such as the level of fuel in the tank. Another example would be loss of tire pressure, signifying a flat tire.
3. Lock-out assistance needed. The reading of a combination of sensors would indicate that the doors are locked but the keys are in the ignition and the driver has exited the vehicle.
4. Driving restrictions. The insured can identify circumstances in which he/she wants to be notified of driving within restricted areas, and warned when he/she is entering a dangerous area. This could be applied to youthful drivers where the parent wants to restrict time or place of driving, and have a record thereof.

Unsafe Operation of the Vehicle

[0051] These events would be recorded in the in-vehicle recording device for future upload.

[0052] Constant trigger events would result in notification of the driver of the exceptions.

1. Excessive speed. The reading of the vehicle speed sensors would indicate the vehicle is exceeding the speed limit. Time would also be measured to determine if the behavior is prolonged.
2. Presence of alcohol. Using an air content analyzer or breath analyzer, the level of alcohol and its use by the driver could be determined.
3. Non-use of seatbelt. Percent of sample of this sensor could result in additional discount for high use or surcharge for low or no use.
4. Non-use of turn signals. Low use could result in surcharge.
5. ABS application without an accident. High use could indicate unsafe driving and be subject to a surcharge.

[0053] With particular reference to FIG. 2, a general block diagram/flowchart of the network design for gathering appropriate information for insurance billing on a periodic basis is illustrated. Each unit of risk **200**, which as noted above, can just as easily be an airplane or boat, as well as a automobile, includes the data storage **202** and data process logic **204** as described more in detail in FIG. 4. The insured **206** responsible for each unit of risk communicates within the insuring entity **208** or its designee (by "designee" is meant someone acting for the insurer, such as a dedicated data collection agent, data handler or equipment vendor **210** and/or a value added service provider **212.)** The data handler can be a third party entity verifying that the operating equipment of the system is in proper working order, and as such, will usually be a subcontractor to the insurer. A value added service provider is another third party entity, such as a directional assistance service, or telephone service provider, also apart from the insurer, whose communications with the units of risk may be important or useable to the insurance computation algorithms.

[0054] Another important feature of FIG. 2 is that the insured **206** may not only communicate with the insurer **208** through the communications link **418** (FIG. 4), but also through an Internet **218** communications path. Such communication will occur through a Webserver **220** and the insurer's Web site so that an insured **206** may get on-line with the insurer **208** to observe and verify recorded data, claims processing, rating and billing **222**, as well as acquire improved insurance cost estimations, as will hereinafter be more fully explained.

[0055] With particular reference to FIG. 5, a more detailed description of system use of data acquired from the unit of risk is explained with particular attention to advantageous Internet communications. The unit of risk **200** is primarily concerned with transferring three classes of data between it and the insurer. The event data **500** and stored sensor data **502** have been discussed with reference to FIG. 1. Data process logic **504** is particular processing logic that can be transferred from the insurer to the unit of risk that is adapted for acquiring data especially important for assessing the particular unit's insurance costs. For example, if a particular unit has a special need for providing information about brake pedal application, special data process logic will be provided to that unit to store data related to this activity. On the other hand, for many other units such data may not be necessary and so the unit may operate with standard data process logic **204.** The important feature of special data process logic **504** is that the data process logic **204** for a unit of risk can be regularly updated as either the insured, the insurer or events warrant. One easily foreseeable special data process logic would be related to breathalyser analysis.

[0056] The process flowchart starting at Begin **506** more generally describes the communication activity between the insurer and the unit of risk. The insurer will acquire event data **508**, sensor data **510**, may update **512** the data process logic and then process **514** the raw data elements to generate either the calculated or derived data elements. All relevant data is stored **516** in a conventional data storage device **518**. If the stored item is an event **524**, then the insurer needs to cause some sort of response to the event. For example, if there is an airbag deployment, the insurer may actually try to communicate with the vehicle, and upon failure of communication, may initiate deployment of emergency medical or police service. If this specific event processing and/or alerts **526** occurs, the system may have to initiate a charge per use event. For instance, charges can also include immediate response claims, EMS contact charges or police dispatch charges. The data or events which are stored in stored device **518** are accessed by a billing algorithm **530** to generate a cost for the unit of risk in consideration of all the relevant data and events occurring in that period. It is a special feature of the subject invention that the cost of insurance is based upon the real time data occurring contemporaneously with the billing so that the system provides an insurance use cost, as opposed to an estimation based upon historical data. After a relevant cost is computed, periodic bills are produced and typically mailed to a customer as an account statement **534.**

[0057] Another important feature of the subject invention illustrated in FIG. 5 is that the insurer provides a Webserver **220** to allow a customer to access via Internet **218** communication, the relevant sensor data and event data associated with the customer.

[0058] Two different types of on-line services interfaces are illustrated; a prospective on-line services interface **550**, or an interface **552** for reporting acquired data. The data reports through the acquired service interface may comprise all of the stored event and sensor data, along with enhanced processing maps showing travel routes during the billing period, or even a map showing current location of the unit of risk. By Geofencing is meant to identify when the unit travels outside of a certain geographical area. It is even possible to determine whether automobile maintenance service is appropriate by diagnostic analysis of the sensor and event data.

[0059] The prospective interface relates to "what if" gaming where a customer can project certain usages of the unit of risk, and the system can, in combination with similar occurring usage in the past or, based upon the overall customer profile or matrix, project a estimated cost for such usage. In effect, a user can determine in advance what particular usage of the unit will incur as insurance cost with a very reliable associated insurance estimate.

[0060] Lastly, enhanced on-line account statements **554** can also be communicated on-line wherein maps with usage, or service usage details can be provided as a more detailed explanation of the resulting costs of an account statement.

[0061] With particular reference to FIG. 6, the subject invention is particularly useful for generating improved rating algorithms due to the improved acquisition and amount of relative data for assessing insurance costs for a unit of risk. In the manner as discussed above, the database **518** has the benefit of the data from a plurality of customers **206**. An insurer can over time use the accumulated underwriting and rating information from individual customers **520** to develop improved rating algorithms **522**. Such improved algorithms can be regularly communicated to the units of risk **200** for improved insurance cost computation accuracies. The improved rating algorithms can be communicated **524** to the units of risk on-board computer **300** (FIG. 4).

[0062] The subject invention is also applicable as a process for collecting data to be used for the following non-insurance related purposes: advertising and marketing, site selection, transportation services, land use planning, determining road design, surface or composition, traffic planning and design, and road conditions.

[0063] The invention has been described with reference to the preferred embodiments. Obviously modifications and alterations will occur to others upon a reading and understanding of this specification. The present invention is intended to include all such modifications and alterations in so far as they come within the scope of the appended claims or equivalents thereof.

Claims

1. A method of communicating a cost of insuring a unit of risk and corresponding operating characteristics for the unit monitored for a selected period, comprising steps of:

   providing a Web site system for communicating data between an insurer and an insured relative to the unit of risk;

monitoring the operating characteristics during the selected period;
deciding the cost of insuring for the period based upon the operating characteristics monitored in that period; and
selectively communicating the monitored operating characteristics and decided cost to the insured through the Web site system.

2. The method as defined in claim 1 wherein the selected period comprises a real time period for operating the unit of risk.

3. The method as defined in claim 1 wherein the selected period comprises a prospective period for operating the unit of risk, the operating characteristics comprise estimated operating characteristics suggested by the insured, and the decided cost of insuring comprises an estimated cost for the estimated operating characteristics.

4. The method as defined in claim 3 wherein the estimated operating characteristics selectively comprise a destination, a travel route, a time of travel or an operator identity for the unit of risk.

5. The method as defined in claim 1 further including generating an operating profile for the unit of risk from the monitored operating characteristics.

6. The method as defined in claim 5 further including identifying an operator as the unit of risk.

7. The method as defined in claim 5 further including identifying an equipment item as the unit of risk.

8. The method as defined in claim 1 further including providing selectively available value added services including telephone services, positioning services and diagnostic services to the unit of risk or operator.

9. The method as defined in claim 8 further including considering the value added services for the deciding of the cost of insurance.

10. A system for Internet on-line communicating between an insurer and insured, of detected operating characteristics of a unit of risk for a selected period, and a cost of insuring the unit for the selected period, as decided by the insurer in consideration of the detected operating characteristics, the system comprising:

a Web site system for selectively communicating the operating characteristics and the cost from the insurer to the insured;
a monitoring system for monitoring the operating characteristics;
a storage system for storing the operating characteristics, the storage system being accessible to the Web site system; and,
a processing system for deciding the cost of insuring the unit for the period based upon the monitored operating characteristics, the processing system being accessible to the Web site system.

11. The system as defined in claim 10 wherein the selected period comprises a real time period for operating the unit of risk.

12. The system as defined in claim 10 wherein the selected period comprises a prospective period for operating the unit of risk, the operating characteristics comprise estimated operating characteristics suggested by the insured, and the decided cost of insuring comprises an estimated cost for the estimated operating characteristics.

13. The system as defined in claim 10 wherein the unit of risk comprises an operator.

14. The system as defined in claim 10 wherein the unit of risk comprises an equipment item.

15. The system as defined in claim 10 including an on-line service interface providing an item from a group comprising usage projection estimates, maps, geofencing and automobile service diagnostics.

16. The system as defined in claim 10 including an on-line account statement interface providing cost information for the unit of risk and further selectively providing maps indicating unit usage, and service usage detail of the unit of risk.

17. The system as defined in claim 10 including a user identification system for authenticating an operator of the unit of risk and wherein the identification of the user corresponds to an associated insurance rating for the user.

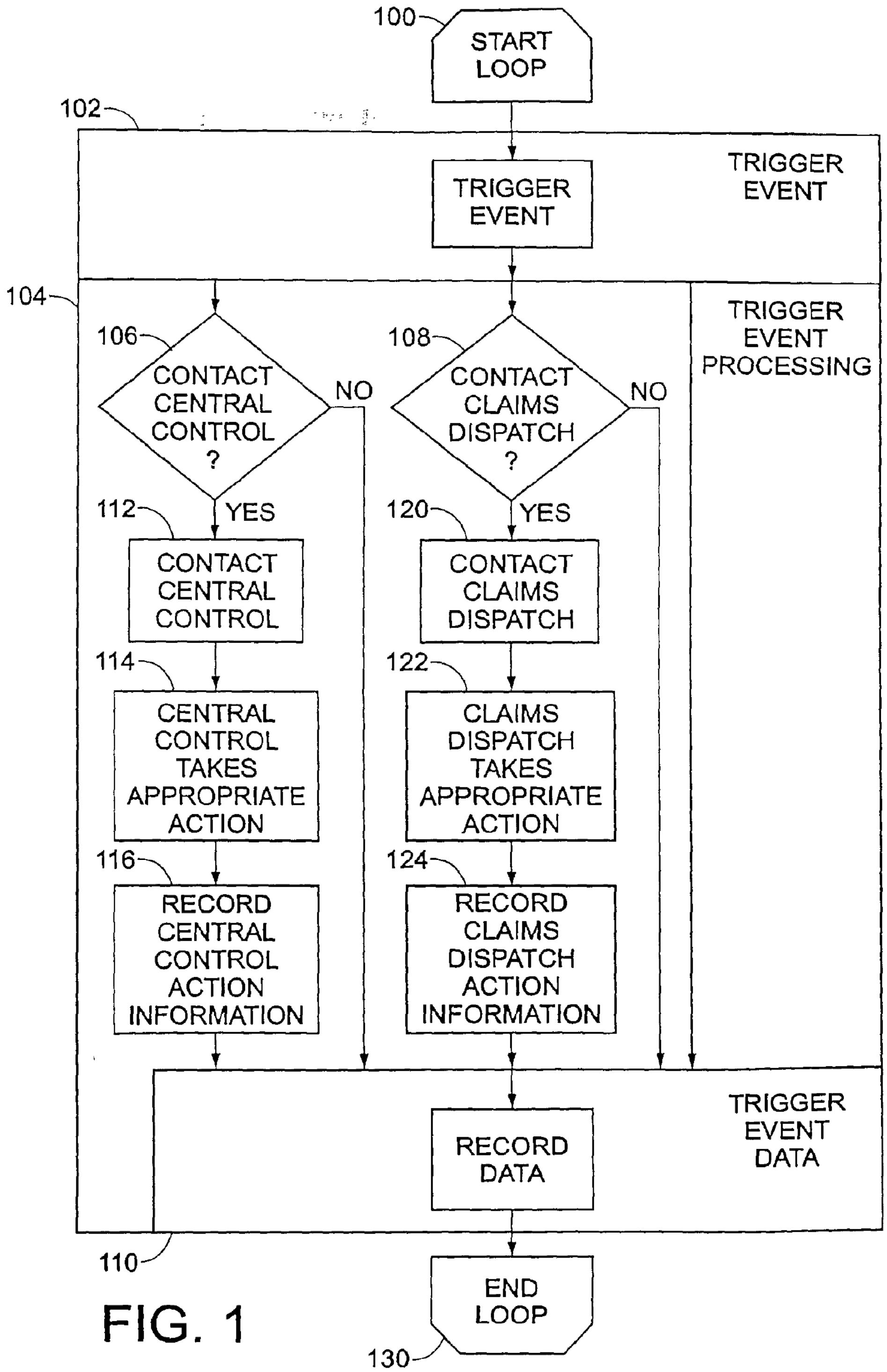
100
START LOOP
102
TRIGGER EVENT
TRIGGER EVENT
104
TRIGGER EVENT PROCESSING
106
CONTACT CENTRAL CONTROL ?
NO
YES
108
CONTACT CLAIMS DISPATCH ?
NO
YES
112
CONTACT CENTRAL CONTROL
120
CONTACT CLAIMS DISPATCH
114
CENTRAL CONTROL TAKES APPROPRIATE ACTION
122
CLAIMS DISPATCH TAKES APPROPRIATE ACTION
116
RECORD CENTRAL CONTROL ACTION INFORMATION
124
RECORD CLAIMS DISPATCH ACTION INFORMATION
RECORD DATA
TRIGGER EVENT DATA
110
END LOOP
130

FIG. 1

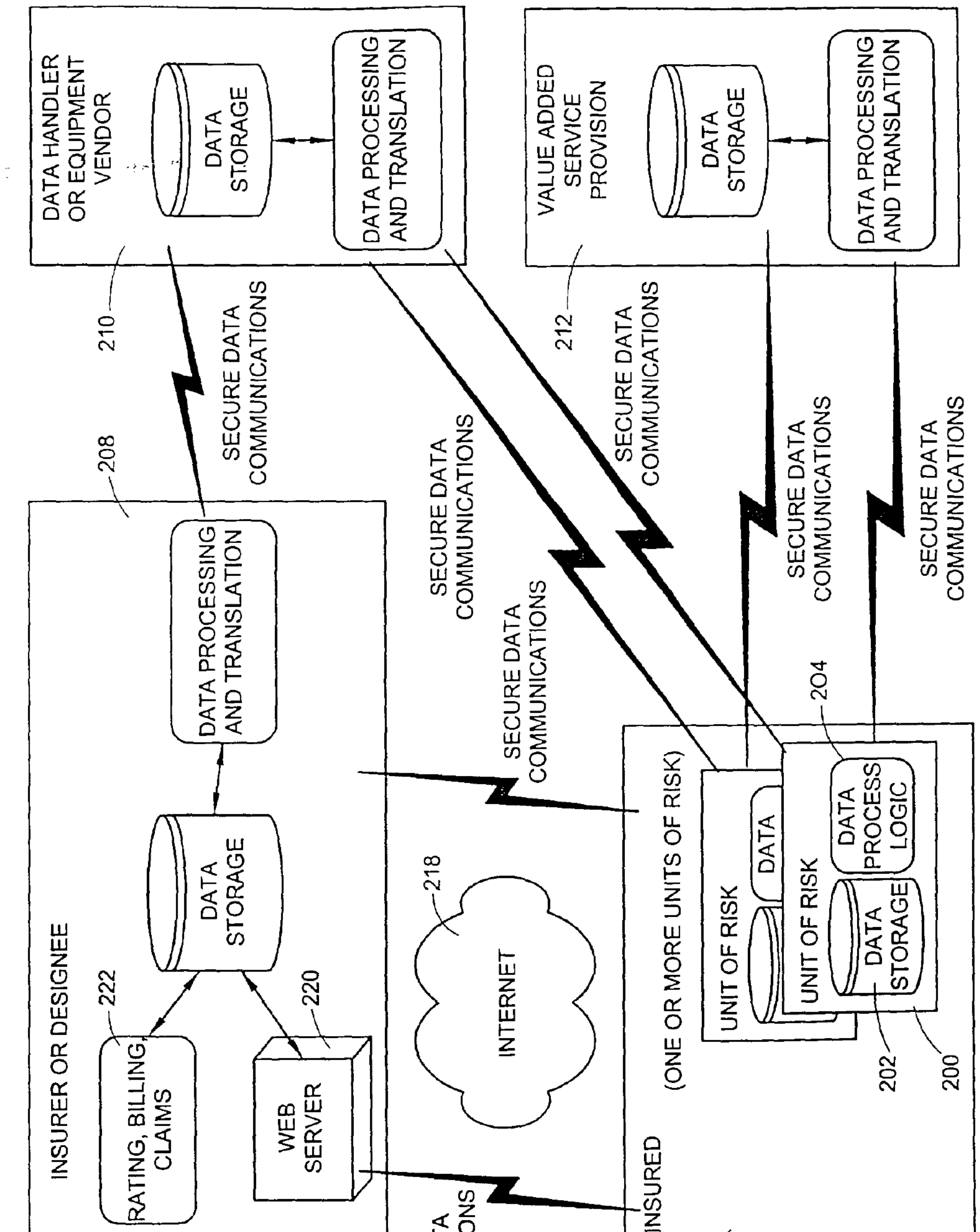
INSURER OR DESIGNEE
208
RATING, BILLING, CLAIMS
222
DATA STORAGE
DATA PROCESSING AND TRANSLATION
WEB SERVER
220
INTERNET
218
SECURE DATA COMMUNICATIONS
SECURE DATA COMMUNICATIONS
SECURE DATA COMMUNICATIONS
SECURE DATA COMMUNICATIONS
SECURE DATA COMMUNICATIONS
SECURE DATA COMMUNICATIONS
SECURE DATA COMMUNICATIONS
INSURED
(ONE OR MORE UNITS OF RISK)
206
UNIT OF RISK
DATA
UNIT OF RISK
DATA PROCESS LOGIC
DATA STORAGE
204
202
200
DATA HANDLER OR EQUIPMENT VENDOR
210
DATA STORAGE
DATA PROCESSING AND TRANSLATION
VALUE ADDED SERVICE PROVISION
212
DATA STORAGE
DATA PROCESSING AND TRANSLATION

