US 20200205716A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0205716 A1**

KAPURIA et al. (43) **Pub. Date: Jul. 2, 2020**

(54) **SYSTEM AND METHOD FOR DETECTING REACTION TIME OF A DRIVER**

(71) Applicant: **THE HI-TECH ROBOTIC SYSTEMZ LTD**, Gurugram (IN)

(72) Inventors: **Anuj KAPURIA**, Gurugram (IN); **Ritukar VIJAY**, Gurugram (IN)

(21) Appl. No.: **16/731,630**

(22) Filed: **Dec. 31, 2019**

(30) **Foreign Application Priority Data**

Dec. 31, 2018 (IN) 201811050067
Dec. 31, 2018 (IN) 201813050098

Publication Classification

(51) **Int. Cl.**

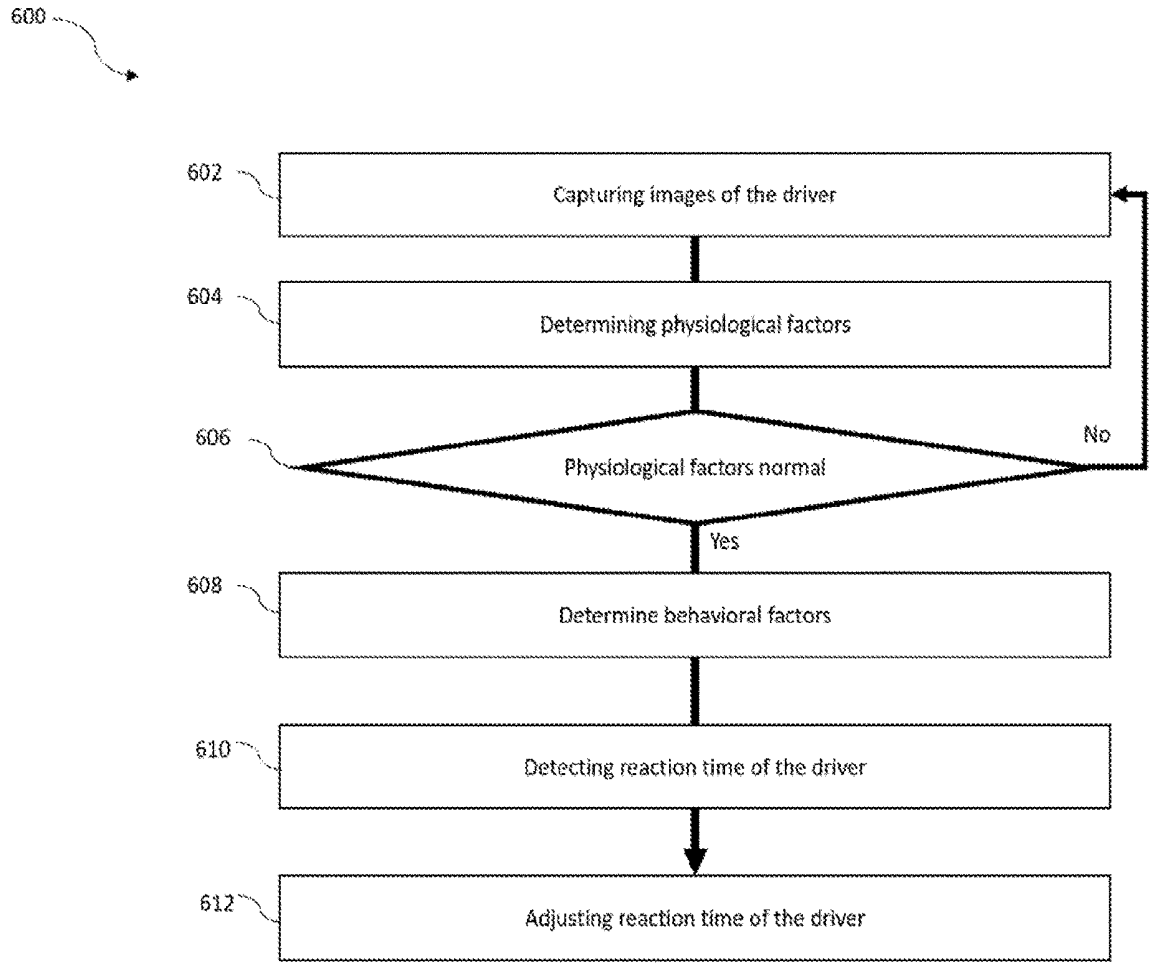
A61B 5/18	(2006.01)
A61B 5/16	(2006.01)
A61B 5/0205	(2006.01)
A61B 5/053	(2006.01)
A61B 5/00	(2006.01)
A61B 5/103	(2006.01)
A61B 5/11	(2006.01)
G06K 9/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 5/18*** (2013.01); ***A61B 5/163*** (2017.08); ***A61B 5/0205*** (2013.01); ***A61B 5/0531*** (2013.01); ***A61B 5/162*** (2013.01); ***A61B 5/0077*** (2013.01); *A61B 5/024* (2013.01); ***A61B 5/11*** (2013.01); ***G06K 9/00308*** (2013.01); ***G06K 9/00315*** (2013.01); ***A61B 5/7275*** (2013.01); ***A61B 5/0002*** (2013.01); ***A61B 5/1032*** (2013.01)

