Title of the Invention: Alarm system and method

Abstract Title: Driver awareness monitoring system

An in-vehicle driver awareness monitoring system comprises one or more brain waves sensors 113, 115, 116 connected to a logic unit or a computer adapted to monitor the driver's awareness state and actively respond if a detected risk trigger is found. As a result an alarm may be activated or a speed limitation may be applied to the vehicle. The brain waves sensors can include EEG and/or MRI sensors. The system can further include memory for keeping track of the driver's awareness state and an internal battery for providing power. The system can be connected to at least one computer of the vehicle. The system may further include driver's head 31 movement and/or position sensors, adapted to help reading the brain waves. Sensors may include sensors 422, 42, 421 may be embedded in a seat, belt or head cushion and a sensor 115 on the windscreen made of a transparent conductive surface. Movement sensors 113, (11, 114 see fig 3) may include a video camera (41 see fig 3).
FIG. 1

1. Read electrical signals (brain waves) from driver
2. Compute / evaluate / analyze driver's awareness state
3. Dangerous / hazardous state?
   - Y: Take action / send an alarm / issue a warning
   - N: Return to step 1
Track head movements

Read sensors

Signals conditioning

Compute brain signals corrected for head movement

Compute / evaluate driver's awareness state

Normal? Y N

Issue warning

Corrected? Y N

Active measures

System DB
## Mock up action table Vs Car status

<table>
<thead>
<tr>
<th>Driver condition</th>
<th>Car is parked</th>
<th>Car in motion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drunk</strong></td>
<td>Not starting Until status is re-settled</td>
<td>Alerting Pattern for parking condition</td>
</tr>
<tr>
<td><strong>Sleepy</strong></td>
<td>Not starting Until status is re-settled</td>
<td>Same as above</td>
</tr>
<tr>
<td><strong>Stress</strong></td>
<td>Not starting Until status is re-settled</td>
<td>Alerting Pattern per a given status</td>
</tr>
</tbody>
</table>

**FIG. 6**
FIG. 8
Brain waves sensors

Driver head movement sensors

Car computer& sensors

Environment sensors

Noise Reduction

Correlation Unit

Driver estimator

Decision making (DMM) mechanism

DB

Warning

Action

FIG. 9
Database Memory

Power management unit

Vehicle's Battery

Internal Battery

Security unit

Speaker

External interface

Car computer

Wireless network

Driver movement sensors

Brain sensors

Noise sensors

Comm. unit

Decision and control unit

FIG. 10
Alarm system

550 Engine
551 Clock
552 Lights
553 Passengers ind
554 Speed
555 Alarm
556 Horn
557 Sound system
558 A/L
559 Windscreen wipers

FIG. 11
Normal Driving -> DRT Scan T1 (565)

DRT Scan T1 -> No DRT

DRT Scan T1 -> DRT Scan T2 (566)

DRT Scan T2 -> DRT2

DRT2 -> Speed Limit (567)

Speed Limit -> DRT Scan T3

DRT Scan T3 -> DRT3

DRT3 -> Pulling over (568)

Pulling over -> DRT4

DRT4 -> Power on (563)

Power on -> No problem

No problem -> DRT4

DRT4 -> Thorough diagnose (562)

Thorough diagnose -> Power off (561)

Power off -> Driver Enters Car (560)

Driver Enters Car -> FIG. 12
Patent Application in Great Britain

Alarm system and method

Field of the Invention

This invention relates to any human behavior state and well being monitoring, in this application presented as a "driver in car" situation driver monitoring and more specifically to any in-vehicle driver monitoring and alarm issuing, using EEG and/or MRI sensors.

Background of the Invention

RDRS (TM) is claimed as a Trade Mark by the present applicants in the fields of alarm systems and methods.
The applicants plan to start commercializing the present invention shortly.

The present application claims priority from patent application No. GB0821318.3 filed in Great Britain on 24 November 2008.

The present invention aims to tackle well known vehicle and driving-related risks in real time. Dangerous situations are addressed in an automatic manner, preconfigured regardless of driver's activities, actions or attentiveness level.

Prior art: Hibbs et al, US Patent No. 7,141,987, discloses a sensor system for measurement of one or more vector components of an electric field.

Human error and mental condition impairment-related car accidents present a major part of the total accidents figures: Wiegmann & Shappell I report
presents "Adverse Mental States, Adverse Physiological States. Physical/mental Limitations & Personal Readiness" as root causes to more than 40% of human related aviation accidents. Even more amazing figures are related with car accidents: in the US alone, 6,420,000 car accidents were reported in Y2005, during which 42,636 people were killed. It is estimated that some 40% of this figure are related to drivers under alcohol influence.