FIG. 2

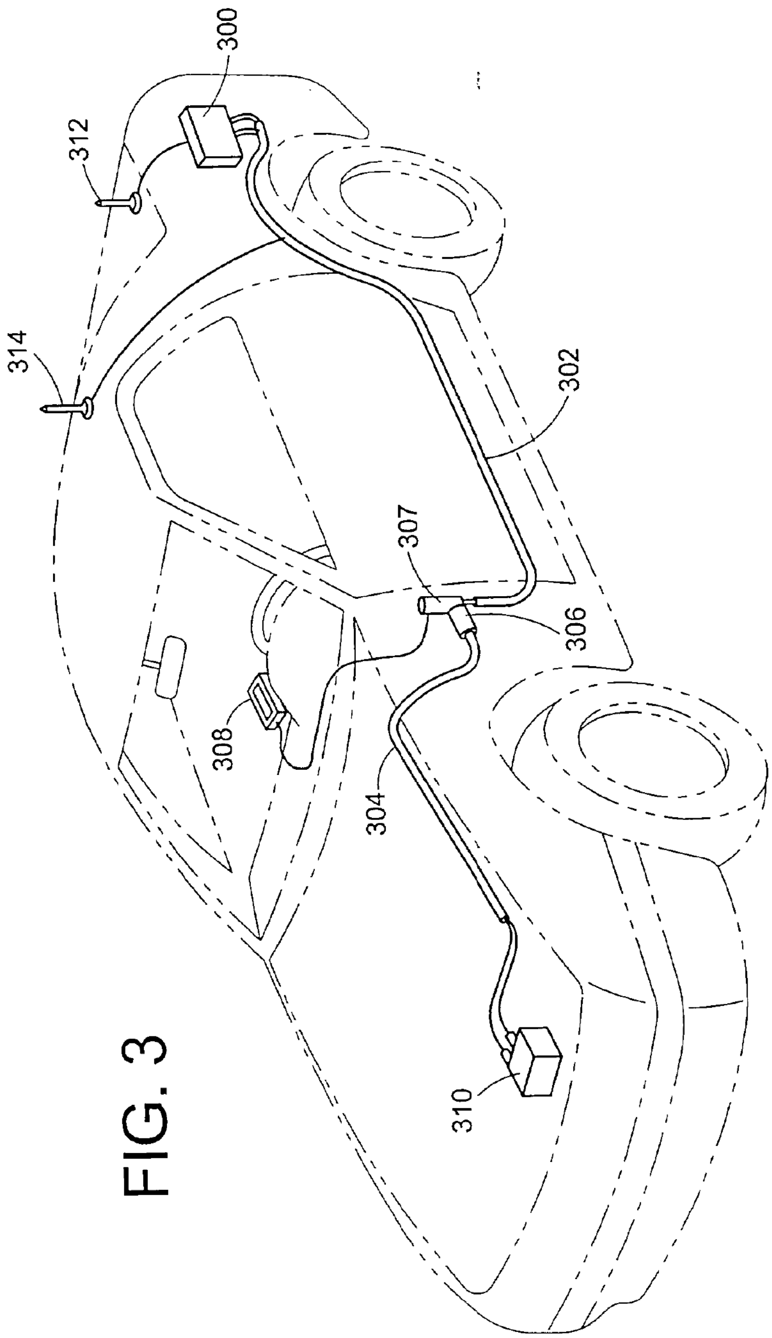

FIG. 3

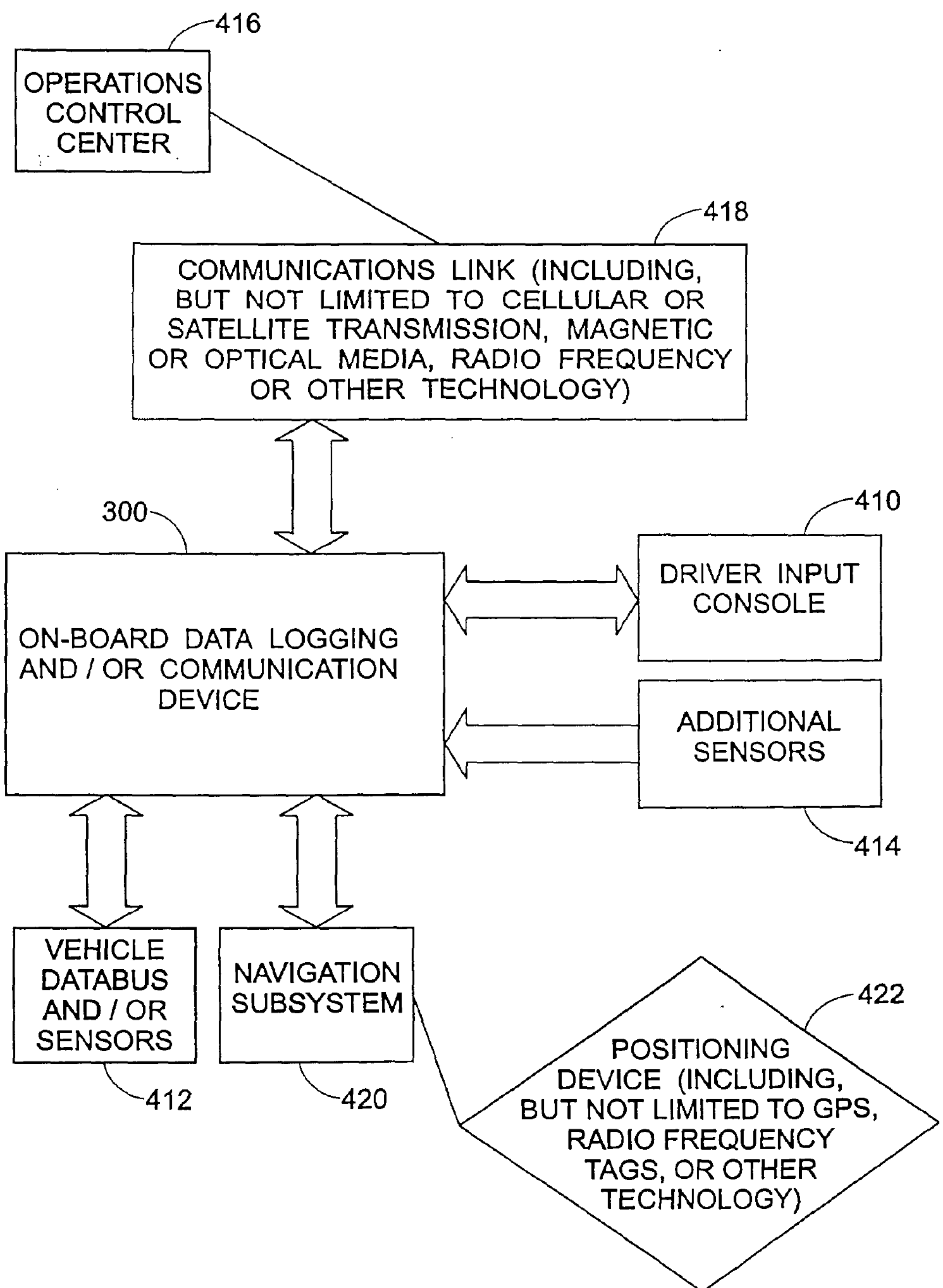
416
OPERATIONS CONTROL CENTER
418
COMMUNICATIONS LINK (INCLUDING, BUT NOT LIMITED TO CELLULAR OR SATELLITE TRANSMISSION, MAGNETIC OR OPTICAL MEDIA, RADIO FREQUENCY OR OTHER TECHNOLOGY)
300
ON-BOARD DATA LOGGING AND / OR COMMUNICATION DEVICE
410
DRIVER INPUT CONSOLE
ADDITIONAL SENSORS
414
VEHICLE DATABUS AND / OR SENSORS
412
NAVIGATION SUBSYSTEM
420
422
POSITIONING DEVICE (INCLUDING, BUT NOT LIMITED TO GPS, RADIO FREQUENCY TAGS, OR OTHER TECHNOLOGY)

FIG. 4

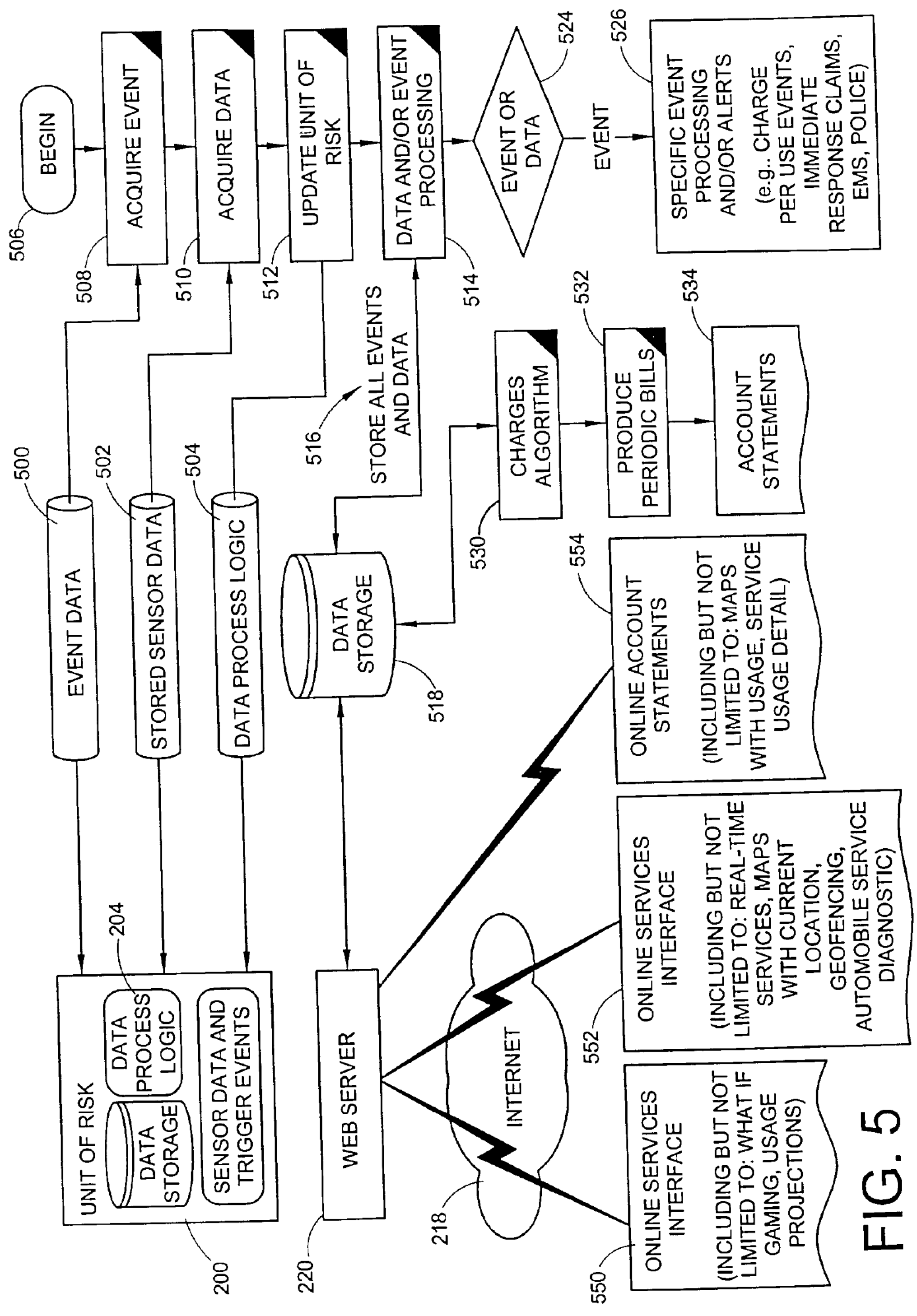
BEGIN
506
ACQUIRE EVENT
508
ACQUIRE DATA
510
UPDATE UNIT OF RISK
512
DATA AND/OR EVENT PROCESSING
514
EVENT OR DATA
524
EVENT
SPECIFIC EVENT PROCESSING AND/OR ALERTS (e.g.. CHARGE PER USE EVENTS, IMMEDIATE RESPONSE CLAIMS, EMS, POLICE)
526
EVENT DATA
500
STORED SENSOR DATA
502
DATA PROCESS LOGIC
504
STORE ALL EVENTS AND DATA
516
DATA STORAGE
518
CHARGES ALGORITHM
530
PRODUCE PERIODIC BILLS
532
ACCOUNT STATEMENTS
534
UNIT OF RISK
DATA STORAGE
DATA PROCESS LOGIC
204
SENSOR DATA AND TRIGGER EVENTS
200
WEB SERVER
220
INTERNET
218
ONLINE SERVICES INTERFACE (INCLUDING BUT NOT LIMITED TO: WHAT IF GAMING, USAGE PROJECTIONS)
550
ONLINE SERVICES INTERFACE (INCLUDING BUT NOT LIMITED TO: REAL-TIME SERVICES, MAPS WITH CURRENT LOCATION, GEOFENCING, AUTOMOBILE SERVICE DIAGNOSTIC)
552
ONLINE ACCOUNT STATEMENTS (INCLUDING BUT NOT LIMITED TO: MAPS WITH USAGE, SERVICE USAGE DETAIL)
554

FIG. 5

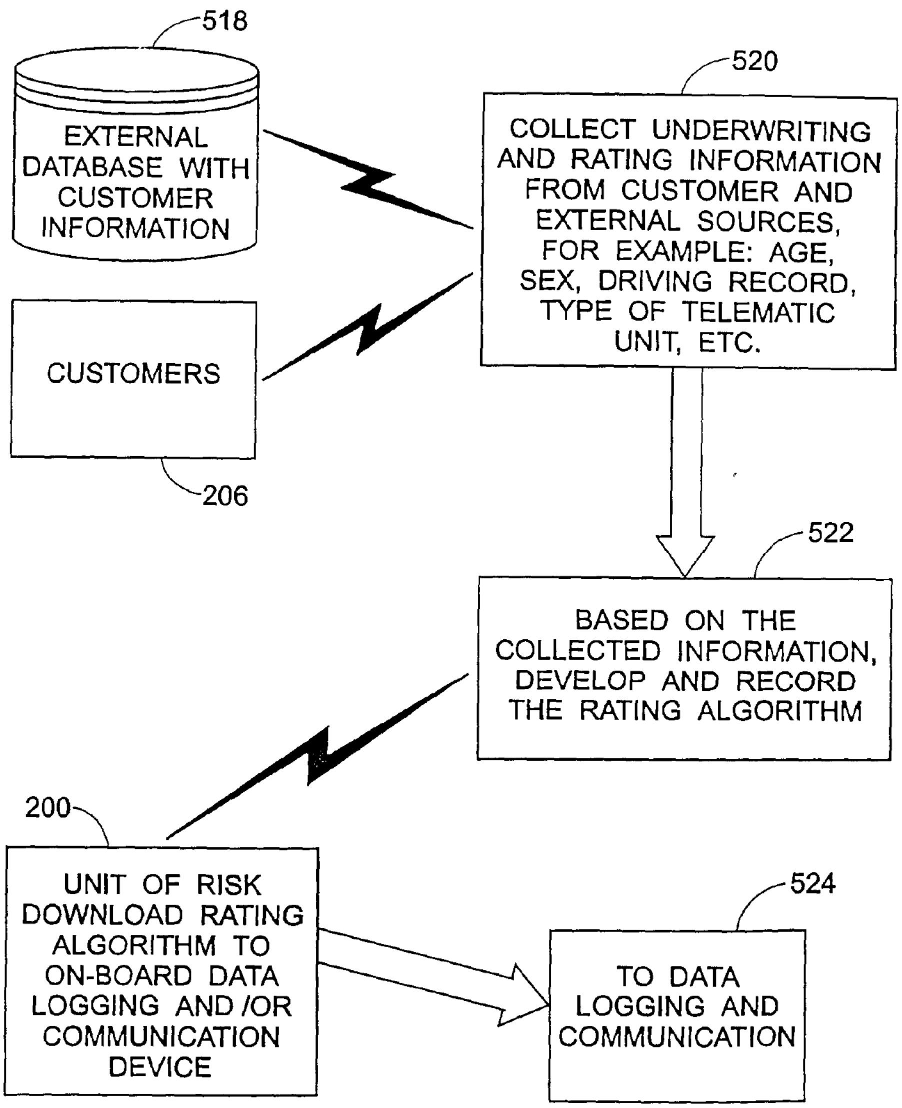
518
EXTERNAL DATABASE WITH CUSTOMER INFORMATION
520
COLLECT UNDERWRITING AND RATING INFORMATION FROM CUSTOMER AND EXTERNAL SOURCES, FOR EXAMPLE: AGE, SEX, DRIVING RECORD, TYPE OF TELEMATIC UNIT, ETC.
CUSTOMERS
206
522
BASED ON THE COLLECTED INFORMATION, DEVELOP AND RECORD THE RATING ALGORITHM
200
UNIT OF RISK DOWNLOAD RATING ALGORITHM TO ON-BOARD DATA LOGGING AND /OR COMMUNICATION DEVICE
524
TO DATA LOGGING AND COMMUNICATION

FIG. 6

European Patent Office

DECLARATION

which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number EP 01 30 3501

The Search Division considers that the present application, does not comply with the provisions of the EPC to such an extent that it is not possible to carry out a meaningful search into the state of the art on the basis of all claims	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Reason:	G06F17/60

The claims relate to subject matter excluded from patentability under Art. 52(2) and (3) EPC. Given that the claims are formulated in terms of such subject matter or merely specify commonplace features relating to its technological implementation, the search examiner could not establish any technical problem which might potentially have required an inventive step to overcome. Hence it was not possible to carry out a meaningful search into the state of the art (Rule 45 EPC). See also Guidelines Part B Chapter VIII, 1-6.

The applicant's attention is drawn to the fact that a search may be carried out during examination following a declaration of no search under Rule 45 EPC, should the problems which led to the declaration being issued be overcome (see EPC Guideline C-VI, 8.5).

Place of search	Date	Examiner
THE HAGUE	12 October 2001	Suendermann, R

EPO FORM 1504 (P04C37)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 241 599 A1

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(54) **An apparatus for monitoring a plurality of real-time insurance contracts**

(57) The present invention provides an apparatus for monitoring a real-time insurance contract whereby said real-time insurance contract has at least two active statuses. The apparatus comprises

- a data processing member
- a data storage member
- an information receiving member for receiving information relating to a change of risk covered by said insurance contract
- an insurance contract status assessment member capable of reassessing the status of said insurance contracts based on information comprising information received by said information receiving member and information stored in said data storage member.

EP 1 241 599 A1

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Description

Field of the invention

[0001] The present invention relates to apparatus for monitoring insurance contracts.

Background

[0002] Insurance contracts have become an integral part of daily lives and are one of the basic foundations of our social security system. They allow individual risks such as the risk of a car accident to be carried collectively by the group insurance holders. The financial loss in case of e.g. a car damage can therefore be paid by regular small monthly payments instead of one large sum at the time of damage.

[0003] Conventional insurance contracts generally have two statuses, they are either on or off. In other words, it is the underlying assumption of such a contract that the transferred risk is an averaged risk . Accordingly, the respective insurance fee also has to be an averaged insurance fee.

[0004] In real life, the situation is of course much more complex. The risk, when for example driving a car, is constantly changing. The weather can be either good or bad. Driving in a crowded city is much riskier than driving on a highway in rural countryside. When the car is parked, the risk drops to almost zero.

[0005] Hence, there is a desire to provide insurance contracts that dynamically adjust to the risk that currently needs to be covered, to provide a so-called real-time insurance contract. Such insurance contracts inherently have the advantage that the insurance fees are adjusted simultaneously so that the insurance holders only have to cover the insurance fees for the actually transferred risks. The insurance agreements could also be tailored much more to the holders' needs.

[0006] From a logistics point of view, real-time insurance contracts are much more difficult to administrate and to monitor. Not only all the changes of the status have to be recorded, it is also desirable that the insurance holder receives almost immediate notice a change in the transferred risk and the associated fee rate.

[0007] Currently, standard computer based apparatuses are used to administrate and monitor insurance contracts. These apparatuses are only capable of handling conventional two status insurance contracts. They can only store the information entered by the insurance administrator and are limited to storing the day of change of off to on and from on to off.

[0008] It is therefore an object of the present invention to provide an apparatus for monitoring real-time insurance contracts which overcomes the disadvantages of the prior apparatuses for monitoring insurance contracts.

Summary of the invention

[0009] The present invention provides an apparatus for monitoring a real-time insurance contract whereby said real-time insurance contract has at least two active statuses. The apparatus comprises

- a data processing member
- a data storage member for storing
  - insurance contract data, said insurance contract data comprising insurance contract status data for each of the statuses of said insurance contract
  - the currently transferred risk covered by said insurance contract,
  - the current insurance fee rate due in respect of said insurance contract
  - the times of the change of the status of said insurance contract
  - the amount of fees due in respect of said insurance contract
- an information receiving member for receiving information relating to a change of risk covered by said insurance contract
- an insurance contract status assessment member capable of reassessing the status of said insurance contracts based on information comprising information received by said information receiving member and information stored in said data storage member

Detailed Description

[0010] The present invention provides an apparatus for monitoring real-time insurance contract.

[0011] The term "insurance contract" as used herein encompasses all agreements between two parties whereby the first party is taking over a risk encountered by the second party and whereby the second party is paying an insurance fee in consideration of the transfer of risk to the first party. In most cases, an object causes the risk covered by the insurance contract. The object can be material (for example a car) or can be immaterial (for example health of a human being).

[0012] The term "status" of an insurance contract as used herein refers to each set of transferred risk and associated insurance fee rate. The two simplest statuses of an insurance contract are active and passive whereby active means a risk is transferred and the respective insurance fee is due and whereby passive means no risk in transferred and only nominal or administrative fees are due if any.

[0013] The term "real-time insurance contract" as used herein refers to insurance contracts having at least two active statuses. These active statuses differ in the risk transferred and generally also in the associated insurance fee rate.

[0014] The apparatus for monitoring real-time insurance contracts of the present invention is typically based on a computer system such as those well known in the art. This computer system provides the data processing member and the data storage member of the apparatus of the present invention. The data storage member can be a temporary storage means such as a memory chip of the computer, but preferably is a permanent storage means such as a CD-ROM, and yet more preferably is a re-writeable storage means such as a hard drive, a floppy drive, a re-writeable CD-ROM, an optical storage means, a magneto-optical storage means, and the like. The computer system of the apparatus of the present invention further provides data input such as a keyboard, a voice recognition system, a scanner, and the like. It further provides data output means such as displays, printers, and the like. Finally, the functionality of the computer system may be relied on for the functionality of the other members of the apparatus of the present invention such as the information receiving system, insurance contract status assessment member.

[0015] The apparatus of the present invention and in particular the computer system is capable of storing data necessary to administrate and monitor an insurance contract and preferably a plurality of insurance contracts. These data for example comprise insurance contract data such as contract status data for each of the statuses of the insurance contract, the currently transferred risk covered by the insurance contract, the current insurance fee rate due, the times of the change of the status of the insurance contract, the sum of fees due in respect of said insurance contract, personal information about the insurance holder, and the like.

[0016] The apparatus of the present invention further comprises an information receiving member for receiving information relating to a change of risk covered by said insurance contract. The information can be received from the insurance administrator, from the insurance holder, or from one or more external information gathering devices or any combination thereof.

[0017] Where the information is received from the insurance administrator or the insurance holder, the information receiving member may be designed so that the transfer of information to the apparatus of the present invention is triggered by the insurance administrator or by the insurance holder respectively. Such an apparatus offers the possibility for the insurance holder to instantaneously change the status of the insurance contract.

[0018] Where information is received from an external information gathering device, this device may gather environmental information relating to the object of the insurance contract such as time of the day, time of the year, weather information, street conditions, and the like. This device may also measure internal information relating to the object of the insurance contract such as the current mode of usage, the position of object, speed and acceleration of the object, and the like. The device may measure any combination of environmental information data and internal information data. Such an apparatus offers the possibility to adjust the status of the insurance contract in dependence of additional, current information about the object of the insurance contract. Sensors for detecting such data are well known in the art and generally are considered suitable for the present invention. The apparatus of the present invention may be designed such that the apparatus requests gathering of information for example on a regular time basis, such that the external information gathering device independently initiates the transfer of information for example triggered by a change of condition picked up by the sensor, or such that the external device independently gathers information (e.g. continuously or in regular time intervals), stores it, and later transmits the information to the information receiving means of the apparatus of the present invention.