(57) **ABSTRACT**

The present invention provides a method and system for monitoring driver inattentiveness using plurality of physiological factors of the driver. In this method, captured images and/or short videos are used to determine the physiological factors of the driver. The first physiological factor from the plurality of physiological factors is used to determine the level of drowsiness and/or inattentiveness of the driver, which further supported by the second physiological factor. The data generated from the analysis of first and second physiological factors is further utilized to generate a predictive warning to the driver. The intensity level of the warning is varied based on the analyzed level of inattentiveness of the driver. The warning may be an audio warning, a visual warning, an audio-visual warning, haptic warning like vibration, etc.



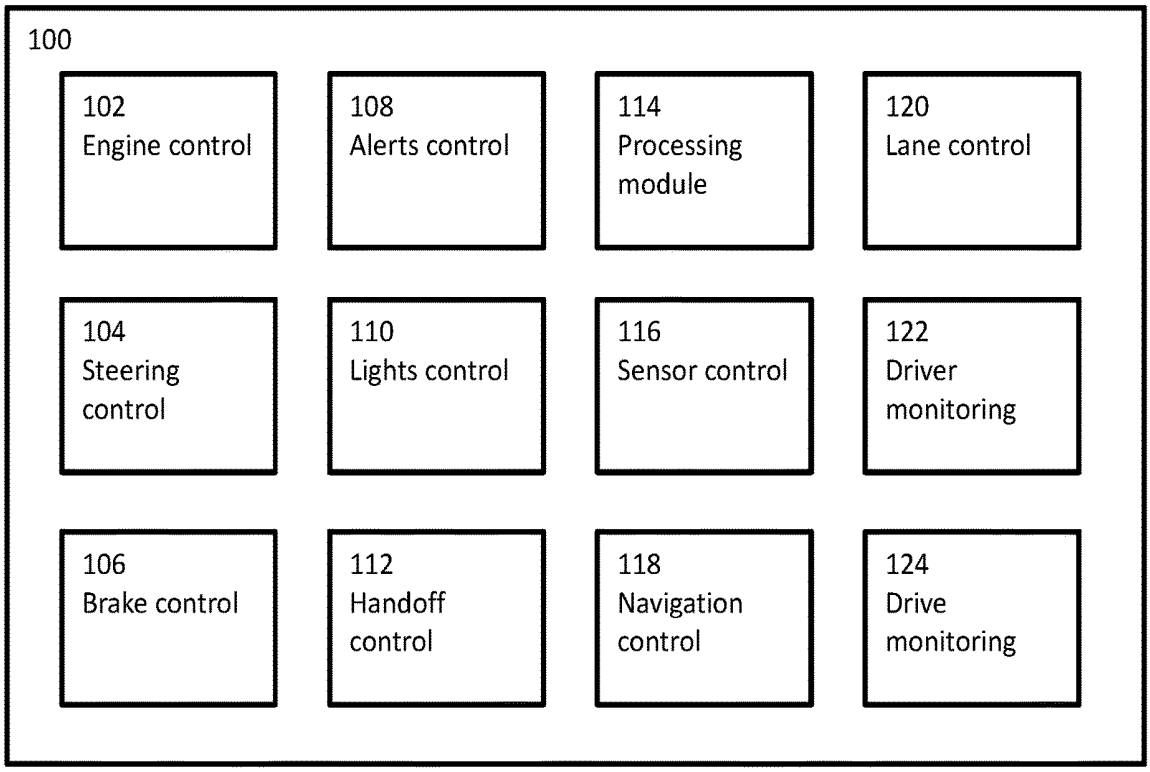

100
102
Engine control
108
Alerts control
114
Processing module
120
Lane control
104
Steering control
110
Lights control
116
Sensor control
122
Driver monitoring
106
Brake control
112
Handoff control
118
Navigation control
124
Drive monitoring