With similar fatalities figures in Y2004, more than 10,000 drivers were killed due to 13AC=.08+ Alcohol levels... It seems that government activities public awareness, as well as advertising didn't do better over the following years. In Y2006 the US bureau of transportation reported 14,861 people killed in alcohol related car-accidents. Needless to say those global figures are more unfortunate...

An in-vehicle driver awareness monitoring system may be of high importance. It is not rare that drivers fall asleep while driving a vehicle. This may pose a critical danger for the driver, the passengers in the vehicle and passengers of neighboring vehicles and property as well.

Another instance of an undesired situation is a drunk or drugged driver, who enters the vehicle and intends to drive. It may not be possible to stop such drivers either in advance or in real time; by the time the dangerous situation is found out, an accident could have already occurred. A driver under stress, who is extremely upset, angry, etc. could impose some risk as well. Thus it may be preferable for such a driver to relax before hitting the road.

Researches have shown that, some specific states of mind could be monitored. Some of these states can be defined as dangerous, critical, or even prove that the driver is not capable of responsible driving, and/or that the driver should not drive.
Thus, a high degree of responsibility and a proper state of mind is required as a prerequisite to driving a vehicle.

While it has been found out that it may be possible to sense some states of mind, such as using EEG and/or MRI sensors, such as by measuring electric fields created in the brain, a vehicle still imposes some challenges, as there is a high level of electric noise and interference, the vehicle’s chassis and other parts are conductive, and the manner in which the driver sits, as well as his actual dimensions and movements are unknown. All these factors arise further difficulties for retrieving reliable, objective and practical measurements, employing capable sensors and reacting accordingly.

In addition, even if such monitoring is possible, it is not known what can be done, and/or how and whether, can the driver be stopped.

Yet in some cases, an alarm provided could be helpful as well. Thus as the driver is busy in driving, he may not be aware or not pay proper attention to his state of mind, such as getting tired or getting angry. In such or other situations, a friend or a passenger sitting next by, could maybe monitor the driver or provide some help, however this may often not occur, or the passenger cannot order the driver to pull over.

Thus, the driver could be completely in his "own world" without any guidance or supervision, and without having anyone or anything to monitor his state of mind. This fact alone can frighten the driver as well as others.

Thus, there is a need for a monitoring and alarm active system, capable of reliably and practically monitoring the driver, capable of deriving whether the driver is in dangerous state of mind; and capable of taking measures to reduce/avoid a possible risk.
The present invention uses non-contact remote measurements of EEG signals from the driver's head to evaluate his state of mind. To measure EEG, the present invention may use a potential sensing plate located in the car.

For that purpose, an electrically conductive sensing plate may be used, with measuring the voltage induced there by the potential or alternative voltage to be measured.

The solution to these and other problems, as well as various benefits, are achieved with the present invention, as will become apparent to persons skilled in the art.

Summary of the Invention

According to the present invention, a novel in-vehicle driver awareness monitoring system and method are provided. The system may be of high importance for reducing risky driving and preventing accidents.

The present invention is intended to efficiently monitor whether the driver falls asleep, is unfocused or is about to fall asleep, while or prior to, driving the vehicle. This may prevent a critical danger for the driver, the passengers in the vehicle and passengers of neighboring vehicles as well.

The system may also detect an undesired situation in which the driver is drunk, or is under the influence of alcohol and/or drugs or other risky state of mind or physical conditions. The system may detect this after the driver enters the vehicle and as he intends to drive. Thus, it may not be possible to stop such drivers either in advance; or detect
dangerous states of mind in real time, and take measures as soon as possible, so that the chances for an accident could be reduced.

Hence the system could monitor and detect that the driver is or becomes under stress; that he is extremely (or in some manner) upset, angry, etc. and decide whether he imposes a risk and to what extent. The system may then command such a driver to relax or improve his state of mind before hitting the road; it could prevent him from driving, issue a warning internal and external, limit the vehicle's speed and/or perform any other operation in order to reduce risk.

The system could also notify a control center, such as an insurance agency, a police station, etc. in order to allow professionals decide what should be done.

The system exploits one or more sensors, which can monitor states of mind, such as by using remote EEG - sensing electric fields originating from the brain and/or using MRI. Some of these states detected by the system can be defined as dangerous, critical, or even prove that the driver is not capable of responsible driving, and/or that the driver should not drive.

Thus, the system can ensure that the driver indeed complies with some degree of responsibility criteria and that he is in a proper state of mind, suitable for safe driving a vehicle.