[0019] In most cases, namely when the source of information is not co-located with the information receiving member, the information receiving member would be connected to the insurance administrator, to the insurance holder, or to the external information gathering device respectively by an information transfer system such as those well known in the art. Preferably, the information transfer system is capable of quickly transmitting information yet more preferably substantially immediately transmitting information. Suitable information transfer systems include but are not limited to phones, wireless phones, computer networks such as the Internet, satellite communication systems, and the like. Such an apparatus allows the status of the insurance contract to be adjusted virtually without any restrictions as to the current position of the insurance holder or the object of the insurance respectively.

[0020] The information receiving member may rely for its functionality on at least a part of the computer system of the apparatus of the present invention. A set of instructions to be carried out by the data processing member and stored on the data storage member may be the basis to provide the functionality of the information receiving member of the present invention. Alternatively, the information receiving member may be separate from the computer system of the apparatus of the present invention.

[0021] The apparatus of the present invention further comprises a insurance contract status assessment member. This member is capable of determining a change in the insurance contract status based on its input, namely the information received by the information receiving member. The member is capable of interpreting the input information received by the information receiving member and in particular so where the information is received from a external information gathering device. As used herein, the term "interpreting" means the received information is put in relation with the various possible statuses of the insurance contract such as by comparing received numerical data with ranges provided by the insurance contract status assessment member. The latter numerical ranges may be part of the insurance contract data stored on the data storage member. The output of the insurance contract status assessment member of the present invention is the current status of the insurance contract after taking into consideration the received information. Preferably, this output is subsequently stored in that data storage member.

[0022] The insurance contract status assessment member may rely for its functionality on at least a part of the computer system of the apparatus of the present invention. A set of instructions to be carried out by the data processing member and stored on the data storage member may be the basis to provide the functionality of the insurance contract status assessment member of the present invention. Alternatively, the insurance contract status assessment member may be separate from the computer system of the apparatus of the present invention.

[0023] The apparatus of the present invention may further comprise an insurance parameter determination member capable of determining insurance parameters for the insurance contract. Preferably, the insurance parameters determined by the insurance parameter determination member include the insurance rate. The output of the insurance parameter determination member is the current set of insurance parameters after consideration of the status input. Preferably, this output is subsequently stored in that data storage member. The determination process may be based on an arithmetic formula whereby the status of the insurance contract (the output parameter of the insurance contract status assessment member) is an input parameter of said arithmetic formula. The most simple suitable formula is based on a predefined array of sets of insurance parameters where the array is indexed by the possible statuses of the insurance contracts. In particular where the status of the insurance contract is defined by a numerical parameter, more complex, arithmetic formulas based on this numeric status parameter are also suitable.

[0024] Optionally, the determination process may have further input parameters such as external information (e.g. time of the day, time of the year, weather conditions, and the like), holder related information (e.g. insurance history of the holder, behavior pattern of the holder, health information of the holder, and the like), and the like.

[0025] The insurance parameter determination member may rely for its functionality on at least a part of the computer system of the apparatus of the present invention. A set of instructions to be carried out by the data processing member and stored on the data storage member may be the basis to provide the functionality of the insurance parameter determination member of the present invention. Alternatively, the insurance parameter determination member may be separate from the computer system of the apparatus of the present invention or may involve interaction with the insurance administrator.

[0026] The apparatus of the present invention may further comprise an information transmission member capable of transmitting information to either party of said insurance contract. Such information may for example comprise the fact of a change of status, the new status, the new fee rate, any combination thereof, and the like. If the information receiving party is not co-located with the apparatus of the present invention, the information may be transmitted via a suitable information transfer system. Suitable information transfer systems include but are not limited to phones, wireless phones, computer networks such as the Internet, satellite communication systems, and the like.

[0027] The information transmission member may rely for its functionality on at least a part of the computer system of the apparatus of the present invention. A set of instructions to be carried out by the data processing member and stored on the data storage member may be the basis to provide the functionality of the information transmission member of the present invention. Alternatively, the information transmission member may be separate from the computer system of the apparatus of the present invention.

Claims

1. An apparatus for monitoring a real-time insurance contract said real-time insurance contract having at least two active statuses, said apparatus comprising

   - a data processing member
   - a data storage member for storing

     - insurance contract data, said insurance contract data comprising insurance contract status data for each of the statuses of said insurance contract
     - the currently transferred risk covered by said insurance contract,
     - the current insurance fee rate due in respect of said insurance contract
     - the times of the change of the status of said insurance contract
     - the amount of fees due in respect of said insurance contract

   - an information receiving member for receiving information relating to a change of risk covered by said insurance contract
   - an insurance contract status assessment member capable of reassessing the status of said insurance contracts based on information comprising information received by said information receiving member and information stored in said data storage member

2. An apparatus for monitoring a real-time insurance contract according to Claim 1
wherein
said apparatus further comprises an insurance parameter determination member capable of determining insurance parameters for said insurance contract based on an arithmetic formula, said status of said insurance contract being an input parameter of said arithmetic formula.

3. An apparatus for monitoring a real-time insurance contract according to Claim 2
whereby
said insurance parameters determined by said insurance parameter determination member comprise the current fee rate.

4. An apparatus for monitoring a real-time insurance according to Claim 2 whereby
said arithmetic formula has a second input parameter, said second input parameter being independent of the object causing the risk covered by said insurance contract.

5. An apparatus for monitoring a real-time insurance contract according to Claim 4
wherein
said second parameter is selected from the group of

- time of the day
- time of the year
- weather conditions

6. An apparatus for monitoring a real-time insurance contract according to Claim 1
whereby
a change of risk covered by said insurance contract is triggered by the user of said object into the said information receiving member.

7. An apparatus for monitoring a real-time insurance contract according to Claim 1,
an object causing the risk covered by said insurance contract
wherein
said information receiving member receives information from an external data gathering device capable of detecting a change of the internal or environmental condition of said object.

8. An apparatus for monitoring a real-time insurance contract according to Claim 7
wherein
said change of the physical condition is selected from the group of

- change mode of usage
- change of position
- change of speed
- change of environmental conditions

9. An apparatus for monitoring a real-time insurance contract according to Claim 7
wherein
said information receiving member is capable of automatically detecting a change of the physical condition of said object.

10. An apparatus for monitoring a real-time insurance contract according to Claim 1
wherein
the information used by said insurance contract status assessment member further comprises an array of insurance parameters comprising a fee rate, said array being indexed by parameters comprising the possible statuses of said insurance contract.

11. An apparatus for monitoring a real-time insurance contract according to Claim 1
wherein
said apparatus further comprises an information transmission member capable of transmitting information to either party of said insurance contract.

European Patent Office

DECLARATION

which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number EP 01 10 6090

The Search Division considers that the present application, does not comply with the provisions of the EPC to such an extent that it is not possible to carry out a meaningful search into the state of the art on the basis of all claims

CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
G06F17/60

Reason:

Claims 1-11 relate to a conventional apparatus for performing a business method. Although these claims do not literally belong to the method category, they essentially claim protection for a commercial effect. The Search Division considers that searching this subject-matter would serve no useful purpose. It is not at present apparent how the subject-matter of the present claims may be considered defensible in any subsequent examination phase in front of the EPO with regard to the provisions of Articles 54 and 56 EPC (novelty, inventive step; see also Guidelines B-VII, 1-6.

The applicant's attention is drawn to the fact that a search may be carried out during examination following a declaration of no search under Rule 45 EPC, should the problems which led to the declaration being issued be overcome (see EPC Guideline C-VI, 8.5).

Place of search	Date	Examiner
THE HAGUE	11 July 2001	Suendermann, R

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(11) **EP 1 746 537 A3**

(12) **EUROPEAN PATENT APPLICATION**

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(54) **Monitoring system for determining and communicating a cost of insurance**

(57) Means are provided for recording, storing, calculating, communicating and reviewing one or more operational aspects of a machine. Insurance costs are based, in part, on activities of the machine operator. A discount may be provided in exchange for recording the operational aspects and providing the recorded information to the insurer. The party may review information and decide whether to provide it to the insurer. The means for reviewing may present comparative information. Information that causes insurance costs to vary may be highlighted. Provided data may be used to verify insurance application information, generate actuarial information or determine insurance rates. Operating data may be reviewed on a computer, a Web site or other display medium so a party can observe how his operating behavior compares to that of other operators of similar machines and may be manipulated so a party can understand how changes in operating behavior can affect his insurance rates.

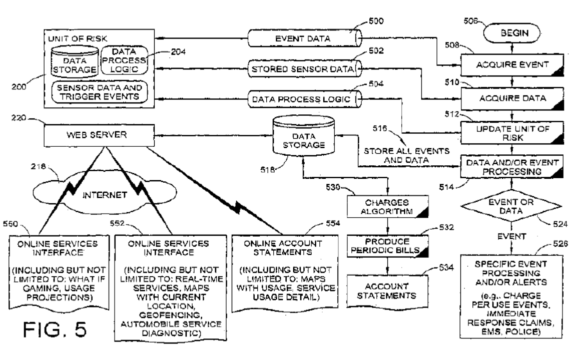

FIG. 5

EP 1 746 537 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 07 6910

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X	EP 1 241 599 A (NETFORMFIVE INFORMATIONSTECHNOLOGIE GMBH) 18 September 2002 (2002-09-18) * column 3, paragraph 16 - column 4, paragraph 20 * * column 5, paragraph 23 - paragraph 24 * -----	1-10	
X	US 2002/095249 A1 (LANG BROOK W) 18 July 2002 (2002-07-18) * abstract * * column 1, line 41 - column 2, line 59 * -----	1-10	
X	US 2003/009347 A1 (IWAI YASUSHI ET AL) 9 January 2003 (2003-01-09) * page 2, paragraph 20 - page 3, paragraph 33 * -----	1-10	TECHNICAL FIELDS SEARCHED (IPC) G06F
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 January 2007	Marcu, Antoniu

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 (P04C01)

8

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 07 6910

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The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-01-2007

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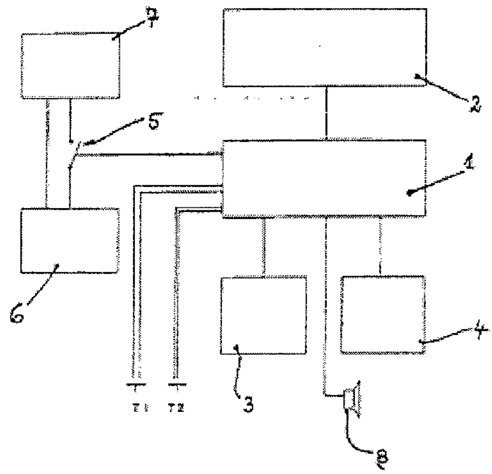
For more details about this annex : see Official Journal of the European Patent Office, No. 12/82



Speech recognition system as means of controlling access

AB
(DE19522940)
The voice controlled access system has a memory 2, a processor 1, a recorder 4, a loudspeaker 8, several batteries 3,6, two input keys T1,T2 and a main switch 5 controlling the activation of the vehicle electronic system 7. A spoken command is recorded, and the analogue signal is converted into a digital format for entering into the memory. The processor compares the command with the digitised reference speech patterns.

IN WAGNER THOMAS BAUER NORBERT

PA FRAUNHOFER

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Published As

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G07C-009/00
G10L-007/08
G10L-017/00

ICAA
B60R-025/00 [2006-01 A - I R M EP];
G07C-009/00 [2006-01 A - I R M EP];
G10L-017/00 [2006-01 A - I R M EP]

ICCA
B60R-025/00 [2006 C - I R M EP];
G07C-009/00 [2006 C - I R M EP];
G10L-017/00 [2006 C - I R M EP]

EC
B60R-025/00
G07C-009/00C2D
G10L-017/00U

CT
(DE19522940)
Search Report [Examiner]
DE4027491(A1) [DE4027491]
DE9419006(U1) [DE9419006U]
US5394135(A) [US5394135]
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(19) BUNDESREPUBLIK DEUTSCHLAND

DEUTSCHES PATENTAMT

(12) Offenlegungsschrift
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B 60 R 25/04

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(43) Offenlegungstag: 2. 1. 97

DE 195 22 940 A 1

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(56) Entgegenhaltungen:

DE	40 27 491 A1
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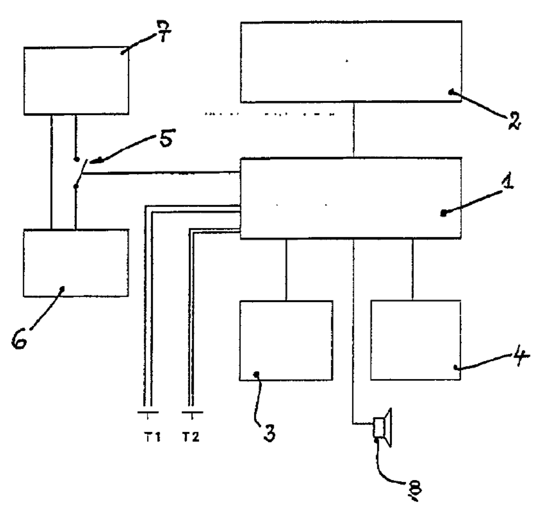
Prüfungsantrag gem. § 44 PatG ist gestellt

(54) Verfahren zum Identifizieren einer menschlichen Stimme

(57) Die Erfindung stellt ein zuverlässig arbeitendes Verfahren und eine solche Vorrichtung zum Identifizieren einer menschlichen Stimme bereit, insbesondere zum Sichern von Gegenständen gegen Diebstahl, umfassend
(a) das Aufnehmen der Stimme mit Hilfe einer Aufnahmeeinheit,
(b) das Umwandeln der aufgenommenen akustischen Signale in elektrische Signale,
(c) das Digitalisieren und Abspeichern der Signale in einer Auswerteeinheit mit Speicher,
wobei ggf. die obigen Schritte (a) bis (c) mit weiteren Stimmen wiederholt werden und
(d) das Vergleichen der digitalisierten Signale der Stimme mit solchen, die sich bereits im Speicher der Auswerteeinheit befinden, und ggf. das Identifizieren der Stimme als im wesentlichen identisch mit einer der Stimmen, die im Speicher der Auswerteeinheit gespeichert sind.



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Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

BUNDESDRUCKEREI 10. 96 602 001/363 1/27

Beschreibung

Die vorliegende Erfindung betrifft das Gebiet der akustischen Personenidentifikation. Das erfindungsgemäße Verfahren eignet sich beispielsweise zum Sichern von Gegenständen gegen Diebstahl, wobei die Identifikation einer Stimme als Schlüssel fungiert. Diese Identifikation muß zuverlässig arbeiten, sollte aber gleichwohl im Rahmen eines vertretbaren Hard- und Softwareaufwandes liegen.

Erfindungsgemäß wird diese Aufgabe dadurch gelöst, daß ein Verfahren zum Identifizieren einer menschlichen Stimme bereitgestellt wird, welches das Aufnehmen der Stimme mit Hilfe einer Aufnahmeeinheit, das Umwandeln der aufgenommenen akustischen Signale in elektrische Signale sowie das Digitalisieren und Abspeichern der Signale in einer Auswerteeinheit mit Speicher umfaßt. Erfindungsgemäß ist es möglich, daß mehrere Stimmen und/oder mehrere Laut folgen ein und derselben Stimme mittels der genannten Schritte im Speicher abgelegt, d. h. "eingelernt" werden. Zum Identifizieren einer bestimmten Stimme werden dann die wie oben erhaltenen digitalisierten Signale dieser Stimme mit solchen anderer Stimmen, die sich bereits im Speicher der Auswerteeinheit befinden, verglichen. Dabei kann die Stimme vom System als im wesentlichen identisch mit einer der Stimmen, die bereits gespeichert sind, identifiziert oder als unbekannt erkannt werden (Anspruch 1, Anspruch 10).

Das erfindungsgemäße Verfahren läßt sich besonders vorteilhaft beim Sichern von Gegenständen einsetzen, wobei die Identifikation der Stimme als "Schlüssel fungiert (Anspruch 11). Dieser "Schlüssel" kann beispielsweise das Unterbrechen oder Schließen eines Stromkreises sein. Auch andere Arten von Schließfunktionen sind denkbar (Computer-Zugangsberechtigung, Personen-Identifikation beim Online-Banking oder Einsatz in Geldautomaten). Um einen solchen Freigabe- oder Schließmechanismus zu konstruieren, wird eine Stimme oder werden mehrere Stimmen, bevorzugt in Form einer charakteristischen Laut- bzw. Tonabfolge, in digitalisierter Form im Speicher abgelegt. Die digitalisierten Charakteristika dieser Stimme oder Stimmen dienen als "Schloß". Nur solche Personen, deren Stimmen abgespeichert sind, verfügen über den zu diesem Schloß gehörigen "Schlüssel". Zum "Aufschließen" muß diese Person die genannten Laut- oder Tonfolgen, beispielsweise ein bestimmtes Codewort, von sich geben. In einer bevorzugten Ausführungsform der Erfindung läßt sich diese "Schließfunktion" aktivieren und deaktivieren, beispielsweise indem zwei Schalter den Ablauf der einzelnen Verfahrensschritte so steuern, daß der eine Schalter das Aufnehmen, Umwandeln und Speichern der Signale ermöglicht, während der andere Schalter das Vergleichen und ggf. Identifizieren ermöglicht (Anspruch 2).

In einer bevorzugten Ausführungsform läßt sich das Verfahren zum Sichern von Kraftfahrzeugen gegen Diebstähle einsetzen (Anspruch 4, Anspruch 5). Bekanntlich nimmt die Zahl von Kfz-Diebstählen, insbesondere bei teueren Modelle, drastisch zu, so daß erhöhte und zusätzliche Schutzmaßnahmen erforderlich sind. Gleichzeitig setzen Versicherungen für eine Kostenerstattung im Schadensfall wirksame Sicherungsmaßnahmen gegen unbefugte Benutzung voraus. Besonders vorteilhaft ist das vorliegende Verfahren, weil es mit einem unverlierbaren Schlüsselsystem arbeitet. Sicherungssysteme im Stand der Technik basieren im wesentlichen auf mechanischen oder elektronischen Schlüsseln, ohne die zwar eine unbefugte Benutzung oft wirkungsvoll verhindert wird, bei deren Verlust oder Diebstahl das Kfz jedoch sofort entwendet werden kann.

In einer bevorzugten Ausführungsform wird bei der Verwendung des erfindungsgemäßen Verfahrens zum Sichern von Kraftfahrzeugen deren Elektrik unterbrochen und erst dann wieder freigegeben, wenn sich ein Benutzer durch Sprechen eines Codewortes, beispielsweise seinen Namen, oder aber auch durch ein anderes eingespeichertes akustisches Signal zu erkennen gibt.

Ausschlaggebend für die Identifikation ist dabei die Kombination vieler Merkmale der Stimme der jeweiligen Person, beispielsweise Stimmfarbe, Tonhöhe, usw. die sich von anderen nicht imitieren lassen; ähnlich der Eigenschaft von Fingerabdrücken.

Die Verwendung des erfindungsgemäßen Verfahrens ist auch deshalb besonders vorteilhaft, da Speicher- und Logikbausteine ständig billiger werden und die meist bereits vorhandene Elektronik im Kfz, insbesondere bei teureren Modellen, beispielsweise das Vorhandensein eines Bordcomputers mit Speicher und Recheneinheit, die Installierung des entsprechenden Systems kostengünstig ermöglicht, bei schon vorhandenen Hardware-Konzept und Ergänzung eines vertretbaren Aufwandes an Software.

Um den Gegenstand zu sichern, ist die Auswerte- und Steuereinheit, mit der das Aufnehmen und Vergleichen der Stimmen ermöglicht wird, so mit dem zu sichernden Gegenstand verbunden, daß die Benutzung des Gegenstandes bei Feststellen der Identität der Stimme mit einer solchen, deren Signale bereits in der Auswerteeinheit des Speichers abgelegt sind, möglich ist; bei Feststellen mangelnder Identität aber unmöglich ist. Dies kann beispielsweise durch einen Schalter in einem Stromkreis des Gegenstandes erfolgen, ohne dessen Geschlossensein der Gegenstand nicht in Benutzung oder in Betrieb genommen werden kann. Im Falle der Sicherung eines Kraftfahrzeugs kann es sich dabei um einen Schalter handeln, der beim Erkennen einer abgespeicherten Stimme die vorher gesperrte Bordelektrik oder -elektronik freigibt.

Das erfindungsgemäße Verfahren wird mit Hilfe einer Auswerte- und Steuereinheit durchgeführt, die z. B. aus einem ASIC bestehen kann. Diese Einheit steuert sowohl das Einlernen als auch das Vergleichen und Identifizieren der Stimme: in einer Aufnahmeeinheit, beispielsweise mit Mikrofon, wird die Stimme des Benutzers zuerst in elektrische Signale umgewandelt, evtl. bandgefiltert und dann digitalisiert. Das digitalisierte Signal wird an die Auswerteeinheit weitergegeben und dort verglichen. Bevorzugt wird dabei ein Vergleichsalgorithmus eingesetzt, der in der Auswerteeinheit abgespeichert sein kann. Dieser Vergleichsalgorithmus hat zum Ziel, die digitalisierten Daten einer sich identifizierenden Person mit den im System gespeicherten Daten anderer, beispielsweise zum Benutzen des Gegenstandes befugter Personen zu vergleichen und so zu entscheiden, ob es sich bei der sich identifizierenden Person um eine befugte Person handelt.

Der Vergleichsalgorithmus berechnet eine Short-Time-Fouriertransformation der eingehenden digitalisierten Daten. Der dabei entstehende neue Datenvektor (auch Merkmalsvektor genannt) wird mit Hilfe eines Klassifikationsverfahrens mit den abgespeicherten Daten verglichen. Als Klassifikatoren können statistische Klassifikationsverfahren, neuronale Netze oder synergetische Computer verwendet werden. Der Klassifikator entscheidet, ob der Merkmalsvektor mit dem Merkmalsvektor einer gespeicherten Stimme so gut übereinstimmt, daß er diese Person als "im wesentlichen identisch" mit einer Person klassifiziert, deren Stimme gespeichert ist (Anspruch 7, Anspruch 8, Anspruch 9).