FIG. 1

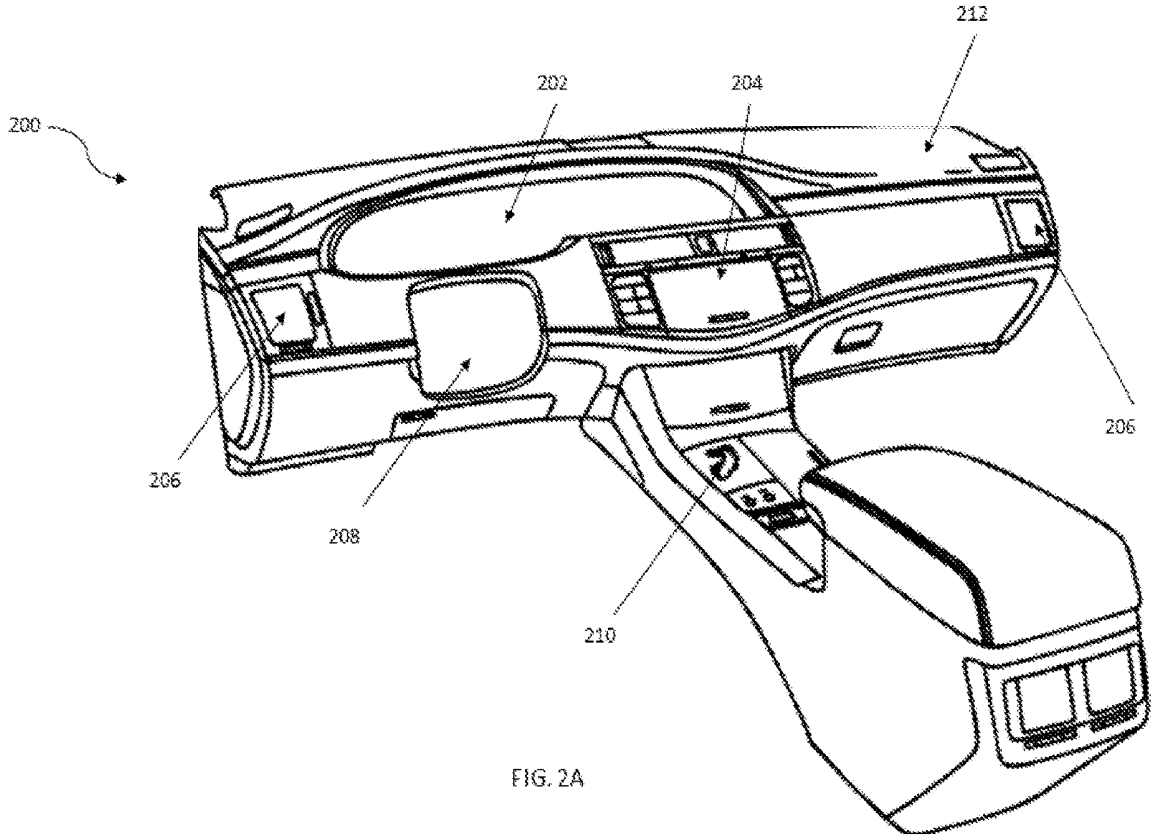


FIG. 2A

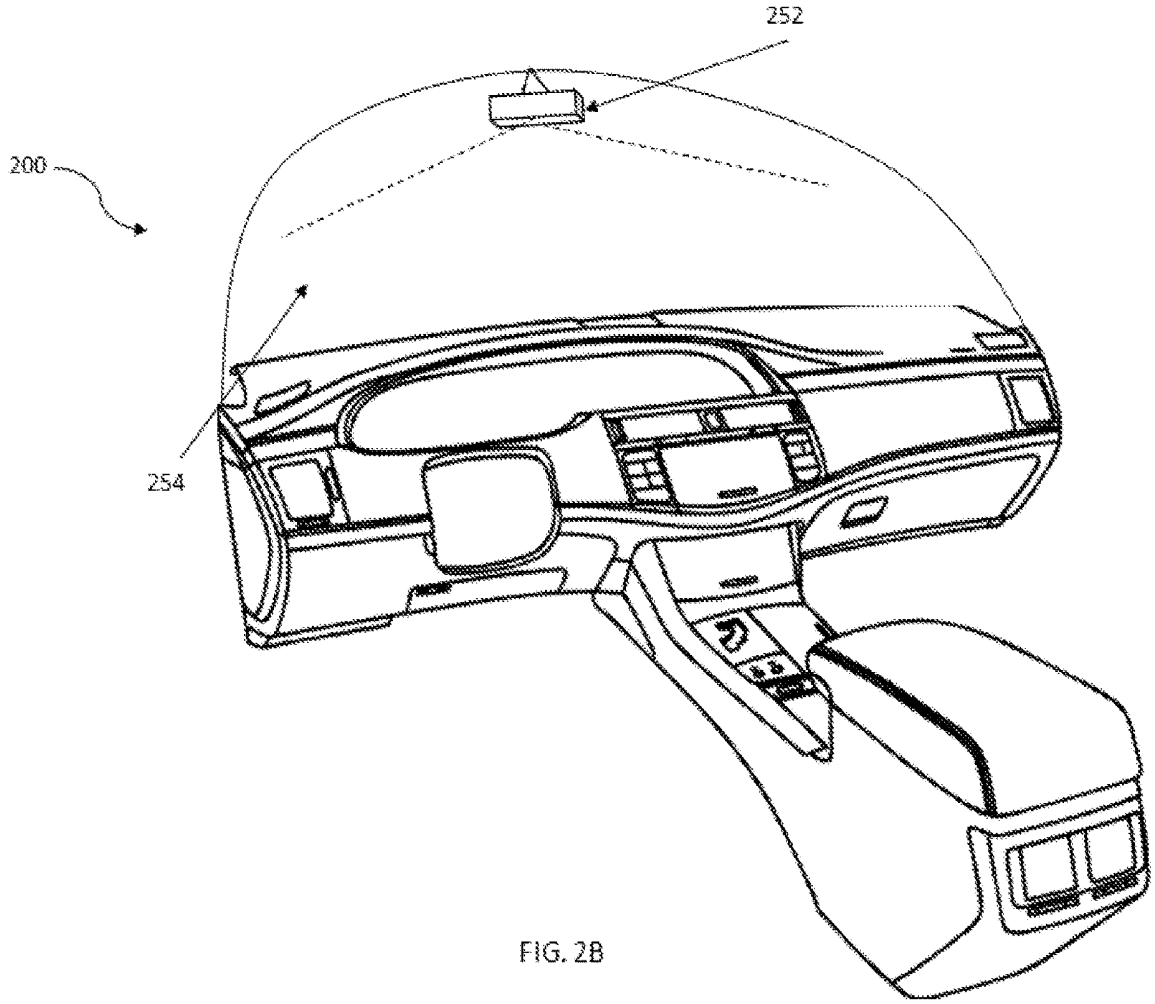


FIG. 2B

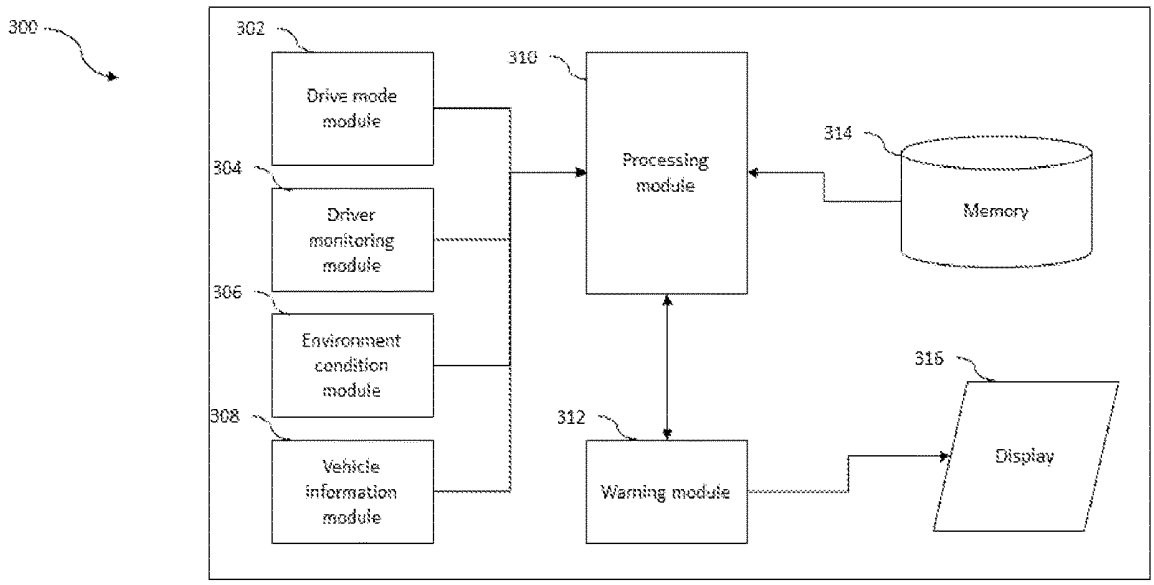

300
302
Drive mode module
304
Driver monitoring module
306
Environment condition module
308