Sensors adapted to the vehicle's unique environment, as well as a combination of monitoring and/or sensing means, physical and electronic, may allow to utilize a practical measuring system for the driver, in the special interior of the vehicle's driver seat.

Some sensors can be placed close all-around to the driver, for allowing
to measure weak signals, while sensors may also be designed to overcome some known noises present in the car, and be directed towards the driver for allowing to measure the driver's state and overcoming known interferences.

Thus, the system introduced herein allows deploying EEG and/or MRI sensors, as well as other sensors, such as optical, ultrasonic, etc., which would all provide a reliable, objective remote driver state of mind measuring system, while coping with the vehicle's chassis and other conductive parts, which may deliver some electric noises or other undesired signals. The manner in which the driver sits, as well as his actual dimensions and movement can be monitored, and can be used to better derive signals and/or cancel or reduce the effects of the movement on the sensors.

The system may further provide modes of operation, for monitoring the driver, reporting to a center, employing capable sensors and reacting accordingly. Thus, the system may include a computer or sophisticated logic, for monitoring the driver over time, and taking proper measured action only when there is no other choice.

In some cases, the system can provide a helpful alarm, rather than physically limiting the driving. Thus as the driver is busy in driving, the system can monitor him, to insure he is aware or pay proper attention to his state of mind. Thus the system will issue a warning if it senses the driver is getting tired or getting angry, for example. In such or certain situations, the system can be as a watching friend, monitoring the driver, suggesting the driver to pull, or actually overriding the driver and gradually stopping the vehicle over if required.

Thus, the driver would remain under guidance or supervision, and could feel safer that the system is monitoring his state of mind.
The system can be connected to a vehicle's computer or be combined with it, so that efficient control of the vehicle could be implemented, such as by providing digital commands by the system's computer to the vehicle's computer, for reducing speed or stopping the vehicle.

Further features of the present invention:

1. uses only one electric field or potential sensor, together with driver's head location - correlation. then has changes in distance, to compute field.

2. If several sensors are used, each can be used to measure a received electric signal.

3. The present invention can measure the AC voltage in the brain, using a capacitive coupling - the capacitance between the voltage source and an electrically conductive plate.

4. The present invention can use NMR/MRI sensors rather than electric field sensors.

**Brief description of the drawings**

Fig. 1 illustrates a Method for monitoring a driver's awareness state

Fig. 2 illustrates the Location of sensors for measuring signals in a driver's head (side view)

Fig. 3 illustrates the Location of sensors for measuring signals in a driver's head (front view)

Fig. 4 details a block diagram of a signals measuring and processing system
Fig. 5 illustrates a Method for monitoring a driver's awareness state and taking action whenever necessary

Fig. 6 illustrates a truth table of possible driver's states of mind and corresponding possible system's actions (page 13/21 of provisional)

Fig. 7 illustrates the cross-correlation between distance head to plate and the amplitude of received signals

Fig. 8 illustrates, in block diagram form, the process flow

Fig. 9 illustrates a signals flow diagram

Fig. 10 illustrates the system block diagram

Fig. 11 illustrates a system block diagram with car computer

Fig. 12 illustrates the states diagram of the system.

**Detailed Description the Invention**

Throughout the present disclosure, for clarity, the abbreviations in the following list may be used:

**List of abbreviations**

* EEG - electro-encephalogram

* DIR - Driver induced risk (s)

* RDRS - Risky driver related situations
* DRT - Detected risk trigger
* DMM - Decision making mechanism
* DSP - Digital signal processor (or: processing)
* NMR - Nuclear magnetic resonance
* MRI - Magnetic resonance imaging
* SMS - Short message service
* ADC - Analog to digital converter
* SNR - Signal to noise ratio
* DB - Data base
* TBD - To be defined

Due to the nature and impact of driver-related accidents, it is claimed that it is in the interest of States authorities, Car manufacturers, Insurance institutes and the Public as a whole that such fatal accidents are reduced to as-minimal-as-possible figures, thus Reducing the financial burden as well as the sorrow and hardship of casualties. This initiative suggests harnessing EEG, a well established, non intrusive medical examination procedure in order to monitor, analyze as well as to further alert and take actions in cases of risky driver related situations (RDRS) as mentioned above.