Wird das Verfahren zur Diebstahlsicherung eingesetzt, dann wird bei dieser — positiven — Klassifizierung die Diebstahlsicherung ausgeschaltet bzw. das "Schloß" mit der als "Schlüssel" erkannten Stimme aufgeschlossen. Im Falle eines Kfz wird dann beispielsweise die Bordelektronik freigegeben oder der Stromkreis zwischen Batterie und Zündung geschlossen.

Wird die Stimme als "fremd" klassifiziert, wird die Sperre nicht aufgehoben. Optional können optische oder akustische Warnsignale ausgegeben werden, beispielsweise mit Hilfe der Hupe oder Lichthupe (Anspruch 6).

Vorzugsweise wird die Spannungsversorgung des Sicherungssystems, über einen Akku gepuffert, von der Batterie des Kfz sichergestellt.

Ebenfalls optional kann ein Ausgang der Auswerteeinheit an vorhandene Bordlautsprecher (Radioanlage) abgeschlossen werden. Dies ermöglichst zusätzlich, daß ein Benutzer vom System durch einen akustischen Hinweis (z. B. den Satz "bitte identifizieren sie sich" oder einen Piepston) zum Versuch der Identifikation aufgefordert wird.

Es ist bevorzugt daß das "Einlernen" neuer befugter Benutzer nur bei ausgeschalteter Diebstahlsicherung erfolgen kann. Bevorzugt sind hierfür zwei Tasten im Fahrerraum vorgesehen, deren eine den "Einlernmodus" aktiviert. Ist dieser Modus aktiviert, kann der "neue Benutzer" mehrmals hintereinander charakteristische Laut- oder Tonfolgen von sich geben, beispielsweise seinen Namen oder ein frei wählbares Kennwort sprechen. Dieses Wort oder diese Laut folge wird vom System aufgenommen und vom Klassifikator der Auswertungseinheit in einer geeigneten Form im Systemspeicher angelegt. Anhand genau dieses Wortes wird der Benutzer nachher wieder identifiziert.

Bevorzugt erfolgt das Einschalten der Diebstahlsicherung von Kfz bei ausgeschalteter Zündung über eine weitere Taste im Fahrerraum. Ganz besonders bevorzugt ist es, daß die einmal eingeschaltete Sicherung nur durch das gesprochene Kennwort eines befugten Benutzers wieder deaktiviert wird.

Ein Beispiel soll das Verständnis der Erfindung vertiefen.

Fig. 1 zeigt das Beispiel einer Anordnung, mit der das erfindungsgemäße Verfahren durchgeführt werden kann, wenn ein Gegenstand wie ein Kfz gegen Diebstahl gesichert werden soll.

Im Bordcomputer befindet sich ein Chip **1** für die Datenauswertung (z. B. ein ASIC), der die Abspeicherung von Stimmen befugter Benutzer in einem Speicher **2** (z. B. einem EPROM oder EEPROM) steuert. Der Chip ist an die Stromversorgung der Batterie **6** angeschlossen. Die Versorgung kann über Akkus **3** gepuffert sein.

Ein Ausgang des Chips **1** ist mit einer Aufnahmeeinheit 4 mit einem Mikrofon verbunden. Ein weiterer Ausgang ist über einen Schalter **5** mit dem Stromkreis verbunden, der die Batterie **6** mit der Zündung oder Bordelektronik **7** verbindet.

Fakultativ sind Schalter oder Taster zum Scharfstellen der Diebstahlsicherung (T1) bzw. zum Starten des Einlernmodus für neue Benutzer (T2) vorgesehen. Ebenfalls fakultativ ist ein Ausgang des Chips mit einem Lautsprecher **8**, beispielsweise dem Radio, verbunden, durch welchen eine akustische Aufforderung zur Benutzeridentifikation aktiviert werden kann.

Die Klassifizierung des gesprochenen Wortes entscheidet, ob der über eine FFT gewonnene Merkmalsvektor der Sprache der Person, die das KfZ öffnen oder anlassen möchte, mit dem im Speicher **2** Vorgegebenen hinreichend übereinstimmt. Bejahendenfalls wird die Fahrzeugtür geöffnet oder das Anlassen erlaubt.

Mit einer Direktanlassung kann ebenfalls gearbeitet werden, so daß Schlüssel entbehrlich sind. Das Abschalten des Motors dagegen kann durch einen weiteren optionellen Taster erfolgen, hierfür ist die Benutzung des Wortes (dessen Merkmalsvektor) nicht zwingend, vorteilhaft sogar entbehrlich.

Patentansprüche

1. Verfahren zum Identifizieren einer menschlichen Stimme, insbesondere zum Sichern von Gegenständen gegen Diebstahl, umfassend
   (a) das Aufnehmen einer Stimme mit Hilfe einer Aufnahmeeinheit (4),
   (b) das Umwandeln der aufgenommenen akustischen Signale in elektrische Signale (4),
   (c) das Digitalisieren und Abspeichern der Signale in einer Auswerteeinheit mit Speicher (1, 2),

   wobei ggf. die Schritte (a) bis (c) mit weiteren Stimmen wiederholt werden, und
   (d) das Vergleichen digitalisierter Signale einer Vergleichs-Stimme mit einer oder mehreren solchen, die sich bereits im Speicher (2) der Auswerteeinheit (1) befinden, und Identifizieren der Stimme als im wesentlichen identisch mit der oder einer der Stimmen, die im Speicher (2) der Auswerteeinheit (1) gespeichert sind.
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Auswerteeinheit (1) über einen ersten Schalter (T2) so gesteuert wird, daß nur die Schritte (a) bis (c) ausgeführt werden können, und/oder über einen zweiten Schalter (T1) so gesteuert wird, daß nur Schritt (d) ausgeführt werden kann.
3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Auswerteeinheit (1) so mit dem zu sichernden Gegenstand verbunden ist, daß die uneingeschränkte Benutzung des Gegenstandes bei Feststellen der Identität der Vergleichs-Stimme mit einer solchen, deren Signale bereits im Speicher (2) abgelegt sind, möglich ist, bei Feststellen mangelnder Identität unmöglich ist.
4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, daß es sich bei dem zu sichernden Gegenstand um ein Kraftfahrzeug handelt, daß die Verbindung einen Schalter (5) umfaßt, der den zum Starten des Kraftfahrzeugs erforderlichen Stromkreis unterbrechen kann und daß die uneingeschränkte Benutzung das Starten und Wegfahren ist.
5. Verfahren nach Anspruch 2 und 4, dadurch gekennzeichnet, daß sich der erste und/oder der zweite Schalter (T1, T2) zur Steuerung der ausführbaren Schritte des Identifizierens im Innenraum des Kraftfahrzeugs befinden.
6. Verfahren nach einem der Ansprüche 3 bis 5, dadurch gekennzeichnet, daß beim Feststellen mangelnder Identität akustische oder optische Warnsignale abgegeben werden.

7. Verfahren nach einem der voranstehenden Ansprüche, dadurch gekennzeichnet, daß in Schritt (d) die Stimmen mit Hilfe eines Vergleichsalgorithmus verglichen werden, der eine Short-Time-Fouriertransformation (FFT) der eingehenden digitalisierten Daten berechnet, wobei der neu entstehende Datenvektor mit Hilfe eines Klassifikationsverfahrens mit Datenvektoren der abgespeicherten Signale verglichen wird.

8. Verfahren nach Anspruch 7, dadurch gekennzeichnet, daß für das Klassifikationsverfahren neuronale Netze oder synergetische Computer verwendet werden.

9. Verfahren nach einem der Ansprüche 3 bis 8, dadurch gekennzeichnet, daß der Klassifikator entscheidet, ob die verglichenen Merkmalsvektoren so gut übereinstimmen, daß im wesentlichen Identität festgestellt wird.

10. Vorrichtung zum Identifizieren einer menschlichen Stimme gemäß einem der erwähnten Verfahrensansprüche, umfassend

(a) eine Aufnahmeeinheit mit Mikrofon (**4**),
(b) eine Auswerte- und Steuereinheit (**1**),
(c) einen Speicher (**2**) für digitalisierte Stimmsignale, sowie
(d) eine Verbindung zu dem zu sichernden Gegenstand, die die Inbetriebnahme des Gegenstandes steuern kann (**5**), und/oder
(e) einen oder mehrere Akkumulatoren (**3**, **6**) für eine gepufferte Spannungsversorgung der Vorrichtung, und/oder
(f) einen oder mehrere Lautsprecher (**8**), und/oder
(g) Schalter (T1, T2) zum Steuern der Bedienungsfunktionen der Vorrichtung.

11. Verwendung mindestens eines gesprochenen Wortes als Schlüssel für das Öffnen einer Autotür oder als Schlüssel für das Freigeben des Motorstartens oder selbiges selbst.

Hierzu 1 Seite(n) Zeichnungen

- Leerseite -

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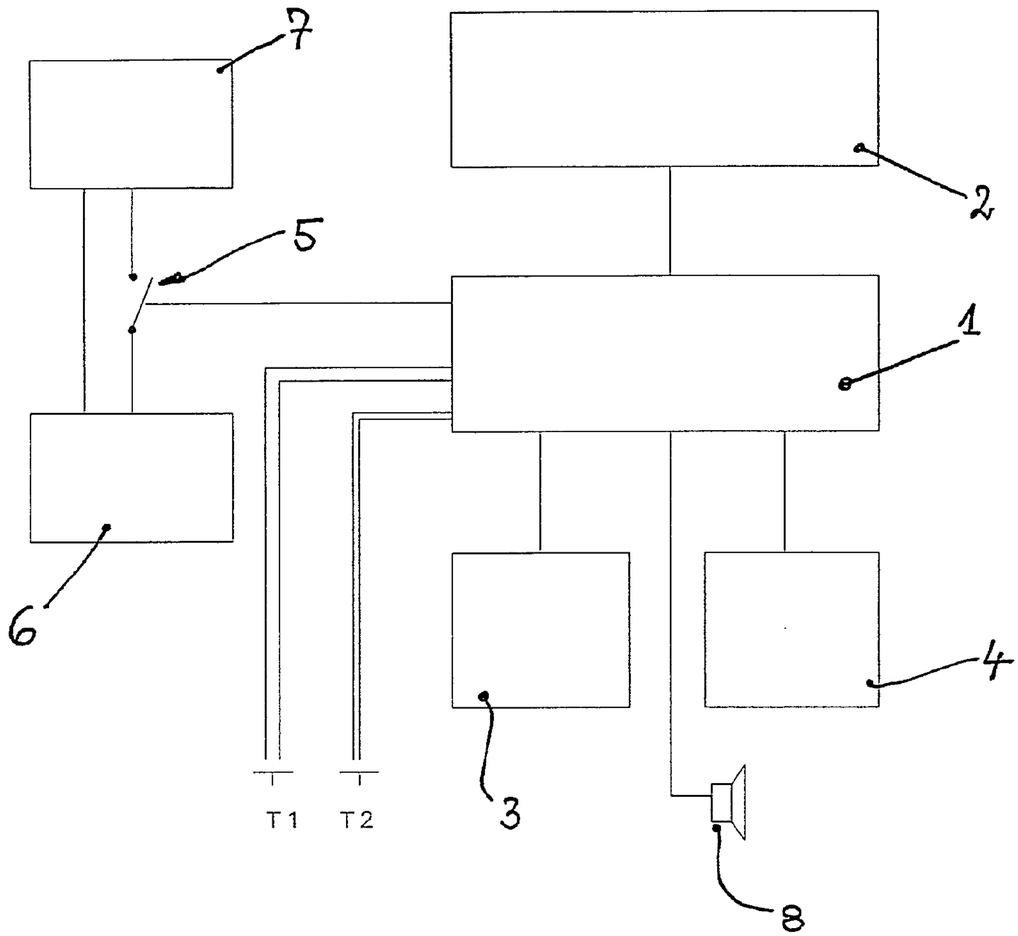

Figur 1

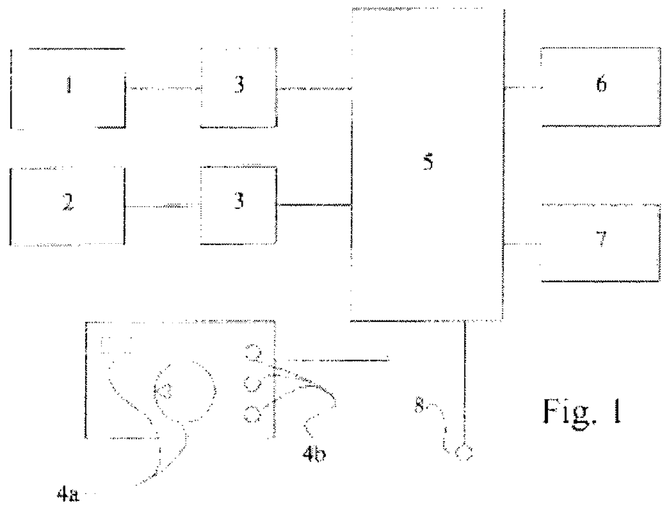

Fig. 1

Recording driving style of driver of motor vehicle

AB
(DE19728872)
The method records acceleration values along vehicle longitudinal and transverse axes using acceleration sensors (1,2) with amplifier and filter (3). One acceleration value is stored in memory (6), if recorded value exceeds a certain limit. The memory size is determined by the duration and size of the infringement by recorded value. The memory stores size and duration of infringement. The storage size is proportional to the integral of the amount of the value over the limit and the time. In addition to each stored value, or at certain distances, time information, particularly the signal of the real time on the clock (7), is stored, memory (7) being non-volatile (ROM). The amount and the size of the values stored are indicated to the driver. Microcontroller (5) connects to diodes (4b) for display and controller (4a) esp. for inputting time. The driver has a value indicated, which depends on the sum of the values stored in the memory. Formerly stored values of the developing sum are more weakly weighted than later stored values.

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(54) Verfahren und Vorrichtung zum Erfassen des Fahrstils eines Fahrers

DE 197 28 872 A 1

Beschreibung

Die Erfindung betrifft ein Verfahren und eine Vorrichtung zum Erfassen des Fahrstils eines KFZ-Fahrers.

Der individuelle Fahrstil eines Autofahrers ist geprägt durch ein typisches Beschleunigungs- bzw. Abbremsverhalten in verschiedenen Verkehrssituationen. Während z. B. ein besonnener Fahrer abrupte Geschwindigkeitsänderungen nach Möglichkeit vorausschauend vermeidet, ist der Stil des "Rasers" gekennzeichnet durch häufige Tempowechsel, ständige starke Beschleunigungs- und Bremsvorgänge, hohes Tempo in engen Kurven etc. Bekanntermaßen stellt ein solcher Fahrstil auch ein sehr hohes Gefährdungspotential für den Fahrer und für andere Verkehrsteilnehmer dar.

Aus der Analyse des Beschleunigungsverhaltens über die Zeit lassen sich folglich Rückschlüsse über den Fahrstil ziehen. Eine Anzeige des Fahrstils könnte damit einerseits der Selbstkontrolle des Fahrers dienen, z. B. für Fahranfänger. Andererseits wären Angaben zum Fahrstil für alle Branchen interessant, in denen aus der potentiellen Gefährdung durch einen schlechten Fahrstil finanzielle Folgen erwachsen, z. B. für Kfz-Versicherer, Autovermieter u. a. Letztlich kann die Ermittlung des Fahrstils auch den Fahrer selbst vor akuten Gefahren warnen, wenn z. B. eine Kurve mit überhöhter Geschwindigkeit durchfahren wird.

Es ist Aufgabe der vorliegenden Erfindung, ein Verfahren und eine Vorrichtung zum Erfassen des Fahrstils eines Fahrers vorzustellen, das die nachträgliche Analyse des Fahrstils ermöglicht. Es soll zum einen dem Autofahrer direkt Hinweise auf unausgeglichenen, gefährlichen Fahrstil geben und andererseits daran interessierten Kreisen, wie beispielsweise Versicherungen, Autovermietungen etc. die Möglichkeit einer nachträglichen Kontrolle bieten.

Erfindungsgemäß wird ein Verfahren zum Erfassen des Fahrstils eines KFZ-Fahrers mit den Merkmalen des Patentanspruches 1 vorgeschlagen.

Im Fahrzeug ist mindestens ein Beschleunigungssensor angeordnet, der die Beschleunigungswerte in Fahrtrichtung oder in der Querachse des Fahrzeuges erfaßt. Besser ist die Verwendung von mindestens zwei Sensoren, damit das Verhalten in der Kurve gleichzeitig mit dem Brems- und Beschleunigungsverhalten in Fahrtrichtung erfaßt werden kann. Die von den Sensoren gemessenen Werte werden schaltungstechnisch aufbereitet und die Werte einer den Beschleunigungswerten zugeordneten Größe in einem Speicher gespeichert. Dabei erfolgt eine Abspeicherung aber nur dann, wenn der erfaßte Beschleunigungswert einen vorgegebenen Grenzwert betragsmäßig übersteigt. Dies hat zur Folge, daß der Speicher nicht mit denjenigen Werten gefüllt wird, die unterhalb bestimmter Grenzen liegen, also im Regelfall unproblematisches und ausgeglichenes Fahrverhalten charakterisieren. Gespeichert werden nur die Werte, bei denen ein Grenzwert überschritten wird.

Eine solche Datenkompression ist erforderlich, um die Größe des Speichers möglichst klein zu halten. Das Verfahren ist damit kostengünstig durchführbar. Die Grenzwerte für die Beschleunigungswerte können in den verschiedenen erfaßten Richtungen unterschiedlich gewählt werden. Damit wird es möglich, daß beispielsweise starkes Beschleunigen solange nicht negativ gewertet wird, als daraus keine starken Bremsmanöver oder überhöhte Querbeschleunigungen durch Ausweichen oder schnelle Kurvenfahrt resultieren.

Während der Fahrt erfolgt eine ständige Überwachung der Beschleunigungswerte auf Überschreitung der festgelegten Grenzwerte. Erfolgt eine Grenzwertüberschreitung, so wird die Höhe dieser Überschreitung solange registriert, bis der Grenzwert wieder unterschritten wird.

Vorzugsweise wird zur weiteren Datenkompression für jede Grenzwertüberschreitung nur ein Wert gespeichert. Der Wert der Speichergröße hängt von der Höhe und der Dauer der Grenzwertüberschreitung ab. Eine nur geringe Grenzwertüberschreitung, die aber lange andauert, würde dann mit dem gleichen Speicherwert abgespeichert wie eine kurzzeitige, aber sehr krasse Grenzwertüberschreitung.

Vorzugsweise ist die Speichergröße proportional zum Integral der Grenzwertüberschreitung nach der Zeit.

Um eine spätere zeitliche Rekonstruktion des Ereignisses vornehmen zu können, kann zusammen mit jedem Speicherwert oder in regelmäßigen Abständen eine Zeitinformation, z. B. von einer Echtzeituhr, abgespeichert werden.

In einer bevorzugten Weiterbildung des erfindungsgemäßen Verfahrens werden die abgespeicherten Werte dem Fahrer angezeigt. Es können die gespeicherten Werte entweder direkt nach Anzahl und Größe angezeigt werden, oder zur Vereinfachung und besseren Übersichtlichkeit während der Fahrt auch nur ein fiktiver, errechneter Wert, der beispielsweise von der Summe der im Speicher abgelegten Werte abhängt.

In einer bevorzugten Form des erfindungsgemäßen Verfahrens bestimmt sich der an gezeigte Wert aus der Summe der Speicherwerte, wobei jeder Speicherwert mit einem Wichtungsfaktor in die Summe eingeht, der um so niedriger ist, je länger der Speicherzeitpunkt des jeweiligen Wertes vergangen ist. Auf diese Art kann eine Änderung des Fahrstils schneller vom Anzeigewert abgelesen werden.

Für die Summenbildung können entweder alle im Speicher verfügbaren Werte herangezogen werden, oder nur die Werte, die innerhalb eines bestimmten Zeitintervalls vor dem Anzeigezeitpunkt oder ab einem bestimmten Zeitpunkt abgespeichert worden sind. Dieses Zeitintervall kann beispielsweise ein Tag, eine Woche oder ein Monat sein. Dadurch wird es möglich, daß beispielsweise bei einem Fahrerwechsel sofort die vom neuen Fahrer erzielten Werte angezeigt werden. Um vergleichbare Werte zu erhalten, müssen entsprechende Ausgleichsfaktoren in das Ergebnis eingehen.

Die Anzeige der gespeicherten Werte kann entweder direkt, beispielsweise durch Anzeige eines Zahlenwertes, erfolgen oder lediglich in groben Bereichen, beispielsweise durch verschiedenfarbige Leuchtdioden, die durch ihre Farben den Bereich des Meßwertes anzeigen.

Da länger zurückliegende Speicherwerte an Interesse verlieren, wird der Speicherinhalt vorzugsweise periodisch überschrieben, wobei die ältesten Werte durch die aktuellen Speicherwerte ersetzt werden.

Durch das erfindungsgemäße Verfahren ist es möglich, das Fahrverhalten eines Fahrers im Nachhinein zu analysieren. Die Anzeige kann beispielsweise per Computer über der Zeitachse ausgedruckt werden, damit die jeweils erzielten Werte visuell darstellbar sind. Der Fahrer kann aber auch bereits während der Fahrt entweder durch die Anzeigewerte oder durch das Aufleuchten verschiedenfarbiger Leuchtdioden unmittelbar feststellen, ob die Beschleunigungswerte kritische Grenzen überschreiten.