Vehicle information module
310
Processing module
312
Warning module
314
Memory
316
Display

FIG. 3

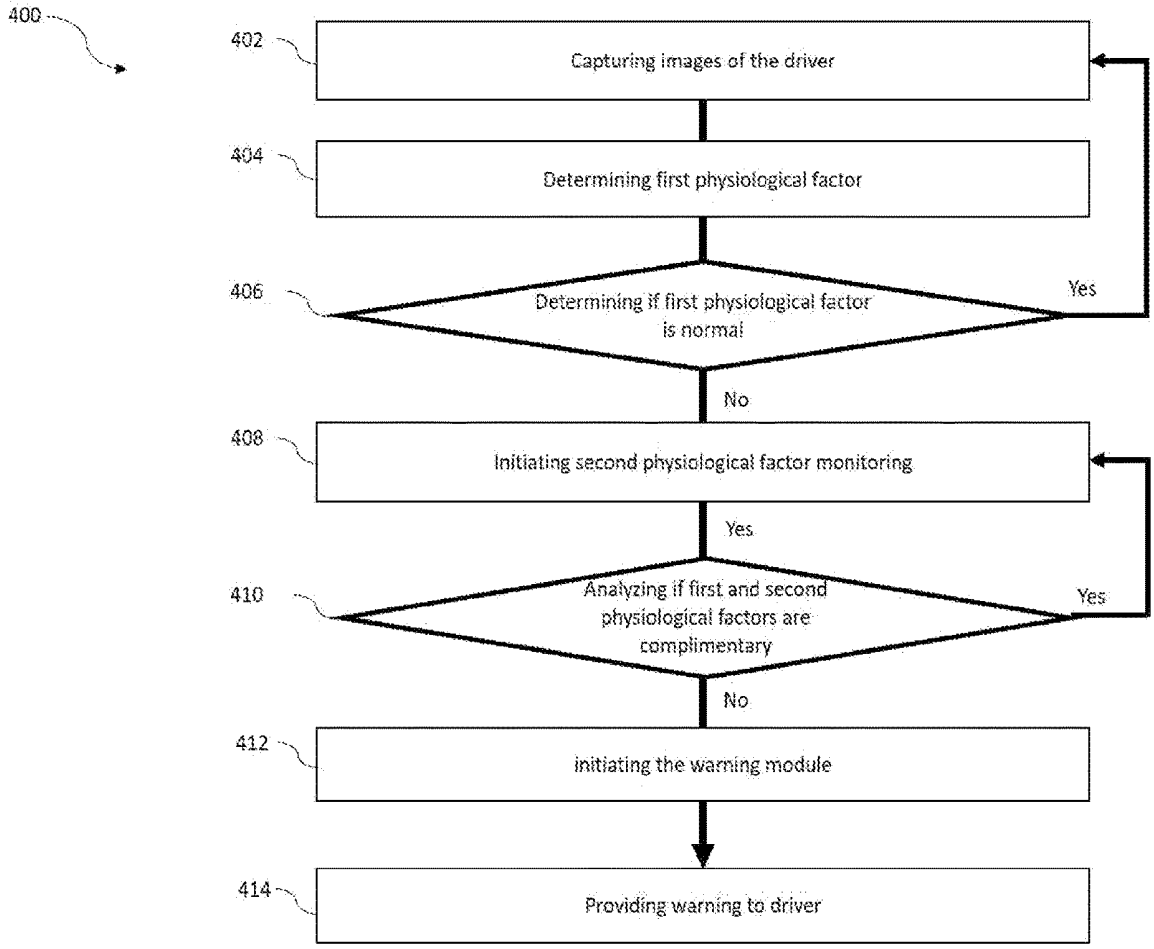

400
402
Capturing images of the driver
404
Determining first physiological factor
406
Determining if first physiological factor is normal
Yes
No
408
Initiating second physiological factor monitoring
Yes
410
Analyzing if first and second physiological factors are complimentary
Yes
No
412
initiating the warning module
414
Providing warning to driver