Driver induced risks (D.I.R)

**Control & Management**

* Process flow Agenda
* List of abbreviations
* Monitoring
* Sensors
* Analysis (real time)
* Data base
* Detection & Activation
* Activation considerations
* Mock up "truth table"
* Alarming (In vehicle)
* Alerting (extrinsic actions) Actions

**System characteristics**

In-vehicle monitoring & alerting system

Separate data collection module(s)

Powered by the car power system and backed-up with an in depended power source
(rechargeable batteries)

Protected from environmental and human induced damages

**Monitoring**

An In-vehicle furnished device which monitors driver awareness state: mental state, state of mind, stress & disorders (also Drugs & Alcohol and other possible conditions)

Using a remote non intrusive sensor

Sensor(s) Location:
The sensor(s) should be located near the vehicle driver's head in order to monitor brain waves.
Therefore there are several possible locations to integrate it:

* Embedded within a safety belt
* Embedded in the drivers' seat or head cushion
* Embedded in the car ceiling

Sensitivity:
The present invention will provide references to several commercial applications.

Analysis (real time)
* Analysis of abnormal status
* Triggering an alert module as further presented
* All analyzed data is served as a baseline for comparison (stable vs. unstable / normal vs. abnormal)
* Data logging feature (into a DB) in order to preserve historical data for further analysis of driver long term state and behavior

Database (Black box)
* Enables Data logging
* Keeps historical data for further analysis
* Enables data download to an external device upon request
* Destruction & impact protected
* Data security protected (access restriction)
* Non moving parts / solid state device is advised

Detection & Activation
Input: detected risk trigger (DRT)
Output: program based action (s)
* This device / module serves as an automatic "decision making" and "process triggering application.
* Upon a certain trigger (s) detection, it triggers the
alerting mechanisms with consideration to the driver state, the car status, environmental issues & road conditions as will be further described.

* This mechanism is pre-defined: actions and alarms patterns and thresholds may be altered
* Using a supervisor credentials
Per a given vehicle user (driver / pilot etc...)

Activation considerations

Decision making mechanism (DIMM)
* Driver status
  Stress, Drunk, Drug use, other;
* Environmental conditions
  Passengers (Y/N), Rain / Snow, Light conditions
* Car conditions- In traffic (road / highway), Car speed, Parked, Powered off

Exemplary Truth table, see Fig. 6.
Driver condition; Car is parked; Car in motion.
For each of the above, the table specifies relevant states and activities.

the diver and / or passenger on a "DIR" situation
* Possible alarms
* Sound (alarm / radio / music)
* Seat vibration
* Light activation
* Dash built-in alarm

Alerting (extrinsic actions)
* Triggering extrinsic routines to alert 3rd parties on a "DIR" situation
* Possible alarms:
* Sound (alarm / radio music)
* Lights flashing
* SMS / radio message to a predefined location(s) (i.e. safety forces, family etc...)
* Cell Phone call

* Possible information / details
  * Area / geographical information (GPS) (location)
  * Car / owner details
  * Current driving conditions (Speed directions)
  * The associated / detected DIR

The Automatic actions taken by the RDRS system

Actions (active)
Possible actions that may be triggered automatically by the RDRS system:
* Car slow down while it's being driven
* Top speed control, hooked up to the car "cruise control" system
* Lane change control (alerting the driver on lane changes)
* Start up cancellation
* Signals "out of use due to "alcohol" or "other" reason
* Air condition activation

* Lights flashing
Placing a message (Radio/ SMS / Phone) to a predefined location which contains applicable data.

Further analysis (Post mortem)

* Analysis of black box data
* TBD

Monitoring
* An In-vehicle furnished devise
* Monitoring of vehicle driver awareness, mental state, state of mind, stress & disorders (also Drugs & Alcohol)
* Using a remote non intrusive sensor Go
* In car system for data collection

Powered by the car power system and backed-up with an in depended power source (rechargeable batteries)

Protected from environmental and human induced damage

Data base (Black box)
* Enables Data logging
* Keeps historical data for further analysis

* Enables data download to an external device upon request
* Destruction & impact protected
* Data security protected (access password)
* Non moving parts / solid state devise is suggested

Detection & Activation
Input: detected risk trigger (DRT)
Output: pre decision based action(s)
* This devise serves as an application decision making tool and process activation.

* Upon a certain trigger(s) detection, it triggers the alerting mechanisms with consideration to the driver state the car status, environmental issues & road conditions as further described.

Method for monitoring a driver's awareness state

See Fig. 1 for the flow chart for the method, including:

a. Read electrical signals from driver 511
Preferably non-contact means are used to measure signals indicative of activities (or lack thereof) in driver's mind.

b. Compute/evaluate driver's awareness state 512

Based on the above signals measurements, conclusions may be drawn to indicate whether the driver is in a normal, lucid state of mind or maybe he under the influence of drugs or alcohol, in an aggressive mood, etc.

c. Dangerous state? 513

The driver's state of mind estimated above is reviewed in a near real time manner for its possibly dangerous consequences.

d. Take action 514

If indeed some negative or dangerous consequences are to be expected, then the driver may be warned and, if this proves ineffective, more drastic actions may be taken, such as stopping the car.