Erfindungsgemäß wird außerdem eine Vorrichtung zum Erfassen des Fahrverhaltens eines Fahrers gemäß Patentanspruch 12 vorgeschlagen. Die erfindungsgemäße Vorrichtung umfaßt mindestens einen Beschleunigungssensor und einen Datenspeicher. Im Speicher ist für alle einen vorgegebenen Grenzwert betragsmäßig übersteigenden Beschleunigungswerte der Wert einer dem Beschleunigungswert zugeordneten Größe abspeicherbar.

Vorzugsweise sind in der Vorrichtung zwei Beschleunigungssensoren angeordnet, von denen einer die Beschleunigung in Fahrtrichtung und der andere die Beschleunigung in Querrichtung des Fahrzeuges erfaßt.

Gemäß einer Weiterbildung der Erfindung verfügt die Vorrichtung über eine Zeitmeßeinrichtung, so daß neben dem Beschleunigungswert auch die Dauer der Grenzwertüberschreitung ermittelt und gespeichert werden kann. Bei der Zeitmeßeinrichtung kann es sich vorzugsweise um eine Echtzeituhr handeln, die aber auch zusätzlich installiert sein kann. Dann kann der Speicherwert zur späteren zeitlichen Rekonstruktion zusammen mit einer Echtzeitinformation abgespeichert werden.

Um die Daten, die von den Beschleunigungssensoren, der Zeitmeßeinrichtung und der Echtzeituhr geliefert werden, verarbeiten zu können, kann die Vorrichtung über eine Datenverarbeitungseinheit verfügen, mit der die Daten vor und/oder nach der Speicherung bearbeitet werden können.

Als Speicher wird vorzugsweise ein sogenannter Ringspeicher eingesetzt, der nach einer bestimmten Zeit oder sobald kein Speicherplatz mehr verfügbar ist, die zuerst gespeicherten Daten kontinuierlich mit den neu aufgenommenen Daten überschreibt.

Die Vorrichtung kann mit einer PC-Schnittstelle ausgerüstet sein, die die Ausgabe der gespeicherten Daten zur weiteren Bearbeitung erlaubt.

Die Vorrichtung kann auch über eine Anzeigevorrichtung verfügen, die die gespeicherten Werte oder daraus abgeleitete Werte anzeigen kann. Eine solche Anzeigevorrichtung kann beispielsweise aus einer Skala bestehen, die einen Zahlenwert anzeigt, oder auch aus Leuchtdioden, die durch verschiedene Farben oder durch die Anzahl der beleuchteten Dioden bestimmte Bereiche anzeigt. Dem Fahrer kann damit sein Fahrstil angezeigt werden. Die Anzeige kann auch so ausgestaltet werden, daß ein über einen bestimmten Zeitraum gemittelter Wert angezeigt wird, gleichzeitig aber Spitzenwerte, wie sie beispielsweise in sehr schnell durchfahrenen Kurven auftreten, sofort sichtbar gemacht werden, beispielsweise durch eine separate Leuchtdiode.

An einem Wählschalter kann der Zeitraum, der den angezeigten Werten zugrunde liegt, eingestellt oder der Anfang des Meßzeitraumes bestimmt werden.

Die Erfindung wird im folgenden anhand der beigefügten Abbildung näher erläutert:

Fig. 1 zeigt eine schematische Darstellung einer erfindungsgemäßen Vorrichtung.

Die Vorrichtung besteht aus zwei Beschleunigungssensoren **1**, **2** mit einem Meßbereich von je ± 1 g. Ein Beschleunigungssensor erfaßt die Beschleunigungswerte in Fahrtrichtung, der andere in Richtung der Fahrzeugquerachse. Über eine Signalverstärkung und analoge Filterung **3** gelangen Signale in einen Microcontroller **5**, der die Registrierungen und Auswertungen der eingehenden Signale sowie die Steuerung der Meßwerterfassung durchführt.

Die Berechnung werden in einem flüchtigen Speicherbereich des Microcontrollers **5** vorgenommen. Zur permanenten Datenspeicherung ist ein ausreichend großer nicht flüchtiger Speicher **6** angeschlossen, z. B. ein Flash-Eprom oder ein Zero-Power-RAM.

An den Mikrocontroller **5** ist außerdem eine Echtzeituhr **7** angeschlossen, die Zeitsignale liefert, die zusammen mit den von den Beschleunigungssensoren **1**, **2** gelieferten Signalen verarbeitet und gespeichert werden können.

Die Speicherung einer Grenzwertüberschreitung zusammen mit einer Zeitmarke, die von der am Microcontroller **5** angeschlossenen Echtzeituhr **7** gewonnen wird, benötigt 4 Byte. Bei einer Verwendung eines 128 kByte großen nicht flüchtigen Speichers **6** können ca. 32.000 Grenzwertüberschreitungen gespeichert werden. Legt man bei einem extrem schlechten Fahrstil durchschnittlich zwei Grenzwertüberschreitungen pro Minute zugrunde und geht von einer mittleren täglichen Fahrzeit von vier Stunden aus, so erlaubt das Gerät die Speicherung über einen Zeitraum von mehr als zwei Monaten; danach werden die ältesten Daten überschrieben. Bei einem durchschnittlichen Fahrstil ist die Aufzeichnungsdauer entsprechend länger.

An den Mikrocontroller **5** sind darüber hinaus Bedien- **4**a und Anzeigeelemente **4**b angeschlossen, die dem Fahrer die ermittelten und gespeicherten Werte oder daraus abgeleitete Werte anzeigen. Die Anzeigeelemente **4**b bestehen aus einer grünen, einer gelben und einer roten Leuchtdiode entsprechend normalem, bedenklichem und schlechtem Fahrstil.

Am Bedienelement **4**a kann der Fahrer den Zeitraum wählen, für den der Fahrstil ermittelt werden soll. Es kann beispielsweise der letzte Tag, die letzte Woche oder der letzte Monat eingestellt werden. An einer Rückstelltaste kann der Fahrer außerdem den Anfangszeitpunkt bestimmen, ab dem der Fahrstil bewertet werden soll, z. B. nach einem Fahrerwechsel.

Das Gerät wird beispielsweise mittels eines Gummisaugers am unteren Rand der Frontscheibe genau in der Mittelachse des Fahrzeuges angebracht. Damit ist die korrekte Ausrichtung in der Fahrebene gewährleistet. Eine waagerechte Einstellung erfolgt über ein arretierbares Drehgelenk.

Die Stromversorgung erfolgt über einen Anschluß am Zigarettenanzünder. Damit ist das Gerät sehr einfach ein- und auszubauen.

Weiterhin ist ein Anschluß **8** zum Auslesen der Daten über einen PC vorgesehen.

Patentansprüche

1. Verfahren zum Erfassen des Fahrstils eines KFZ-Fahrers, wobei die Beschleunigungswerte entlang der Fahrzeuglängsachse und/oder entlang der Fahrzeugquerachse durch Beschleunigungssensoren erfaßt und die Werte einer den Beschleunigungswerten zugeordneten Größe in einem Speicher (**6**) gespeichert werden, **dadurch gekennzeichnet**, daß nur dann eine Speicherung erfolgt, wenn der erfaßte Beschleunigungswert einen vorgegebenen Grenzwert betragsmäßig übersteigt.
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß für jede Grenzwertüberschreitung nur ein Wert gespeichert wird.
3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Speichergröße von der Dauer und der Größe der Grenzwertüberschreitung des erfaßten Beschleunigungswertes bestimmt wird.
4. Verfahren nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß die Speichergröße proportional zum Integral der Grenzwertüberschreitung nach der Zeit ist.
5. Verfahren nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß zusätzlich zu jedem Speicherwert oder in bestimmten Abständen eine Zeitinformation, insbesondere das Signal einer Echtzeituhr (**7**), gespeichert wird.
6. Verfahren nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß die Anzahl und/oder die Größe der im Speicher (**6**) gespeicherten Werte dem Fahrer angezeigt werden.
7. Verfahren nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß dem Fahrer ein Wert angezeigt wird, der von der Summe der im Speicher gespeicherten Werte abhängt.
8. Verfahren nach Anspruch 7, dadurch gekennzeichnet, daß früher abgespeicherte Werte bei der Summenbildung schwächer gewichtet werden als später abgespeicherte Werte.
9. Verfahren nach einem der Ansprüche 6 bis 8, dadurch gekennzeichnet, daß die Anzeige mittels Leucht-

dioden (4b) erfolgt.

10. Verfahren nach einem der Ansprüche 6 bis 9, dadurch gekennzeichnet, daß der angezeigte Wert aus den Speicherdaten eines vorgegebenen Zeitintervalls vor dem Anzeigezeitpunkt, insbesondere des letzten Tages, der letzten Woche oder des letzten Monats, oder den seit einem vorgegebenen Zeitpunkt gespeicherten Werten, gebildet wird.

11. Verfahren nach einem der Ansprüche 1 bis 10, dadurch gekennzeichnet, daß die gespeicherten Werte kontinuierlich mit den neu zu speichernden Werten überschrieben werden.

12. Vorrichtung zum Erfassen des Fahrstils eines KFZ-Fahrers, bestehend aus mindestens einem in Fahrtrichtung oder in Querrichtung des Fahrzeuges angeordneten Beschleunigungssensor (1, 2) und einem Datenspeicher (6), dadurch gekennzeichnet, daß für alle einen vorgegebenen Grenzwert betragsmäßig übersteigenden Beschleunigungswerte der Wert einer dem Beschleunigungswert zugeordneten Größe im Datenspeicher (6) abspeicherbar ist.

13. Vorrichtung nach Anspruch 12, dadurch gekennzeichnet, daß zwei Beschleunigungssensoren (1, 2) vorgesehen sind, von denen einer die Beschleunigung in Fahrtrichtung und der andere in Querrichtung des Fahrzeuges erfaßt.

14. Vorrichtung nach Anspruch 12 oder 13, dadurch gekennzeichnet, daß sie über eine Zeitmeßeinrichtung (7) verfügt und die Dauer einer Grenzwertüberschreitung mit der Speichergröße abspeicherbar ist.

15. Vorrichtung nach einem der Ansprüche 12 bis 14, dadurch gekennzeichnet, daß sie über eine Echtzeituhr (7) verfügt und das von der Echtzeituhr (7) abgegebene Zeitsignal mit der Speichergröße abspeicherbar ist.

16. Vorrichtung nach einem der Ansprüche 12 bis 15, dadurch gekennzeichnet, daß sie über eine Datenverarbeitungseinheit (5) verfügt, mit der die Signale des oder der Beschleunigungssensoren (1, 2) und/oder der Zeitmeßeinrichtung (7) und/oder der Echtzeituhr vor und/oder nach der Speicherung bearbeitet werden können.

17. Vorrichtung nach einem der Ansprüche 12 bis 16, dadurch gekennzeichnet, daß der Speicher (6) ein kontinuierlich überschreibbarer Ringspeicher ist.

18. Vorrichtung nach einem der Ansprüche 12 bis 17, dadurch gekennzeichnet, daß die gespeicherten Daten über eine PC-Schnittstelle (8) auslesbar sind.

19. Vorrichtung nach einem der Ansprüche 12 bis 18, dadurch gekennzeichnet, daß die im Speicher (6) gespeicherten Daten oder daraus abgeleitete Werte anzeigbar sind.

20. Vorrichtung nach Anspruch 19, dadurch gekennzeichnet, daß die Anzeige mittels einer Skala oder mehrerer Leuchtdioden (4b) erfolgt.

21. Vorrichtung nach einem der Ansprüche 12 bis 20, dadurch gekennzeichnet, daß die Vorrichtung über einen Wählschalter (4a) verfügt, an dem das Meßintervall und/oder der Beginn des Meßzeitraumes wählbar ist.

Hierzu 1 Seite(n) Zeichnungen

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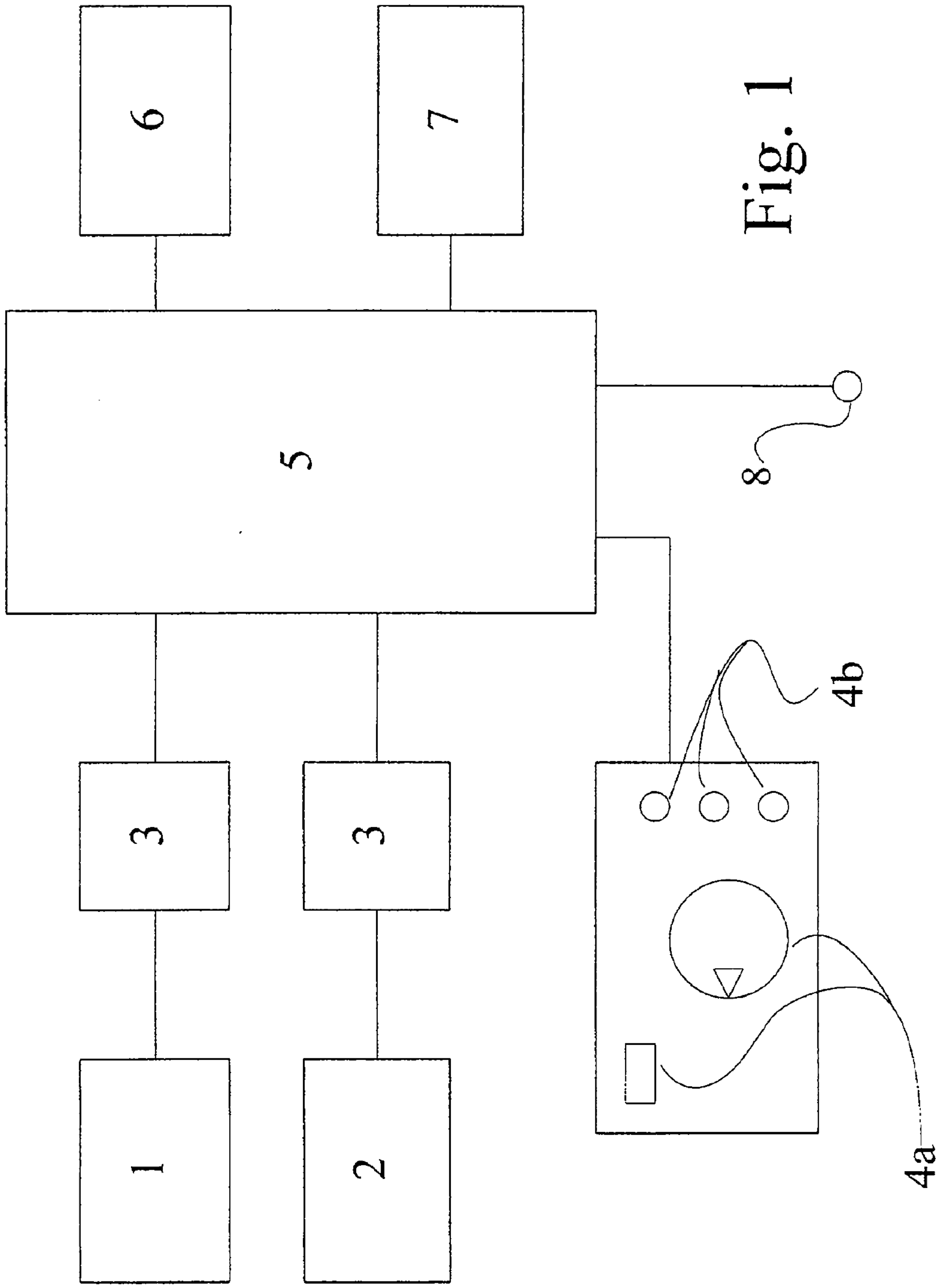

Fig. 1

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(54) Title: RAPID SATELLITE SIGNAL ACQUISITION IN A SATELLITE POSITIONING SYSTEM

(57) Abstract

A method for fast acquisition of Satellite Positioning System (SATPS) signals that does not require permanent storage of satellite almanac information at a ground station. A nearby reference SATPS station (13), whose position is known, provides a new SATPS station (14) with differential positioning SATPS information and optionally with SATPS satellite ephemeride information on each visible satellite (15, 17, 19, 21). By limiting the search to the frequency range and code-phase attributes corresponding to the visible satellites, the ranges to be searched are decreased. When a first SATPS satellite signal is acquired and locked onto by the new station, the frequency range for searching is narrowed to a range corresponding to the Doppler shift frequency range for the visible satellites, and acquisition of additional SATPS satellite signals proceeds quickly. The system allows the use of less accurate timing sources for the new stations.

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RAPID SATELLITE SIGNAL ACQUISITION IN A SATELLITE POSITIONING SYSTEM

Background of the Invention

When a Satellite Positioning System (SATPS) receiver/processor powers up, or when the receiver/processor experiences SATPS signal interruption, if the receiver/processor has no almanac that indicates the present location of the visible SATPS satellites, the receiver/processor and associated SATPS antenna will perform a blind satellite search to find a sufficient number of SATPS satellites, usually three or more, to begin establishing the antenna's SATPS-determined location and/or proper time. The SATPS antenna and receiver/processor will usually select SATPS satellite numbers at random for the search. This procedure will often consume several minutes before "lock" on an adequate number of SATPS satellite signals is achieved. Several workers in electrical communications have disclosed methods and/or apparati for reducing the time or difficulty of acquiring signals communicated from satellites.

United States Patent No. 4,384,293, issued to Deem et al, discloses apparatus for providing pointing information, using one or more GPS satellites and two antennas spaced apart about ten carrier signal wavelengths. The difference in phase of GPS signals received by the two antennas determines the pointing direction determined by the line of sight between the two antennas. Phase differences of GPS signals received by arrays of three or more collinear or non-collinear antennas are used to determine the attitude of an object on which the antennas are mounted in U.S. Patent No. 5,021,792, issued to Hwang, and in U.S. Patent No. 5,101,356, issued to Timothy et al.

Sekine discloses GPS receiver/processor apparatus that quickly maximizes correlation between a received GPS pseudo-random noise (PRN) code and an internally stored GPS code, in U.S. Patent No. 4,968,981. This approach uses a separate channel for each of N PRN codes and shifts the phase of the internally stored code n/2 bits at a time (n

= 1, 2, ... , N), in a search for a position of increased code correlation value.

In U.S. Patent No. 5,036,329, Ando discloses a satellite reacquisition or initial acquisition method applicable to GPS satellites. Using an estimate of the average Doppler shifted frequency f_{avg} manifested by the GPS signals received from a visible GPS satellite, a narrow band search is first performed in the frequency range f_{avg} - 8600 Hz $\leq f \leq f_{avg}$ + 8600 Hz. If no GPS satellite signals are found in this range within 3.75 minutes, the search range is widened until at least one GPS satellite signal is found.

A simultaneous multi-channel search for reacquisition of GPS satellite signals after signal interruption occurs is disclosed by Sakaguchi and Ando in U.S. Patent No. 5,059,969. This method first searches for the GPS satellite with the highest elevation angle relative to the GPS antenna. Two or more sequences of signal frequency ranges are swept over in parallel until at least one GPS signal is reacquired.

United States Patent No. 5,061,936, issued to Suzuki, discloses attitude control for a rotationally mobile antenna. If the strength of the initial signal received by the antenna from a spacecraft (whose position is yet unknown) is below a first selected threshold and above a second selected threshold, the antenna attitude is scanned over a relatively small range, to increase the signal strength toward or above the first threshold value. If the signal strength is initially below the second threshold, the antenna attitude is scanned over a larger range, to increase the signal strength above the second threshold value so that a smaller range antenna scan can be implemented.

In U.S. Patent No. 5,119,504, Durboraw discloses a satellite-aided cellular communications system in which a subscriber unit self-determines its own (changing) location and transmits this information to the satellites for use in subsequent communications. This requires that each subscriber unit transmit and receive signals, and one subscriber unit does not communicate directly with, or provide satellite location information for, another subscriber unit.

An electronic direction finder that avoids reliance on sensing of terrestrial magnetic fields for establishing a preferred direction for satellite signal acquisition is disclosed by Ghaem et al in U.S. Patent No. 5,146,231. The apparatus uses a receiver/processor for GPS or similar navigation signals received from a satellite, and requires (stored) knowledge of the present location of at least one reference satellite from which signals are received. The orientation of the finder or its housing relative to a line of sight vector from the finder to this reference satellite is determined. This orientation is visually displayed as a projection on a horizontal plane. Any other direction in this horizontal plane can then be determined with reference to this projection from a knowledge of the reference satellite location.

Ando, in U.S. Patent No. 5,155,491, discloses a method for tracking radio signals from GPS satellites that follow a single orbit around the Earth. At most four GPS satellites follow one of the six GPS orbits, as the constellation is presently configured. The C/A-code and/or P-code is known for each of the at-most-four GPS satellites in a single orbit so that searching along a single orbit requires acquisition of only one of the four known codes associated with these satellites, and at least one of these four GPS satellites is not visible at a particular observation time. After acquisition of whatever GPS satellites on a particular GPS orbit can be tracked, the system moves sequentially from one GPS orbit to another orbit until all trackable GPS satellites are found. The system then selects the three or four GPS satellites that are most suitable for global positioning computations.

These methods either require storage of detailed knowledge of the satellite trajectories or of satellite signal indicia. This information for SATPS satellites can be voluminous and is not present in many SATPS signal receiver/processor systems. What is needed is a method that relies only upon information that is already available within the receiving system or from another nearby receiving system. Preferably, the method should provide reasonably accurate information on the present location of any visible SATPS satellite, should allow rapid acquisition of SATPS signals from one or a plurality of visible SATPS satellites, and should not require consumption of much additional power for operation.