** End of method **

Fig. 2 illustrates the Location of sensors for measuring signals in a driver's head 31 (side view)

The sensors may include:
sensor located above driver's head 113
sensor located on the front windshield 115, can be made of a transparent conductive surface
sensor embedded in or located on the dashboard 116
sensor embedded in the driver's seat or head cushion 421
sensor embedded within a safety belt 42
sensor embedded on the lower part of the driver's seat 422

Fig. 3 illustrates the Location of sensors for measuring signals in a driver's head (front view)
To measure a driver’s head 31 movements, sensors may be located a the car’s
top 13, for example:
sensor located above driver’s head 113
sensors located above and in the vicinity of a driver’s head 11, 114
video camera 41
sensor located above driver’s head 113.

Other sensors may include:
sensor embedded within a safety belt 42
sensor embedded on the lower part of the driver’s seat 422
sensor in the car’s body 138

Fig. 4 details a block diagram of a signals measuring and processing system
comprising:
electrical signals sensors 11, 113, 114 - may include for example plates for
measuring an induced voltage, see for example Figs. 8a, 8B - 12.

sensor embedded within a safety belt 42
sensor embedded on the lower part of the driver’s seat 422
video camera 41 and/or Infrared/heat sensing means
signal conditioning means 43, ie filtering, limiting.

All the signals from the above sensors are transferred to a processor 44
or microcomputer, with a keypad 46 or other commands and data entering
means.

The processor further includes a communication channel 462, a
database storage means 443, preferably removable (black box), a
wireless communication antenna 451
display/visual warning means 452
lou
dspeaker/audio warning means 453
siren 454
active measures activation interface 455, such as braking the car

Method for monitoring a driver's awareness state and taking action whenever necessary

The method (see Fig. 5) includes:

a. Track driver's head movements 501
using for example two video cameras. Two cameras located at a normal angle
can measure driver head’s movements in two or three dimensions. Such random
head movements are to be expected during driving.

Read sensors 502
which may include reading one or more EEG sensors, MRI sensors, etc.

Signals conditioning 503
may include limiting, amplification, filtering (usually lowpass or band
pass) and analog to digital converting (ADC) for subsequent digital
processing.

Compute brain signals 504 - corrected for head movement and correlated
therewith.
It is to be expected that the amplitude of received signals change in inverse
proportion to distance (or the square of distance). Thus, head movements will
modulate the amplitude of received signals. Digital signal processing (DSP)
may include a cross-correlation between the distance measured visually and the
modulation of signals, to identify and select only signals being transmitted
from driver's head - this is the required EEG signal.
Compute/evaluate driver's awareness state 505
Prior art research accumulated copious data on variations in EEG responsive to a person's state of mind. Based on this data, and according to the measured and processed signals from a driver's head, it is possible to compute and/or evaluate a driver's awareness state of mind.

Normal? 506
The evaluated driver's awareness state of mind can be compared with known values of normal/dangerous behavior, and a decision can be reached regarding the present state of mind of the driver.

Issue warning 507
If necessary, a warning may be issued to the driver, to refrain from carrying on with driving the car, as the alarm system expects trouble - a possibly dangerous situation. The driver can rest, calm down and/or take any other corrective activity.

If that is impossible, then another person in the car can replace the driver, in which case the other person's state of mind is measured and evaluated as detailed above.

Corrected? 508
The system checks that the dangerous previous situation was corrected.

Active measures 509
If the dangerous situation was not corrected, the system will resort, after a period of grace for allowing the driver to take action, to more active, decisive and aggressive measures, for example reporting to a remote monitoring center or the police, activating a siren and/or disabling the car so the present driver cannot continue driving that car.
However, the system continues to verify whether the situation was corrected, for example with the present driver being replaced with a sober person. If such an event occurs, the system can be so programmed as to automatically re-enable the car to allow driving.

** End of method **

Fig. 6 illustrates one possible embodiment of a truth table of possible driver's states of mind and corresponding possible system's actions.

Fig. 7 illustrates, by way of example, one possible instance of a cross-correlation between distance head to plate and amplitude of received signals can be performed based on the known pattern of signals variation, wherein the amplitude of received signals change in inverse proportion to distance (or the square of distance) as illustrated in Fig. 7.

Thus, head movements will actually enhance the quality of signals received from the driver's head.

Fig. 8 illustrates, in block diagram form, the process flow, including:

Monitoring 521
Analysis 522
Database 523
Detection/Activation 525
Alarming 526
Alerting 524
Actions to be taken 527
Re-Monitoring 528

and as further detailed elsewhere in the present disclosure.
Fig. 9 illustrates a signals flow diagram

Brain waves sensors 531, receive electronic signals indicating wave activity, however these weak signals may be affected by the strong noisy signals of the vehicle, even if those signals are attenuated.

The Car computer and sensors unit 533 provide information describing noises created by the car, such as by placing additional sensors, and known noises of the car, such may be calculated by knowing the noises created by the engine - such as when there is an electric stroke. These indications as well as noises themselves can be compared to the signals of interest from unit 531, and thus can be reduced to obtain a signal with less noise affecting.

Noise reduction 535 can be implemented by DSP for estimating the signal out of the noise, or can be implemented in simpler means, such as by adaptive filters, by ignoring the signal when there is strong noise, or by providing indication of the SNR.

Correlation unit 536 would compensate the signals’ intensity with the physical movement of the driver’s head. Driver movement sensors 532 may include optical and ultrasonic sensors, from which it can be derived what is the difference of distance from the brain waves sensors. Thus, the correlation unit 536 outputs a signal, which is less affected by the head movement of the driver and can be better analyzed.

Estimator 537 finds driver's awareness state, from the modified brain waves, from which noise, interferences and movements effects where removed or attenuated.
An indication, preferably a digital description is provided to a decision making mechanism (DMM) 538, which can issue a warning or perform an action in the vehicle, for implementing the system.

A thorough driver awareness state estimation can be performed as the driver enters the car. This may be beneficial for an initial estimation, which can have little or gradual change while driving.

It may be possible to achieve a better estimation, which can be performed before the car’s power is turned on, thus when there are no electric noises and interferences of the car.

Fig. 10 illustrates the system block diagram. A decision and control unit 541 controls and also gets indications and data from power management unit 543, security unit 544, communication unit 545 and driver monitoring unit 546.

The decision and control unit can have a database memory 542. The memory can store awareness states and detected risk triggers DRTs, which were found in diagnoses. Thus, the system decision and control unit can decide what to perform based on recent and far history of the driver, and current situation.

Real Time analysis and control, as well as allocation of computing and power can be determined based on concurrent state of the driver, the vehicle and the environment (such as whether there are additional passengers and the type of weather).

Power management unit 543, can provide power from either the vehicle's battery 5431 or from internal battery 5432. The internal battery may be required in emergency situations, such as if someone tempers with the system (in such a case a security unit 544 would be notified or would detect this), or if there is a failure. The power management unit 543 is responsible that the
system would have power, especially when performing critical operations or
detecting that some action should be made.

The power management unit provides power to the system’s units, allowing
them to work properly. In cases the system is disconnected, it may still operate
using the internal battery, which should preferably be rechargeable.

Security unit 544 is responsible to prevent tempering or to prevent from anyone
to bypass the system. It can stop the vehicle or disable driving the vehicle.

Thus, disconnecting the system would not allow bypassing. It may also send
external indications, such as to the police, through the communication unit 545.

The security unit may operate a speaker as a warning or alarm, or may provide
an indication to the decision and control unit to make such an alarm trough the
car’s resources, such as by communicating with the car’s computer 547.
The security unit may be notified that the driver’s awareness state is
problematic, and as such, perform security checks more often, or ask to notify
police, insurance, etc through wireless network 5453.

The communication unit 545 may optionally allow user interaction, through
external interface 5451, which may include a display and a keypad, for
controlling the system, bypassing it by administrator, uploading or
downloading data or updating the software. A USB or other connection may be
present as well, such as for downloading data from the system’s memory.

Communication unit 545 allows sending and receiving data, as well as
communicating with a center through wireless network 5453 this may be
initiated by the driver, by the system and/or by an outside source such as a
control center related to the risk – for checking system and driver status,
and send important information with regards to the driver state of mind, and
also record the information to a DB for further uses.
It may be required to override a conclusion or a state of the system. Such an option may be enabled in the system. For example, if the driver is allowed to take a certain medicine, which affects his wave brains in a way that might have prevented him from driving by the system.

Communication with the car computer may be vital for both learning the car environment and passengers’ status and sending commands or limiting driving.

It may be possible to implement a mechanism that bypasses the car computer for controlling the car, however it is preferred to provide commands directly to the car’s computer, or to at least one of its computers.