Summary of the Invention

The invention focuses on initial acquisition and identification of visible SATPS satellites by an SATPS signal antenna and receiver/processor ("SATPS station") at the time of power-up. Receipt of differential SATPS signals from another already-operative SATPS station allows the SATPS station that is now powering up (the "new" SATPS station) to reduce the number of SATPS channels searched. The new SATPS Station need not store the SATPS almanac information and may use less expensive timing sources. This eliminates the need for a back-up battery and allows quicker acquisition of the visible SATPS satellites upon power-up.

In one embodiment, the method includes the steps of: (1) providing a reference SATPS station, whose location coordinates are known with high accuracy, with a transmitter to broadcast differential SATPS information to other nearby SATPS stations, including the new SATPS station; (2) providing differential SATPS information from the reference station to the new station, including the pseudorange corrections and satellite index of each SATPS satellite that is visible from the reference station (the SATPS "reference/visible" satellites); (3) establishing a selected number of channels at the new station to acquire SATPS signals from the reference/visible satellites; (4) stepping through the pseudorange and code-phase attributes for each of the visible SATPS satellites to acquire and lock onto the SATPS signals from one or more of the SATPS satellites; (5) once one SATPS satellite signal is acquired, narrowing the frequency tuning range of all the other tuning channels to a much smaller frequency range, based upon the calculated frequency error and Doppler shift frequency range; and (6) using this smaller frequency range to more quickly acquire and lock onto additional SATPS satellite signals, if needed.

Limiting the search for SATPS satellite signals at the new station to the visible SATPS satellites for which differential SATPS information is available provides the following benefits. First, a station that is not a reference station does not need battery backup for the random access memory in order to store the satellite almanac information. Second, as each SATPS satellite signal is acquired and identified, the frequency range that needs to be searched for that satellite can be narrowed substantially, using an estimate of the Doppler shift for signals emitted from that satellite. Third, an inexpensive time base source for an SATPS receiver/processor can be used without incurring a large penalty in satellite signal acquisition time. Once one satellite signal is locked onto, the SATPS receiver/processor can correct for the (relatively large) frequency error of the associated time base and can search over a smaller frequency range that covers the appropriate Doppler shifted frequencies received.

Brief Description of the Drawings

Figure 1 is a schematic view of a differential satellite positioning system in operation, showing a reference SATPS station and another SATPS station that receives differential SATPS information from the reference station.

Figure 2 is a flow chart illustrating acquisition of and lock-on for one or more SATPS satellites signals by a new SATPS station according to one embodiment of the invention.

Description of Best Mode of the Invention

Figure 1 illustrates operation of a differential satellite positioning system in simplified form. A reference SATPS station 13, including an SATPS receiver/processor and associated SATPS antenna 23, and a roving SATPS station 14, including an SATPS receiver/processor and associated SATPS antenna 25, are spaced apart on or adjacent to the Earth's surface, where it is assumed that the reference receiver's location is known very accurately at any time. Presently, an SATPS signal antenna is approximately omni-directional so that SATPS signals can be received from any area of the sky, except near the horizon, without "pointing" the antenna.

An SATPS antenna receives SATPS signals from a plurality (preferably four or more) of SATPS satellites and passes these signals to an SATPS signal receiver/processor, which (1) identifies the SATPS satellite source (satellite number or other indicia) for each SATPS signal, (2) determines the time at which each identified SATPS signal arrives at the antenna, and (3) determines the present location of the SATPS antenna from this information and from information on the ephemerides, stored in the receiver/processor, for each identified SATPS satellite. The SATPS signal antenna and signal receiver/processor are part of the user segment of a particular SATPS, the Global Positioning System, as discussed by Tom Logsdon in The NAVSTAR Global Positioning System, Van Nostrand Reinhold, 1992, pp. 33-90, incorporated by reference herein.

The reference station 13 may be stationary or may be moving with location coordinates known as a function of time t. Four or more SATPS satellites 15, 17, 19 and 21 transmit SATPS signals that are received by the reference and roving stations 13 and 14 and converted to present location, velocity and time for that station. The reference and roving stations 13 and 14 also include modems 27 and 29, respectively, or other communication means that provide a one-way link between the reference station 13 and the roving station 14 or a two-way link, as shown. Optionally, the system shown in Figure 1 may also include one or more signal repeaters 31, located between the two stations 13 and 14, to facilitate long distance or non-line-of-sight communication between these two stations. Optionally, the system may include two or more roving stations.

Assume that a roving station 14 has lost its lock on one or more (or all) visible SATPS satellites 15, 17, 19 and 21, or that the roving station is powering up after a period of no activity. This roving station 14 (referred to herein as a "new" station for convenience) will need to acquire or reacquire, and to lock onto, one or more of the SATPS satellites visible from the reference station 13 (referred to as a "reference/visible satellite" herein for convenience), in order to provide location and/or time information for this new station. The reference station 13 may be moving or may be stationary. It is assumed that the reference station 13 is located nearby (i.e., within 250 kilometers) and that its location coordinates are known with high accuracy at any time so that differential satellite positioning system ("DSATPS") information is available from the reference station.

According to one embodiment of the invention, this procedure for (re)acquisition and lock-on for one or more visible SATPS satellites is illustrated in Figure 2. In step 41, the new station either powers up or senses that it has lost lock on all SATPS satellites. In steps 43 and 45, the new station 14 receives DSATPS information from the reference station 13 and determines the reference/visible SATPS satellites. In step 47, the new station 14 sets up a sufficient number of SATPS signal channels to receive SATPS signals directly from the reference/visible SATPS satellites. In step 49, the frequency range and code-phase attributes (PRN codes, etc.) are stepped through for each of these reference/visible SATPS satellites to acquire and lock onto the SATPS signals from one or more of the SATPS satellites. This may be implemented by searching simultaneously over, say, six channels, each corresponding to a different reference/visible SATPS satellite. After a first SATPS satellite signal is acquired, the frequency tuning range for all the other SATPS satellites is narrowed, in step 51, to a small frequency range around the calculated frequency, based upon Doppler shift frequency ranges. In step 53, additional SATPS satellite signals are acquired and locked onto, if needed.

Once an SATPS satellite is tracked and its SATPS signals are acquired and locked onto, the frequency range for the search can be narrowed, because an estimate can be made of the error of the roving station frequency source. Two sources of significant error in SATPS signal acquisition are (1) Doppler frequency shift due to the non-zero velocity of a satellite relative to an SATPS receiver/processor and (2) SATPS receiver/processor time base error relative to the more accurate satellite time base. Where a relatively inexpensive clock is used to provide a time base for an SATPS receiver/processor, the second of these two errors can be about ten times as large as the first error. For example, the maximum Doppler shift frequency may be 5-8 kHz, and the time base error may correspond to a frequency error of 47 kHz (30 ppm for a frequency of 1.575 GHz). Use of a relatively expensive and more accurate clock to provide a time base for the SATPS receiver/processor will reduce the time base error. Once an SATPS signal is locked onto and that satellite is identified, the receiver/processor time base error, which is approximately the same for any SATPS satellite, can be determined and the frequency range for subsequent searches for other SATPS satellites can be reduced to the Doppler shift frequency range, which is much smaller than the original frequency range that must be searched.

The system disclosed here allows rapid acquisition of SATPS satellite lock-on for any number of visible satellites. Whereas, acquisition of a first SATPS satellite may require a time interval of several minutes, the system disclosed here allows acquisition of a first SATPS satellite in reduced time, depending on the number of satellite acquisition channels used.

Further, the clock used to provide a time base for the SATPS receiver/processor at the roving station may be much less precise using the disclosed system for satellite acquisition. For example, a receiver clock that is accurate to within 2.5 ppm or lower, with a representative cost of the order of $25, is often required for reasonably prompt SATPS satellite acquisition in a conventional setting. A receiver clock that is accurate to within 10 ppm, with a representative cost of about $5, will suffice for the system disclosed here; and it is possible that a clock that is merely accurate to within 20 ppm can be used with the disclosed system, which would reduce the cost of the clock further.

Finally, the new station need not store the SATPS satellite ephemeride information itself. The new station can call up and make use of this information from the reference station when the new station is operated, and thus use smaller permanent memory for general operations.

A Satellite Positioning System (SATPS) is a system of satellite signal transmitters, with receivers located on the Earth's surface or adjacent to the Earth's surface, that transmits information from which an observer's present location and/or the time of observation can be determined. Two operational systems, each of which qualifies as an SATPS, are the Global Positioning System and the Global Orbiting Navigational System.

The Global Positioning System (GPS) is part of a satellite-based navigation system developed by the United States Defense Department under its NAVSTAR satellite program. A fully operational GPS includes up to 24 satellites approximately uniformly dispersed around six circular orbits with four satellites each, the orbits being inclined at an angle of 55° relative to the equator and being separated from each other by multiples of 60° longitude. The orbits have radii of 26,560 kilometers and are approximately circular. The orbits are non-geosynchronous, with 0.5 sidereal day (11.967 hours) orbital time intervals, so that the satellites move with time relative to the Earth below. Theoretically, four or more GPS satellites will be visible from most points on the Earth's surface, and visual access to three or more such satellites can be used to determine an observer's position anywhere on the Earth's surface, 24 hours per day. Each satellite carries a cesium or rubidium atomic clock to provide timing information for the signals transmitted by the satellites. Internal clock correction is provided for each satellite clock.

Each GPS satellite transmits two spread spectrum, L-band carrier signals: an L1 signal having a frequency f1 = 1575.42 MHz and an L2 signal having a frequency f2 = 1227.6 MHz. These two frequencies are integral multiples f1 = 1540 f0 and f2 = 1200 f0 of a base frequency f0 = 1.023 MHz. The L1 signal from each satellite is binary phase shift key (BPSK) modulated by two pseudo-random noise (PRN) codes in phase quadrature, designated as the C/A-code and P-code. The L2 signal from each satellite is BPSK modulated by only the C/A-code. The nature of these PRN codes is described below.

One motivation for use of two carrier signals L1 and L2 is to allow partial compensation for propagation delay of such a signal through the ionosphere, which delay varies approximately as the inverse square of signal frequency f (delay$\propto f^{-2}$). This phenomenon is discussed by MacDoran in U.S. Patent No. 4,463,357, which discussion is incorporated by reference herein. When transit time delay through the ionosphere is determined, a phase delay associated with a given carrier signal can be determined.

Use of the PRN codes allows use of a plurality of GPS satellite signals for determining an observer's position and for providing navigation information. A signal transmitted by a particular GPS signal is selected by generating and matching, or correlating, the PRN code for that particular satellite. All PRN codes are known and are generated or stored in GPS satellite signal receivers carried by ground observers. A first PRN code for each GPS satellite, sometimes referred to as a precision code or P-code, is a relatively long, fine-grained code having an associated clock or chip rate of 10 f0 = 10.23 MHz. A second PRN code for each GPS satellite, sometimes referred to as a clear/acquisition code or C/A-code, is intended to facilitate rapid satellite signal acquisition and hand-over to the P-code and is a relatively short, coarser-grained code having a clock or chip rate of f0 = 1.023 MHz. The C/A-code for any GPS satellite has a length of 1023 chips or time increments before this code repeats. The full P-code has a length of 259 days, with each satellite transmitting a unique portion of the full P-code. The portion of P-code used for a given GPS satellite has a length of precisely one week (7.000 days) before this code portion repeats. Accepted methods for generating the C/A-code and P-code are set forth in the document GPS Interface Control Document ICD-GPS-200, published by Rockwell International Corporation, Satellite Systems Division, Revision A, 26 September 1984, which is incorporated by reference herein.

The GPS satellite bit stream includes navigational information on the ephemeris of the transmitting GPS satellite and an almanac for all GPS satellites, with parameters providing corrections for ionospheric signal propagation delays suitable for single frequency receivers and for an offset time between satellite clock time and true GPS time. The navigational information is transmitted at a rate of 50 Baud. A useful discussion of the GPS and techniques for obtaining position information from the satellite signals is found in Tom Logsdon, The NAVSTAR

Global Positioning System, Van Nostrand Reinhold, New York, 1992, incorporated by reference herein.

A second configuration for global positioning is the Global Orbiting Navigation Satellite System (GLONASS), placed in orbit by the former Soviet Union and now maintained by the Russian Republic. GLONASS also uses 24 satellites, distributed approximately uniformly in three orbital planes of eight satellites each. Each orbital plane has a nominal inclination of 64.8^o relative to the equator, and the three orbital planes are separated from each other by multiples of 120^o longitude. The GLONASS circular orbits have smaller radii, about 25,510 kilometers, and a satellite period of revolution of 8/17 of a sidereal day (11.26 hours). A GLONASS satellite and a GPS satellite will thus complete 17 and 16 revolutions, respectively, around the Earth every 8 days. The GLONASS system uses two carrier signals L1 and L2 with frequencies of f1 = (1.602 + 9k/16) GHz and f2 = (1.246 + 7k/16) GHz, where k (= 0, 1, 2, ..., 23) is the channel or satellite number. These frequencies lie in two bands at 1.597-1.617 GHz (L1) and 1,240-1,260 GHz (L2). The L1 code is modulated by a C/A-code (chip rate = 0.511 MHz) and by a P-code (chip rate = 5.11 MHz). The L2 code is presently modulated only by the P-code. The GLONASS satellites also transmit navigational data at at rate of 50 Baud. Because the channel frequencies are distinguishable from each other, the P-code is the same, and the C/A-code is the same, for each satellite. The methods for receiving and analyzing the GLONASS signals are similar to the methods used for the GPS signals.

Reference to a Satellite Positioning System or SATPS herein refers to a Global Positioning System , to a Global Orbiting Navigation System, and to any other compatible satellite-based system that provides information by which an observer's position and the time of observation can be determined, all of which meet the requirements of the present invention.

A Satellite Positioning System (SATPS), such as the Global Positioning System (GPS) or the Global Orbiting Navigation Satellite System (GLONASS), uses transmission of coded radio signals, with the structure described above, from a plurality of Earth-orbiting satellites. A single passive receiver of such signals is capable of determining receiver absolute position in an Earth-centered, Earth-fixed coordinate reference system utilized by the SATPS. A configuration of two or more receivers can be used to accurately determine the relative positions between the receivers or stations. This method, known as differential positioning, is far more accurate than absolute positioning, provided that the distances between these stations are substantially less than the distances from these stations to the satellites, which is the usual case. Differential positioning can be used for survey or construction work in the field, providing location coordinates and distances that are accurate to within a few centimeters in some circumstances.

In differential position determination, many of the errors in the SATPS that compromise the accuracy of absolute position determination are similar in magnitude for stations that are physically close. The effect of these errors on the accuracy of differential position determination is therefore substantially reduced by a process of partial error cancellation.

Claims

1. A method for rapid acquisition of one or more Satellite Positioning System (SATPS) satellite signals by an SATPS station, referred to as a new SATPS station, that seeks to acquire or to reacquire such SATPS signals, the method comprising the steps of:

(1) providing a reference SATPS station, whose location coordinates are known with high accuracy, with a transmitter to broadcast differential SATPS information to other nearby SATPS stations, including the new SATPS station;

(2) providing differential SATPS information from the reference station to the new station, including satellite number or equivalent satellite indicia, for each SATPS satellite that is visible from the reference station, referred to as an SATPS reference/visible satellite;

(3) establishing a selected number of channels to acquire SATPS signals from each of the SATPS reference/visible satellites;

(4) stepping through the frequency range and code-phase attributes for each of the SATPS reference/visible satellites to acquire and lock onto the SATPS signals;

(5) after one SATPS satellite signal is acquired and the satellite is identified, reducing the frequency tuning range to a smaller frequency range, based upon that satellite's expected Doppler shift frequency range; and

(6) using this smaller frequency range to search for and acquire an SATPS signal from at least one additional SATPS satellite.

2. The method of claim 1, further comprising the step of choosing said Satellite Positioning System to be a Global Positioning System or a Global Orbiting Navigation Satellite System.

3. A method for acquisition of one or more SATPS satellite signals by an SATPS station, referred to as a new SATPS station, that seeks to acquire or to reacquire such SATPS signals, without requiring storage of

SATPS satellite ephemeride information at the new station, the method comprising the steps of:

(1) providing a reference SATPS station, whose location coordinates are known with high accuracy, with a transmitter to broadcast differential SATPS information to other nearby SATPS stations, including the new SATPS station;

(2) providing differential SATPS information from the reference station to the new station, including satellite number or equivalent satellite indicia, for each SATPS satellite that is visible from the reference station, referred to as an SATPS reference/visible satellite, and information on the ephemeride for each SATPS reference/visible satellite;

(3) establishing a selected number of channels to acquire SATPS signals from each of the SATPS reference/visible satellites;

(4) stepping through the frequency range and code-phase attributes for each of the SATPS reference/visible satellites to acquire and lock onto the SATPS signals;

(5) after one SATPS satellite signal is acquired and the satellite is identified, reducing the frequency tuning range to a smaller frequency range, based upon that satellite's expected Doppler shift frequency range; and

(6) using this smaller frequency range to search for and acquire an SATPS signal from at least one additional SATPS satellite.

4. The method of claim 3, further comprising the step of choosing said Satellite Positioning System to be a Global Positioning System or a Global Orbiting Navigation Satellite System.

5. A method for rapid acquisition of one or more SATPS satellite signals by an SATPS station, referred to as a new SATPS station, that seeks to acquire or to reacquire such SATPS signals, the method comprising the steps of:

(1) providing a reference SATPS station, whose location coordinates are known with high accuracy, with a transmitter to broadcast differential

SATPS information to other nearby SATPS stations, including the new SATPS station;

(2) providing differential SATPS information from the reference station to the new station, including satellite identifying number or equivalent indicia, for each SATPS satellite that is visible from the reference station, referred to as an SATPS reference/visible satellite, where the reference station and the new station each have a timing source and the new station timing source has an associated inaccuracy of as high as 20 parts per million;

(3) establishing a selected number of channels to acquire SATPS signals from each of the SATPS reference/visible satellites;

(4) stepping through the frequency range and code-phase attributes for each of the SATPS reference/visible satellites to acquire and lock onto the SATPS signals;

(5) after one SATPS satellite signal is acquired and the satellite is identified, reducing the frequency tuning range to a smaller frequency range, based upon that satellite's expected Doppler shift frequency range; and

(6) using this smaller frequency range to search for and acquire an SATPS signal from at least one additional SATPS satellite.

6. The method of claim 5, further comprising the step of choosing said Satellite Positioning System to be a Global Positioning System or a Global Orbiting Navigation Satellite System.

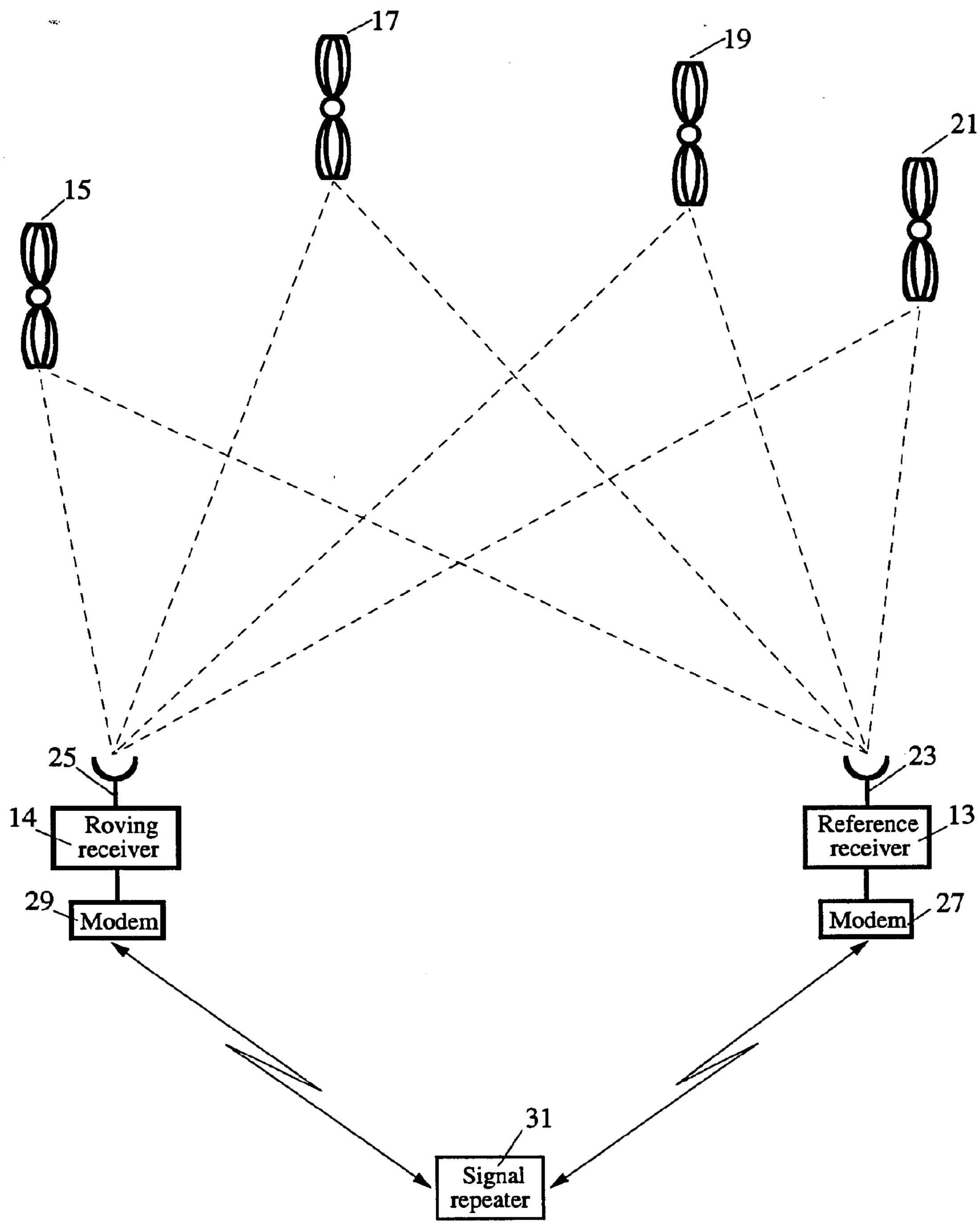
17
19
21
15
25
23
14
Roving receiver
Reference receiver
13
29
Modem
Modem
27
31
Signal repeater