The wireless network 5453 may be implemented using Wi-Fi or any other wireless communication protocol available, such as a 3G cellular network.

Driver monitoring unit 546 is the heart of the system – including dedicated sensors for sensing electric fields originated from the driver’s brain 5462, additional sensors for sensing the driver’s head movement and/or position 5461 – such as acoustic and/or visual sensors and noise sensors 5463 – used to detect and help remove or reduce unwanted interferences. These sensors may be part of the brain field sensors 5462 and/or may be implemented in separate additional sensors.

The driver monitoring unit 546, can operate independently to read the sensors, and provide digital and/or analog data to the decision and control unit 541. Thus the decision making mechanism, such as the DMM 538 in Fig. 9, can be implemented in unit 541, and may perform complex and slow calculations while the monitoring unit 546 is able to constantly read the sensors.
The units and the memory 541-546 can be implemented separately such as on different chips, boards and/or software blocks, thus each of them may be easily upgraded, edited, checked and/or replaced.

Fig. 11 illustrates a system block diagram with car computer 547. The system 44 and/or any of its possible components, such as the units described in Fig. 10, may communicate, send and/or received data from the car computer 547.

This may include, for example, any of the following:
Engine commands/information 550 – for deciding whether the engine is turned on, finding when strokes occur to block or identify noises, finding the RPM to verify irresponsible or reckless driving etc.

Clock information 551 – finding out the time, if this info is not available in the system, for verifying it is late or early – such as if it is found the driver is too tired or drunk or drugged at late hours, or very nervous at rush hours.
Lights information 552 – such as finding whether it is night and whether the driver did not forget to turn the lights on.

Passengers indication 553 – for example, finding the number of passengers, and whether they are all belted. This information is often available by the car computer. This info may help deciding whether and in what manner to allow a driver for which a DRT was found.

Vehicle’s Speed information 554 – can help decide whether to interfere in driving and in what manner if a DRT was found. For example, if there is a DRT of slight tiredness and the driver drives too fast – then an alarm or indication can be provided asking the driver to reduce speed. If he does not
respond or ignores this request, then the system 44 can actively limit the car’s speed by communicating with the car computer 547.

The Alarm system 555, sound system 557 or speakers of the vehicle – can be accessed to warn the driver or provide him indications. This may override the sound system such as if the driver listens to loud music.

Horn system 556 – can be similarly accessed to warn the driver and/or others, such as when stopping the car, or if it is suspected the driver fell asleep, uses alcohol or drugs, and emergency action such as alarm should be provided.

Sound system 557 - can be used for synthetic speech to warn the driver or give her instructions as deemed appropriate.

Air condition working status 558 – can be checked to learn about the weather, and to find out whether the driver uses it is excessively, such as heating too much when he is suspected to be tired or cooling too much when he is suspected to be nervous – this may further help to verify unusual state of mind.

Windscreen wipers status 559 – can indicate whether there is rain, thus visibility is reduced and the driver should drive slower.

Again, this may help to take stronger actions, such as reducing car’s speed if a DRT is found. It should be noted that these indications can be provided from more than one computer or source in the car, not all are necessary and others may be retrieved as well, for the purpose of better determining car status, driver and passengers status, what features or mode of operations of the car are used, and overall driving conditions (such as whether, visibility and time of the day).

Fig. 12 illustrates the states diagram of the system. The system’s operation when the driver enters the car 560, and even prior to starting the car.
For example, the driver may be required to first place the belt along with some optional sensors placed on it, and/or place his head back next to sensors in the seat. These or additional operations may be required, and the system may actively prevent starting the car, thus a power off 561 mode is present, as long as an initial thorough diagnose 562 is not completed.

The initial thorough diagnose 562 can be performed once or periodically. It may be likely the diagnosing is more reliable prior to turning the car’s power.

If a DRT is found then it may be prevented from the driver to start the car prior to changing his state of mind and successfully passing the diagnosing. It is referred herein as DRT4, a state of mind in which the driver is not allowed to drive. This may be a factor of several causes, such as the weather and the number of passengers together with one or more DRTs found.

If the driver passed the thorough diagnose then he is allowed to turn on the power 563, an indication may be provided such as by a voice or through a display.

The driver can then normally drive 564, wherein the driver’s state of mind is periodically verified (or monitored and analyzed) 565, in accordance with DRT T1 scan mode.

If there is no DRT found or known, a less frequent scan/diagnose can be performed, such as once in 10 to 20 minutes. This would provide minimal interference to the driver, and would allow him not to be bothered by diagnoses.