FIG. 1

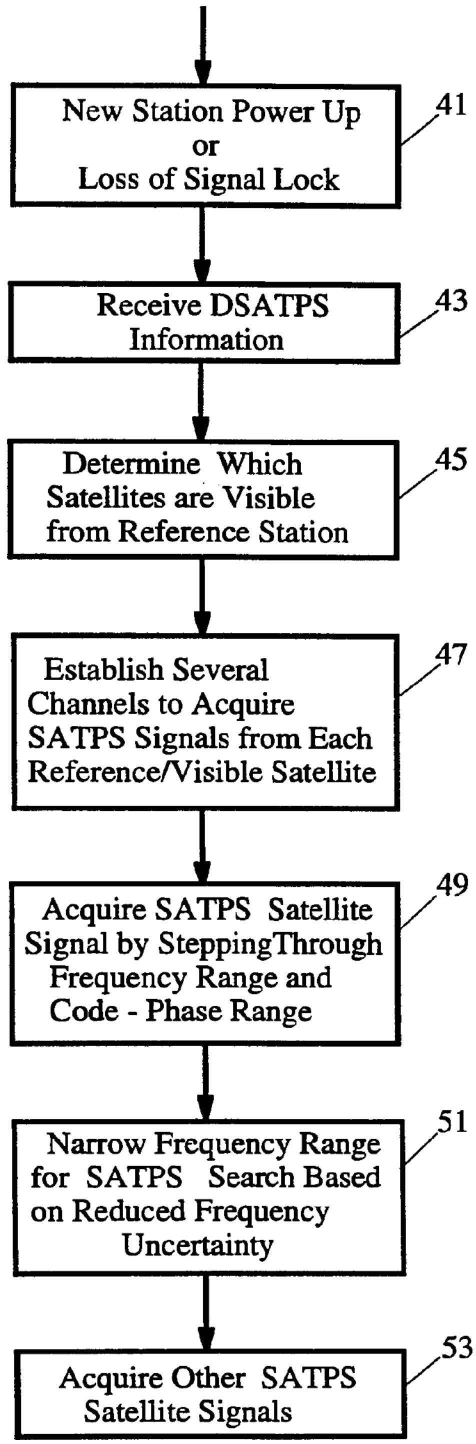
New Station Power Up or Loss of Signal Lock
41
Receive DSATPS Information
43
Determine Which Satellites are Visible from Reference Station
45
Establish Several Channels to Acquire SATPS Signals from Each Reference/Visible Satellite
47
Acquire SATPS Satellite Signal by SteppingThrough Frequency Range and Code - Phase Range
49
Narrow Frequency Range for SATPS Search Based on Reduced Frequency Uncertainty
51
Acquire Other SATPS Satellite Signals
53

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/05603

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :G01S 5/02
US CL :342/357

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 342/357,358; 375/1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,701,934 (JASPER) 20 OCTOBER 1987 SEE COLS. 19-20	1-6
A	US, A, 4,751,512 (LONGAKER) 14 JUNE 1988 SEE FIG. 1.	1-6
A	US, A, 5,119,102 (BARNARD) 02 JUNE 1992 SEE COL. 4 LINE 63-COL. 5, LINE 61.	1-6
A	US, A, 5,185,761 (KAWASAKI) 09 FEBRUARY 1993 SEE ENTIRE DOCUMENT.	1-6
A,P	US, A, 5,225,842 (BROWN ET AL) 06 JULY 1993 SEE ENTIRE DOCUMENT	1-6

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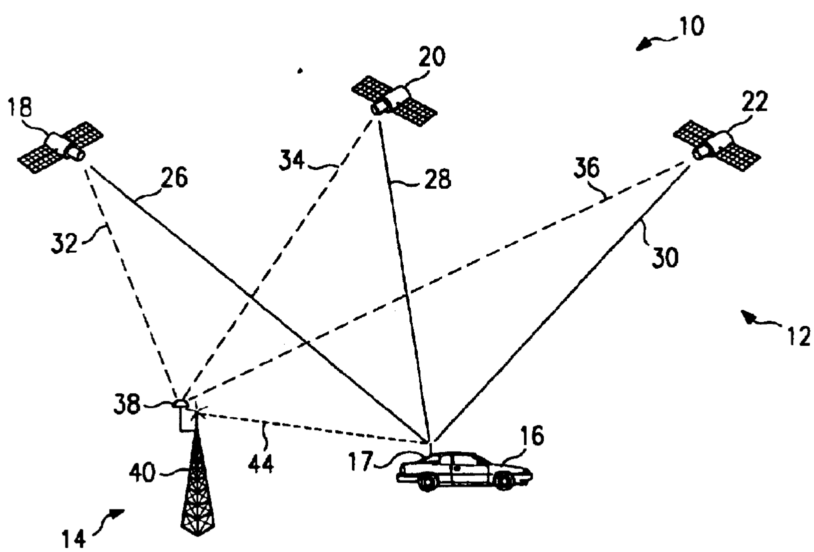

(57) Abstract

A differential positioning system (10) includes components of a satellite-based or land-based positioning system (12) and components of a mobile communications network (14). The differential positioning system (10) provides accurate and immediate position information to a mobile unit (17). A transmitter site (40) of a mobile communications network (14) is associated with a reference positioning receiver (38). The reference positioning receiver (38) generates correction data for transmission to the mobile unit (17). The mobile unit (17) includes a mobile communications device (42) for receiving the correction data generated by the reference positioning receiver (38) and a mobile positioning receiver (24) for generating a position fix. The mobile unit (17) refines the position fix generated by the mobile positioning receiver (24) using correction data received by the mobile communications device (42).

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LOCATING SYSTEM AND METHOD USING A MOBILE COMMUNICATIONS NETWORK

TECHNICAL FIELD OF THE INVENTION

This invention relates to locating systems, and more particularly to a locating system and method using a mobile communications network.

BACKGROUND OF THE INVENTION

Mobile communications technology has enjoyed substantial growth over the past decade. Many cars, trucks, airplanes, boats, and other vehicles are equipped with devices that allow convenient and reliable mobile communication through a network of satellite-based or land-based transceivers. Advances in this technology have also led to widespread use of hand-held, portable mobile communications devices.

Many customers of mobile communications systems also require an accurate determination of their position, and perhaps reporting of this position to a remote location. For example, a cellular telephone in a vehicle or carried by a person offers a convenient communication link to report position information. The position information may be generated by traditional positioning systems, including a satellite-based positioning system such as the global positioning system (GPS), or a land-based positioning system, such as LORAN-C. These approaches, however, may not be suitable for particular applications that require great position accuracy.

SUMMARY OF THE INVENTION

In accordance with the present invention, the disadvantages and problems associated with previous techniques used to locate and report the position of a vehicle, person, or object equipped with a mobile communications device have been substantially reduced or eliminated. One aspect of the present invention provides a differential positioning system that integrates positioning technology with an existing mobile communications infrastructure.

According to an embodiment of the present invention, a locating system using a cellular telephone network and a positioning system includes a reference positioning receiver having known position coordinates. The reference positioning receiver receives first position signals from the positioning system and generates correction data in response to the first position signals and the known position coordinates. A transmitter site of the cellular telephone network is coupled to the reference positioning receiver and transmits the correction data generated by the reference positioning receiver. A mobile unit in communication with the cellular telephone network and the positioning system receives correction data transmitted by the transmitter site. The mobile unit also receives second position signals from the positioning system and determines the location of the mobile unit in response to the second position signals and the correction data.

According to another embodiment of the present invention, a system for locating a mobile unit within the service area of a mobile communications network includes a plurality of transmitter sites having known position coordinates, each transmitter site broadcasting time-of-arrival (TOA) data. A mobile communications device on the mobile unit receives the TOA data transmitted by at least three transmitter sites. A memory on the mobile unit stores known position coordinates of the transmitter sites. A processor receives the TOA data from the mobile communications device and determines the position of the mobile unit in response to the TOA data received from the transmitter sites and the known position coordinates of the transmitter sites stored in the memory.

Important technical advantages of the present invention include improving the accuracy of existing positioning systems using a mobile communications system. In particular, existing transmitter sites of a mobile communications network may be used as reference points to transmit position correction data to mobile units within the mobile communications network service area. Other important technical advantages include integration of communicating, locating, and reporting functions for an overall reduction in the cost and complexity of the system. For example, a differential GPS (DGPS) positioning system may use an existing communications link, such as the overhead message stream of a cellular telephone network, to send correction data from the transmitter site to the mobile unit. Important technical advantages may also include accurate and immediate position fixes without relying on calculations performed at a remote location. Other important technical advantages may also include implementation of a time-of-arrival (TOA) positioning system within the mobile communications network without land-based or satellite-based positioning technology. Other technical advantages are readily apparent to one skilled in the art from the following figures, description, and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and for further features and advantages, reference is now made to the following description taken in conjunction with the accompanying drawings, wherein like reference numerals represent like parts, in which:

FIGURE 1 illustrates a differential positioning system;

FIGURE 2 illustrates an alternative embodiment of the differential positioning system of FIGURE 1;

FIGURE 3 is a schematic representation of a transmitter site associated with a reference positioning receiver;

FIGURE 4 is a schematic representation of a mobile unit;

FIGURE 5 is a schematic representation of a central host; and

FIGURE 6 illustrates an alternative positioning system.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE 1 illustrates several components used in a differential positioning system 10. The system includes components of a satellite-based or land-based positioning system 12 and components of a mobile communications network 14. Differential positioning system 10 provides accurate and immediate position information to vehicle 16 equipped with a mobile unit 17.

Positioning system 12 is illustrated as a satellite-based radio navigation system, such as the NAVSTAR positioning system (GPS). The description uses the NAVSTAR GPS as a representative positioning system 12, but any land-based or satellite-based system may be used. For example, positioning system 12 may be a land-based LORAN-C, a space-based GLONASS, or any other appropriate positioning technology. In general, positioning system 12 comprises a plurality of space-based or land-based transmitters that emit position signals.

The NAVSTAR GPS consists of a number of satellites in approximately twelve hour, inclined orbits of the earth, each satellite transmitting position signals. The GPS concept of operation is based upon satellite ranging. With position signals from three satellites, a GPS receiver can make an accurate calculation of its position in three dimensions. To make a valid position fix, the GPS receiver measures the propagation times of position signals from the satellites to a very high accuracy. This is accomplished by synchronizing the transmission of position signals to an atomic clock. However, to reduce costs and complexity, the GPS receiver may not maintain such an accurate clock, which introduces a clock bias (C_B) between the satellite clock and the GPS receiver clock. By measuring the apparent satellite signal propagation times from four satellites rather than three, the redundancy can be used to solve C_B. The signal propagation times correspond to ranges of the GPS receiver from the satellites, related by the speed of light. Prior to correction for the clock bias C_B, the apparent ranges of the satellites are all in error by a fixed amount and are called pseudoranges.

Two positioning services are provided by the NAVSTAR GPS. The precise positioning service (PPS) which is reserved for military use provides accuracy to within twenty-one meters (2drms). The statistical term "2drms" refers to a value that falls within two standard deviations (using the root-mean-squared method) of the sampled performance data mean. Therefore, a stated accuracy of twenty-one meters (2drms) means that the position error has an error of less than twenty-one meters approximately ninety-five percent of the time.

The standard positioning service (SPS) which is available for general use provides accuracy to within thirty meters (2drms). However, the SPS signal accuracy is intentionally degraded to protect U.S. national security interests. This process, called selective availability, degrades the accuracy of SPS position fixes to within one hundred meters (2drms). The SPS may be degraded in a number of ways, for example, by providing slightly inaccurate satellite orbital data to the receivers or by dithering the ranging information. Certain applications require better accuracy than provided by degraded SPS, SPS, or even PPS.

Differential GPS technology (DGPS) may provide location accuracies to within three meters (2drms). Such accuracies allow, for example, accurate positioning of a delivery truck on a street map or precise locating for an in-vehicle navigation system. The precision of the GPS system is improved by broadcasting differential correction data to a GPS receiver. A typical DGPS positioning system, such as the one implemented by the U.S. Coast Guard, uses known position coordinates of a reference station to compute corrections to GPS parameters, error sources, and resultant positions. This correction data is transmitted to GPS receivers to refine received position signals or computed position.

Traditional DGPS positioning systems require the user to carry both a GPS receiver and an additional communications device to receive the correction data. For example, the Coast Guard implementation requires a maritime radio beacon receiver to obtain GPS correction data. This Coast Guard system is described in a document entitled "Implementation of the U.S. Coast Guard's Differential GPS Navigation Service," U.S.C.G. Headquarters, Office of Navigation Safety and Waterway Services, Radio Navigation Division, June 28, 1993. Another system, described in U.S. Patent No. 5,311,194, entitled "GPS Precision Approach and Landing System for Aircraft" and issued to Brown, describes a differential GPS implementation for use in a precision approach and landing system for aircraft. In this system, the aircraft is required to carry a broadband GPS receiver with added functionality to receive pseudolite signals that contain the correction data.

Differential positioning system 10 in FIGURE 1 implements the DGPS concept using positioning system 12 integrated with mobile communications network 14 to accurately determine the location of vehicle 16. Differential positioning system 10 utilizes components of mobile communications network 14 as reference stations that provide correction data to vehicle 16 over an existing communications link, such as the control channel, overhead message stream, or paging channel of a cellular telephone network. Mobile communications network 14 may be a cellular telephone network, specialized mobile radio (SMR), enhanced specialized mobile radio (ESMR), a personal communications service (PCS), a satellite-based or land-based paging system, a citizen's band (CB), a dedicated radio system, such as those used by police and firefighters, or any other appropriate mobile communications technology.

Differential positioning system 10 is described with reference to location of vehicle 16. The present invention contemplates location of all types of vehicles, including cars, trucks, airplanes, boats, barges, rail cars, truck trailers, or any other movable object that is desirable to locate or track. Furthermore, differential positioning system 10 can also be used to accurately locate a person carrying a portable or hand-held mobile unit 17. Potential applications of this technology may include delivery service dispatch, less-than-full-load (LTL) trucking applications, in-vehicle navigation systems, surveying applications, collision avoidance, emergency location using mobile 911 services, or any other application requiring accurate positioning information of a vehicle, object, or person.

Differential positioning system 10 provides a more accurate position fix than currently available navigation services, and may provide these fixes near instantaneously or "on the fly." In some applications, low frequency and low accuracy updates are sufficient, but other applications may need better accuracy and higher frequency updates in near real-time. For example, a delivery truck may require accurate, high frequency position fixes for in-vehicle navigation to locate a specific delivery address or to provide real-time directions to the driver. Differential positioning system 10 may provide these high frequency updates without relying on off-vehicle computations prevalent in previous DGPS implementations. In addition, the same delivery truck may send lower frequency position reports to a remote location. These position reports may be sent at fixed time intervals, on-demand, or as a result of a predetermined reporting event. Differential positioning system 10 may provide both low and high frequency position fixes and reports in such a hybrid navigation and position reporting system.

Satellite-based positioning system 12 is a navigation system using NAVSTAR GPS, GLONASS, or other satellite-based or land-based radio navigation system to provide ranging data to mobile unit 17. Satellites 18, 20, 22 maintain accurate and synchronized time and simultaneously transmit position signals that contain satellite specific and system information required by mobile unit 17 to generate position fixes. The position signals transmitted by satellites 18, 20, 22 may include high precision clock and ephemeris data for a particular satellite, low precision clock and ephemeris (called "almanac") data for every satellite in the constellation, health and configuration status for all satellites, user text messages, and parameters describing the offset between GPS system time and UTC.

Mobile unit 17 receives position signals over message data streams 26, 28, 30 from satellites 18, 20, 22, respectively. Additional satellites (not shown) may also communicate message data streams to mobile unit 17. Typically, mobile unit 17 receives at least four satellite message data streams to solve for position information independent of inherent clock bias (C_B) between positioning system 12 and mobile unit 17. Currently the NAVSTAR GPS system has twenty-one active satellites at 11,000 mile orbits of fifty-five degrees inclination with the equator. In normal conditions, mobile unit 17 may receive position signals from seven satellites.

Using information from position signals 26, 28, 30 and optionally additional message data streams, mobile unit 17 may determine its position using accurate satellite position information transmitted by satellites 18, 20, 22 and pseudorange data represented by the time of arrival of message data streams 26, 28, 30 to mobile unit 17. Using SPS this position fix may be accurate to within 30 meters (2drms) or 100 meters (2drms) when selective availability degradation is activated. If mobile unit 17 is allowed to operate using PPS, then the position fix may be accurate to within 21 meters (2drms).

To provide a more accurate position fix for mobile unit 17, satellites 18, 20, 22 also transmit message data streams 32, 34, 36, respectively, to a reference positioning receiver 38 on or in proximity to a transmitter site 40 of mobile communications network 14. Reference positioning receiver 38 performs similar calculations to determine a position fix from position signals received from satellites 18, 20, 22. Reference positioning receiver 38 compares the computed position fix to known position coordinates and generates correction data for transmission over correction data stream 44 to mobile unit 17 for further refinements of position fix provided by mobile positioning receiver 24 (FIGURE 4).

The known position coordinates of transmitter site 40 may be determined by traditional surveying techniques. In addition, reference positioning receiver 38 may perform position fixes over a statistically significant period of time to determine the known position coordinates. Filtering or averaging position fixes by reference positioning receiver 38 over time removes or substantially reduces the effect of selective availability degradation and may provide a more accurate position determination than uncorrupted SPS or even PPS.

One type of correction data generated by reference positioning receiver 38 is a position correction which is applied to the position fix of mobile positioning receiver 24 (FIGURE 4) of mobile unit 17 to achieve a more accurate position fix. The position correction may be in latitude/longitude, compass direction and distance, or any other appropriate coordinate system. When using a

GPS positioning system 12, this technique provides accurate correction data when mobile unit 17 and reference positioning receiver 38 are located in a satellite common view area of approximately thirty square miles. In the satellite common view area all receivers operating in positioning system 12 receive approximately the same pseudorange errors assuming they are all listening to the same group of satellites 18, 20, 22. This correction method places less correction data in correction data stream 44 than other methods, but the validity of those correction terms decreases rapidly as the distance between mobile unit 17 and reference positioning receiver 38 increases. The usefulness of this correction method is impaired when mobile unit 17 and reference positioning receiver 38 compute their position fixes using position signals from different satellites. Furthermore, this method requires that both mobile unit 17 and reference positioning receiver 38 compute a navigation solution.

In an alternative correction method, reference positioning receiver 38 computes pseudorange corrections (PRCs) to each satellite 18, 20, 22, which are then transmitted over correction data stream 44 to mobile unit 17 to refine its navigation solution. The PRCs for satellites 18, 20, 22 in view of reference positioning receiver 38 are the difference between the pseudorange and the computed range to each satellite 18, 20, 22 based on the known position coordinates of reference positioning receiver 38. Each PRC message includes an identification of the satellite 18, 20, 22 and a linear measure of the PRC. Although this method may include more transmission of data, it may result in a more accurate position fix. Furthermore, such a scheme provides additional flexibility to allow mobile unit 17 to use navigation data from any of the satellites that reference positioning receiver 38 has furnished PRCs.

An additional correction method generates position corrections based on possible combinations of satellites 18, 20, 22 currently in view of reference positioning receiver 38. This approach may be computationally intensive at reference positioning receiver 38, but would allow for a simple adjustment of the solution computed by mobile unit 17. The number of position corrections (PCs) may be computed using the following formula:

$$No.\ of\ PCs = \frac{n!}{r!\ (n-r)!}$$

where n is the number of satellites in the common view area and r is the number of satellites used in the position correction calculation. For example, for a position fix using four satellites and with six satellites in the satellite common view area, reference positioning receiver 38 would have to generate fifteen PCs corresponding to fifteen combinations of four satellites each.

Each satellite 18, 20, 22 sends an identifier in its respective message data stream. Both mobile unit 17 and reference positioning receiver 38 may use these identifiers to generate satellite group IDs (SGIDs) that identify the specific combination of satellites used for a position fix. Reference receiver 38 may generate the position correction for fifteen combinations (four satellites chosen from a total of six), and tag the position corrections with the appropriate SGIDs. Mobile unit 17, having determined an SGID for its position fix, may then choose the proper position correction identified by the same SGID to ensure that mobile unit 17 and reference positioning receiver 38 use the same combination of satellites. Using this scheme with the NAVSTAR GPS, there would be 10,626 unique SGIDs for satellite combinations of four out of twenty-four satellites in the planned constellation.

The size and structure of a correction data message generated by reference positioning receiver 38 and transmitter over correction data stream 44 depends on the correction method employed and the precision required. A single pseudorange correction (PRC) message for a satellite in the satellite common view area may include a satellite ID, the range correction in a selected precision, and other associated portions of the message, such as a header, delimiter, and checksum. A typical PRC message for six satellites described in the Motorola GPS Technical Reference Manual (October 1993) is fifty-two bytes long, including the header, delimiter, and checksum.

The size and structure of a single position correction message also depends on the precision required and the transmission protocol. A typical position correction message may include a four byte SGID (1 through 10,626), a one byte latitude correction, and a one byte longitude correction. A multiple position correction message for fifteen satellite combinations (four satellites chosen from a total of six) may total 90 bytes of correction data. Appropriate header, delimiter and checksum bytes consistent with the communication protocol of mobile communications network 14 may be added.