If there is a DRT found, and it is determined by the system that an alarm should be provided, then a DRT2 state of mind is set, in which a DRT T2 scan mode 566 is maintained, together with alarmed driving mode 568. In such a mode an alarm may be provided, such as visual or vocal, through the car’s peripherals,
such as by the sound system or through dedicated display or speakers of the system.

An exact indication can be provided as to what DRT was found, for example, if it is found that the driver is under the influence of drugs or alcohol, is tired, unfocused, upset, etc. A frequent scan/diagnose can be performed, such as once in 2 to 10 minutes. This would provide some guidance and support to the driver, and would allow him to have some confidence he is diagnosed, and that a permission to drive is granted, thus although a DRT was found and the driver is warned he is still capable of driving.

In case the same DRT is kept and not resolved, or a new one is found, in a manner, which the system decides is dangerous, for example the driver is tired for a long time, then it may be determined by the system that it should actively limit the driving, then a DRT3 state of mind is set, in which a DRT T3 scan mode 567 is initiated. A speed limit mode 570 can limit the driver and the car to a certain speed, such as by accessing the car computer or by overriding digital commands.

The speed limit can be calculated by actual conditions, or can have a preset value, which is considered as safer for the driver, such as 40 km/h. Yet, if this is not sufficient or if the driver may endanger himself or others, then the system may force the driver to stop over 571, this can be done by a procedure first asking the driver to safely pull over, then actively take measures such as constantly reducing maximum speed limit till stopping the car. The car is then powered off 561, and can be started once again after the thorough diagnose 562 is performed.

It can be possible to quickly switch between modes 565, 566, 567 and 571 so that if the system suddenly diagnoses a serious DRT or problem, it can stop the
car within a short time, such as if it is found that the driver falls asleep, then the car may be stopped within seconds, for example.

It can be possible to switch from mode 567 to mode 566 and from mode 566 to mode 565, if no DRTs are found, or if the DRTs found are not severe. Thus, it may be possible that the scans/diagnoses 566, 567 also allow returning to a mode with less supervision and interference by the system, if the driver proves he is entitled to that over time. For example the driver may prove to be focused and not tired, more relaxed and not upset, etc.

The system may monitor if the driver's switch, or if the driver leaves his seat, so that a new diagnosis may be performed when the driver returns, and he may be treated as a new driver who enters the car 560.

This allows for example for a drunken driver to be replace with another, sober person so the possibly dangerous situation is addressed and corrected.

The above detailed embodiments of the invention may use a real time operating system OS (or NRT OS) and application to assure fast response and good performance.

The system may further include means for detecting an attempt to sabotage it, and further means for reporting to the driver and/or issuing an alarm if the driver (or any other person) is trying to disable the unit.

Various embodiments of the present invention will become obvious to persons skilled in the art upon reading the present disclosure and the drawings attached thereto. Such embodiments should not be regarded as a departure from the scope and spirit of the present invention.
Claims

1. An in-vehicle driver awareness monitoring system comprising one or more brain waves sensors connected to a logic unit or a computer adapted to monitor the driver's awareness state and actively respond if a detected risk trigger (DRT) is found.

2. The in-vehicle driver awareness monitoring system of claim 1, wherein the brain waves sensors are comprised of EEG and/or MRI sensors.

3. The in-vehicle driver awareness monitoring system of claim 2, further including memory for keeping track of the driver's awareness state or DRTs and an internal battery for providing power.

4. The in-vehicle driver awareness monitoring system of claim 2, wherein the system is connected to the vehicle's systems and is adapted to actively respond by playing an alarm or limiting the vehicle's speed.

5. The in-vehicle driver awareness monitoring system of claim 4, wherein the system is connected to at least one computer of the vehicle.

6. The in-vehicle driver awareness monitoring system of claim 1 further including driver’s head movement and/or position sensors, adapted to help reading the brain waves.

7. The in-vehicle driver awareness monitoring system of claim 1, wherein the brain waves sensors are embedded in the drivers' seat, in the belt and/or in the head cushion.
8. An in-vehicle driver awareness monitoring apparatus substantially as described in the present disclosure and its related drawings.

9. An in-vehicle driver awareness monitoring method substantially as described in the present disclosure and its related drawings.
**Patents Act 1977: Search Report under Section 17**

**Documents considered to be relevant:**

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Field of Search:
Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X:

Worldwide search of patent documents classified in the following areas of the IPC
A61B; B60K; G08B

The following online and other databases have been used in the preparation of this search report
WPI, EPODOC, TXTE

International Classification:

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