The precision of pseudorange or position corrections depends on the anticipated range of error and the number of bytes allocated to the correction data. For example, one byte of eight bits may provide correction in the range of +/- 127 meters with one meter bit resolution. One byte may also provide correction in 0.25 meter bit resolution over a range of approximately +/- 32 meters. The precision, correction range, and byte allocation is a design choice that considers various factors, such as the available bandwidth in correction data stream 44, the accuracy of the unrefined position fix at mobile unit 17, the correction method employed, and the inherent inaccuracies of positioning system 12.

Correction data stream 44 allows correction data to be transmitted from reference positioning receiver 38 to mobile unit 17. In one embodiment, correction data stream 44 may be the control channel, paging channel, or overhead message stream currently implemented in cellular telephone technology. Currently, the control channel provides paging of incoming calls, hand-off instructions, and other features of the cellular telephone network, but may be modified by one skilled in the art to include transmission of correction data. Correction data stream 44 may also be implemented using any other communication link between transmitter site 40 and mobile communications device 42 (FIGURE 4) in mobile unit 17, whether or not the communication link requires seizing of a voice or data channel.

There are several developing technologies that may provide a convenient implementation of correction data stream 44. For example, cellular digital packet data (CDPD) technology allows integration of data and voice using the existing cellular telephone infrastructure. In a CDPD system, digital packets of data and analog voice segments share the same channel. Other developments in digital cellular communications, such as code division multiple access (CDMA) and time division multiple access (TDMA), allow digital data and digital voice signals to be interspersed on a communications channel. These technologies integrate digital data transmission in a mobile communications network 14, and therefore provide a convenient implementation scheme for correction data stream 44.

Using the technologies mentioned above or other appropriate digital communications link, transmitter site

40 may either continuously broadcast correction data over correction data stream 44, such as in the control channel of the cellular telephone network, or only send correction data to mobile unit 17 when requested by a feature code request or by any other appropriate manner. Transmitter site 40 may send correction data to mobile unit 17 in one large packet or in several smaller packets interspersed with other data used for mobile communications. The correction data may be packaged in existing, but unused, bytes of the control channel or in a dedicated protocol. One possible implementation would place correction data in the extended protocol described in the EIA/TIA-533 mobile communications standard, which provides for bidirectional communication between transmitter site 40 and mobile unit 17.

Reference positioning receiver 38 may continuously receive position updates and continuously compute correction data for transmission to mobile unit 17 over correction data stream 44. Alternatively, reference positioning receiver 38 may send correction data over correction data stream 44 at predetermined time intervals, at designated times when correction data stream 44 can accommodate the additional traffic, or when requested by mobile unit 17.

Reference positioning receiver 38 may include an additional capability to ensure that correction data transmitted to mobile unit 17 by transmitter site 40 is current. This may be accomplished by including a time stamp in the correction data message to account for latency in the system. Using GPS technology as an example, satellites 18, 20, 22 in positioning system 12 provide position navigation data each second. Reference positioning receiver 38 may include an additional byte that indicates the delay in seconds of the correction data. The mobile unit 17 may save time-stamped position signals and later synchronize and correct the position signals with the time-stamped correction data received from transmitter site 40. The post-processing to refine past position fixes may be performed by mobile positioning receiver 24 (FIGURE 4) or other separate processor in mobile unit 17.

Correction data stream 44 may be part of the control channel, part of a seized voice or data channel, or a separate channel requiring mobile unit 17 to re-tune to the correction data stream channel to receive valid corrections for the area. Mobile unit 17 may continuously monitor correction data stream 44 transmitted from transmitter site 40. Furthermore, mobile unit 17 may alternately tune between several correction data streams 44 from several transmitter sites 40 to determine the strongest signal, usually relating to the nearest transmitter site 40. This strongest channel select feature of mobile unit 17 assures that reference positioning receiver 38 and mobile unit 17 will be in close proximity and receive position signals from the same group or nearly the same group of satellites 18, 20, 22. For a typical transmitter site spacing in a cellular telephone network, the distance between mobile unit 17 and reference positioning receiver 38 may be less than five miles, well within the satellite common view area of the GPS system.

Differential positioning system 10, as illustrated in FIGURE 1, contemplates placing reference positioning receiver 38 on each transmitter site 40 within mobile communications network 14. When using GPS technology as positioning system 12 and a cellular telephone network as mobile communications network 14, the satellite common view area may be much larger than the coverage area of a single transmitter site 40, thereby obviating the need to have reference positioning receivers 38 on each transmitter site 40. For example, differential positioning system 10 may include reference positioning receivers 38 on selected transmitter sites 40 of mobile communications network 14. In this configuration, mobile unit 17, which may be capable of simultaneously monitoring correction data streams 44 from multiple transmitter sites 40, may still receive correction data from a transmitter site 40 that is currently not providing communication service to mobile unit 17. Selected transmitter sites 40 equipped with reference positioning receivers 38 may be spaced so that mobile unit 17 located anywhere in mobile communications network 14 can receive correction data of sufficient signal strength from one of the selected transmitter sites 40 equipped with reference positioning receivers 38.

FIGURE 2 shows an alternative embodiment of differential positioning system 10 that places reference receivers 38 on selected transmitter sites 40 in mobile communications network 14. As in FIGURE 1, transmitter site 40 is associated with reference positioning receiver 38, which receives position signals in message data streams 32, 34, 36 from satellites 18, 20, 22, respectively. However, mobile unit 17 is located in an area serviced by transmitter site 46, which is not equipped with reference positioning receiver 38. Furthermore, mobile unit 17 is unable to receive correction data directly from transmitter site 40 due to the inability to monitor communications from transmitter sites 40 and 46, the distance from transmitter site 40, or other reasons. However, mobile unit 17 is close enough to reference positioning receiver 38 to receive navigation data from at least a subset of satellites 18, 20, 22 serving reference positioning receiver 38. Using any of the correction methods described above with reference to FIGURE 1, reference positioning receiver 38 generates correction data and transmits this correction data through link 48 to transmitter site 46. Transmitter site 46 transmits correction data generated by reference positioning receiver 38 over correction data stream 44 to mobile unit 17. Mobile unit 17 uses the correction data to refine a position fix derived from position signals received from satellites 18, 20, 22 over message data streams 26, 28, 30.

Differential positioning system 10, illustrated in FIGURE 2, reduces the number of reference positioning receivers 38 required by networking correction data through link 48 between transmitter sites 40, 46. Link 48 between transmitter sites 40, 46 may include microwave communications, bidirectional paging or control channels, direct land-line connections, switching stations such as MTSOs, or any other appropriate communications device to send correction data from transmitter site 40 to transmitter site 46.

FIGURE 3 is a schematic representation of transmitter site 40 associated with reference positioning receiver 38. Reference positioning receiver 38 may be mounted directly on transmitter site 40 or on a separate structure or mounting. Reference positioning receiver 38 includes an antenna 50, receiver 51, controller 52, and memory 54. The following description relates to the operation of reference positioning receiver 38 with a GPS positioning system, however, the same concepts apply to other land-based and satellite-based positioning systems.

Reference positioning receiver 38 receives position signals in message data streams 32, 34, 36 from satellites 18, 20, 22, respectively. The position signals include navigation data, such as ephemeris, almanac, and clock correction data. Ephemeris data includes detailed information about the specific satellite course over the next two hours, the almanac data includes less detailed information about the complete satellite constellation for a longer period, and the clock correction data includes information to correct for clock errors. The satellite transmissions received by antenna 50 consist of a direct sequence spread spectrum signal containing the ephemeris, almanac, and clock correction data at a rate of fifty bits per second. In the case of the SPS, a pseudorandom noise signal with a chip rate of 1.023 MHz that is unique to each satellite is used to spread the spectrum of the information which is then transmitted on a center frequency of 1575.42 MHz.

Receiver 51 receives satellite position signals having a bandwidth of approximately 2 MHz and a signal-to-noise ratio of approximately -20 dB. The relative movement between satellites 18, 20, 22 and reference positioning receiver 38 causes an additional Doppler frequency offset from the GPS center frequency. To recover the navigation data and measure the propagation time of the satellite position signals, receiver 51 must cancel or allow for the Doppler frequency offset and generate the proper coarse/acquisition code associated with each satellite 18, 20, 22 to despread the signal. Once synchronization with the pseudorandom noise signal is achieved, receiver 51 may extract the ephemeris, almanac, and clock correction data and pass this information to controller 52.

Controller 52 receives navigation data from at least three satellites and uses this information to determine a navigation solution based on well-known triangulation techniques. In a four satellite fix, with each satellite position represented by coordinates (X_n, Y_n, Z_n) with the indice n equal to one through four, the position coordinates (X, Y, Z) of reference positioning receiver 38 may be determined by solving the following equations:

$$(X_1 - X)^2 + (Y_1 - Y)^2 + (Z_1 - Z)^2 = (R_1 - C_B)^2$$
$$(X_2 - X)^2 + (Y_2 - Y)^2 + (Z_2 - Z)^2 = (R_2 - C_B)^2$$
$$(X_3 - X)^2 + (Y_3 - Y)^2 + (Z_3 - Z)^2 = (R_3 - C_B)^2$$
$$(X_4 - X)^2 + (Y_4 - Y)^2 + (Z_4 - Z)^2 = (R_4 - C_B)^2$$

where R_1, R_2, R_3, R_4 are pseudorange measurements from the satellites and C_B is a common clock bias. Controller 52 may use certain data stored in memory 54 to arrive at a navigation solution. Controller 52 may then compare the instantaneous navigation solution (X, Y, Z) to known position coordinates (X_0, Y_0, Z_0) stored in memory 54 to generate position correction data in latitude/longitude, compass direction and distance, or other appropriate coordinate system.

In an alternative embodiment, controller 52 may receive ephemeris, almanac, and clock correction data from satellites 18, 20, 22 and compute a pseudorange (R_N) for each satellite. Since the satellite signal contains information on the precise satellite orbits and controller 52 has known position coordinates (X_0, Y_0, Z_0) stored in memory 54, the true range to each satellite 18, 20, 22 can be calculated. By comparing the true range and the measured pseudorange, a pseudorange correction (PRC) for each satellite 18, 20, 22 may be computed and sent as correction data. As described above with reference to FIGURE 1, controller 52 may also provide position correction data based on navigation solutions using all possible combinations of satellites 18, 20, 22 currently in view of reference positioning receiver 38.

Correction data in any of the various forms described above is sent by controller 52 to channel controller 56 of transmitter site 40 over communication link 58. Communication link 58 may be a direct wire connection, a radio communication link, a connection through a switched telephone system, or other appropriate communication link. Depending on the configuration of differential positioning system 10, channel controller 56 may send correction data to radio duplexer 60 for transmission over transmitter site antenna 62 to mobile unit 17. Alternatively, channel controller 56 may pass correction data through link 48 to transmitter site 46 currently serving mobile unit 17.

Also shown in FIGURE 3 as part of transmitter site 40 are time-of-arrival (TOA) data generator 64 and clock 66 that may be used in an alternative positioning system 200 described with reference to FIGURE 6. TOA data generator 64 generates a TOA data message and sends this message to channel controller 56 for transmission to mobile unit 17 over transmitter site antenna 62. The TOA data message may include a precise time of transmission based on information maintained by clock 66. Clock 66 and TOA data generator 64 are shown as elements of transmitter site 40, but it should be understood that their functions may also be implemented in a central or distributed device accessible by transmitter sites 40, 46 of mobile communications network 14.

FIGURE 4 is a schematic representation of a mobile unit 17 that includes mobile positioning receiver 24, mobile communications device 42, and other associated hardware and software, described below. Mobile positioning receiver 24 is similar in construction and function to reference positioning receiver 38 and includes an antenna 82, receiver 84, controller 86, and memory 88. In operation, mobile positioning receiver 24 receives position signals from satellites 18, 20, 22 over message data streams 26, 28, 30 at antenna 82. Receiver 84 processes these signals to extract ephemeris, almanac, and clock correction data. Controller 86 receives this information and computes a navigation solution or pseudorange measurements. These calculations performed by controller 86 may use data stored in memory 88.

Mobile communications device 42 includes an antenna 90, transceiver 92, and hand set 94. In operation, mobile communications device 42 receives correction data at antenna 90 over correction data stream 44. The correction data may be transmitted directly from transmitter site 40 equipped with reference positioning receiver 38 as described with reference to FIGURE 1, or indirectly through link 48 and transmitter site 46 as described with reference to FIGURE 2. As described above, the correction data may be in a variety of forms, including single or multiple position corrections, or pseudorange corrections to each satellite. Correction data is then stripped from correction data stream 44 by transceiver 92. Correction data may be passed to processor 100 over link 95 or over any other appropriate path, such as through bus drivers 112 and modem or dual tone multifrequency (DTMF) coder/decoder 110. Hand set 94 provides traditional voice or data communication using mobile communications device 42.

Processor 100 manages the communicating, locating, and reporting features of mobile unit 17. Processor 100 receives a navigation solution or pseudorange measurements from controller 86 and correction data from transceiver 92. Coupled to processor 100 is memory 102 which may contain programs, databases, and other information required by processor 100 to perform its functions. For example, memory 102 may contain a table of known position coordinates of transmitter sites 40 for use in computing the position of mobile unit 17 in the alternative positioning system 200 described with reference to FIGURE 6. Memory 102 may be random access memory (RAM), read-only memory (ROM), CD-ROM, removable memory devices, or any other device that allows storage or retrieval of data.

Processor 100 and controller 86, as well as memory 102 and memory 88, may be separate or integral components of mobile unit 17. For example, controller 86 may include a port that directly receives correction data and allows mobile positioning receiver 24 to output a refined position fix. Mobile unit 17 contemplates any arrangement, processing capability, or task assignment between controller 86 and processor 100.

In operation, processor 100 generates a refined position fix for mobile unit 17 based on the navigation solution or pseudorange measurements from controller 86 and the correction data from transceiver 92. This refined position fix may be sent to output device 104 to generate a moving or static display of vehicle 16 on a map represented by map data stored in memory 102. Alternatively, output device 104 may produce audible information, such as directions or location updates, to the operator of vehicle 16.

Processor 100 is also coupled to input device 106 that allows operation of mobile unit 17. Input device 106 may be a keypad or touch screen, as well as voice recognition software and hardware that can accept audible commands and information. Furthermore, both output device 104 and input device 106 may include fixed or removable storage media, such as magnetic computer discs, CD-ROM, or other suitable media to both receive output and provide input to processor 100.

Processor 100 may also generate data messages for transmission to a remote location using mobile communications device 42. The data messages may include the refined position fix of mobile unit 17, the time of reporting, or information input by the vehicle operator, as well as any other information collected by processor 100 from various sensors 108. For example, sensors 108 may include various engine sensors, truck trailer sensors, security monitors, or other devices generating information on the status or condition of mobile unit 17, vehicle 16, or its operator. The generation and transmission of a data message may be based on elapsed time, movement of mobile unit 17, sensor readings, or any other piece of information that may necessitate reporting to a remote location. The data messages are sent from processor 100 through modem or DTMF coder/decoder 110 to bus drivers 112, and then to transceiver 92 for transmission over antenna 90 to a remote location, such as central host 120 (FIGURE 5). Data messages may also be sent directly to transceiver 92 over link 95.

Mobile unit 17 may also include a clock 116 coupled to processor 100 that may be used to synchronize the navigation solutions or pseudorange measurements received from controller 86 with latent correction data received from transceiver 92. Clock 116 may also be used in alternative positioning system 200 described with reference to FIGURE 6. In operation, clock 116 provides accurate time to processor 100, and may receive clock correction updates from mobile positioning receiver 24 or through correction data from mobile communications device 42.

Components of mobile unit 17 shown in FIGURE 4 may be packaged into one or more housings. Mobile unit 17 may be mounted to vehicle 16 or an object to be tracked. Mobile unit 17 may also be packaged as a portable, hand-held device that provides personal locating, communicating, and reporting functions. For example, a portable, hand-held mobile unit 17 may be used by surveyors, rescue teams, individuals that may change forms of transportation, or any other application requiring portability of mobile unit 17.

FIGURE 5 is a schematic representation of a central host 120. Central host 120 receives communications from mobile unit 17, such as reports generated by processor 100, through link 122. Link 122 may be one or a combination of dedicated telephone lines, switched telephone lines, microwave communications links, satellite-based communications links, or any other suitable communication link that allows mobile unit 17 to transmit data to or receive data from central host 120.

A data message from mobile unit 17 enters central host 120 through a modem or DTMF coder/decoder 124 and passes to central controller 126. Coupled to central controller 126 is memory 128 and input/output device 130. Memory 128 may be RAM, ROM, CD-ROM, removable memory devices, or any other device that allows storage or retrieval of data. Input/output 130 includes any variety of output devices, such as a display, a speaker to provide audible information, removable storage media, or any other appropriate output device. Input/output device 130 may also include a variety of input devices, such as a keyboard, mouse, touch screen, removable storage media, or any other appropriate input device.

Central controller 126 receives data messages from mobile unit 17 and processes this information to locate, track, dispatch, and communicate with mobile unit 17. For example, central controller 126 can maintain a database in memory 128 of all mobile units 17 with their current location, status, and relevant sensor readings. This database can also be used to initiate communication with mobile unit 17. Furthermore, central controller 126 may perform a call delivery function that routes incoming calls to mobile unit 17 through link 122. This aspect of call delivery is fully described in Application Serial No. 08/095,166, entitled "Method and Apparatus for a Nation-Wide Cellular Telephone Network" filed July 20, 1993, and Application Serial No. 08/175,256 entitled "Data Messaging in a Communications Network" filed December 28, 1993, both applications commonly owned by the assignee of the present application, and both applications hereby incorporated by reference.

FIGURE 6 illustrates an alternative positioning system 200 that utilizes equipment of the existing mobile communications network 14 to locate vehicle 16 equipped with a modified mobile unit 17. Mobile unit 17 communicates with transmitter sites 202, 204, 206 over communications links 208, 210, 212, respectively. Communication links 208, 210, 212 may be the control channel, overhead message stream, or paging channel of a cellular telephone network, a portion or all of a seized voice or data channel, or a dedicated channel. Transmitter sites 202, 204, 206 may be coupled to a network in a variety of ways. For example, transmitter site 202 is coupled to transmitter site 204 over land-line connections through MTSO 214. Transmitter site 202 is coupled to transmitter site 206 over a microwave or other radio link 216. Transmitter site 204 is coupled to transmitter site 206 over a direct or dedicated connection 218.

Positioning system 200 operates in a similar fashion to an aspect of differential positioning system 10 described with reference to FIGUREs 1 and 2, but does not rely on a positioning system 12 to transmit navigation data. Instead, transmitter sites 202, 204, 206 transmit time-of-arrival (TOA) data over respective communications links 208, 210, 212. Mobile unit 17 receives TOA data and computes the position of mobile unit 17 using the TOA data and known position coordinates of transmitter sites 202, 204, 206.

The TOA data from transmitter sites 202, 204, 206 may be transmitted in a variety of ways. In one method, a network clock 220 synchronizes the instantaneous transmission of TOA data from transmitter sites 202, 204, 206. Using this method, the time of reception at mobile unit 17 provides pseudorange measurements to transmitter sites 202, 204, 206. As in differential positioning system 10 of FIGUREs 1 and 2, a fourth transmitter site allows the position of mobile unit 17 to be computed without regard for a clock bias (C_B) between network clock 220 and clock 116 (FIGURE 4) maintained on mobile unit 17.

In another embodiment, transmitter sites 202, 204, 206 transmit TOA data at different times, but include the time of transmission in the message to mobile unit 17. Assuming cellular transmitter sites 202, 204, 206 maintain synchronized time through network clock 220, mobile unit 17 can generate pseudorange measurements by comparing the message time of arrival to the time of transmission.

Transmitter sites 202, 204, 206 and mobile unit 17 may have different configurations when operating in positioning system 200. Referring to FIGURE 3, transmitter site 40 does not need an associated reference positioning receiver 38 to provide location information in positioning system 200. Transmitter site 40, however, does include TOA data generator 64 and clock 66 to generate the TOA data for transmission to mobile unit 17. Referring now to FIGURE 4, mobile unit 17 does not require mobile positioning receiver 24 for operation within positioning system 200. TOA data is received by transceiver 92 and sent to processor 100, which uses the TOA data to compute pseudoranges to cellular transmitter sites 202, 204, 206. Using well-known triangulation techniques described with reference to FIGURE 3, processor 100 may then compute a position fix of mobile unit 17 using the pseudoranges and known position coordinates of transmitter sites 202, 204, 206 stored in memory 102.

Although the present invention has been described with several embodiments, various changes and modifications may be suggested to one skilled in the art, and it is intended that the present invention encompass such changes and modifications as fall within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A locating system using a cellular telephone network and a positioning system, comprising:

a reference positioning receiver having known position coordinates and operable to receive first position signals from the positioning system, the reference positioning receiver further operable to generate correction data in response to the first position signals and the known position coordinates;

a transmitter site of the cellular telephone network coupled to the reference positioning receiver, the transmitter site operable to transmit the correction data generated by the reference positioning receiver; and

a mobile unit in communication with the cellular telephone network and the positioning system, the mobile unit operable to receive correction data transmitted by the transmitter site, the mobile unit further operable to receive second position signals from the positioning system and to determine the location of the mobile unit in response to the second position signals and the correction data.

2. The system of Claim 1, wherein the transmitter site transmits the correction data in a control channel.

3. The system of Claim 1, wherein the reference positioning receiver is mounted on the transmitter site.

4. The system of Claim 1, wherein the known position coordinates of the reference positioning receiver are based on data received by the reference positioning receiver over a statistically significant period of time.