FIG. 4

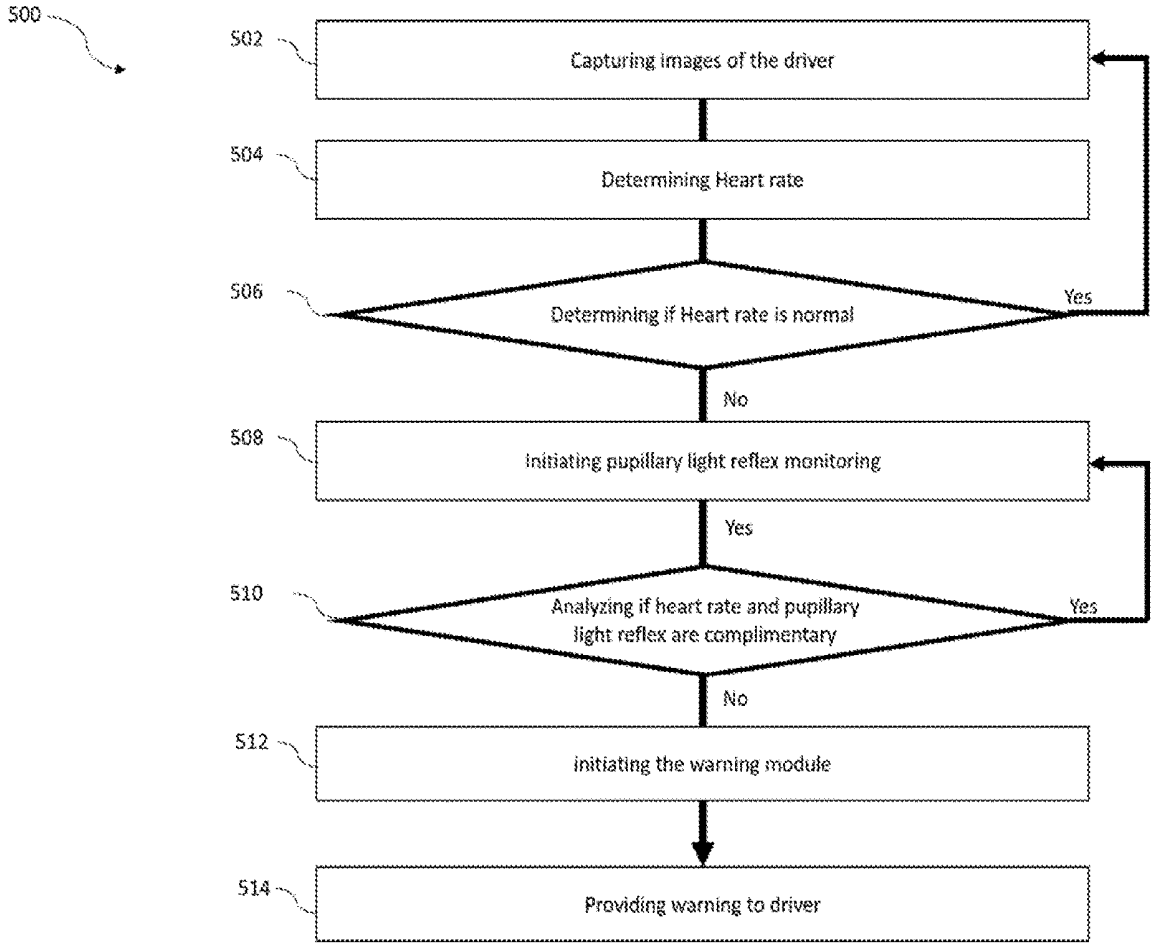

500
502
Capturing images of the driver
504
Determining Heart rate
506
Determining if Heart rate is normal
Yes
No
508
Initiating pupillary light reflex monitoring
Yes
510
Analyzing if heart rate and pupillary light reflex are complimentary
Yes
No
512
Initiating the warning module
514
Providing warning to driver

FIG. 5

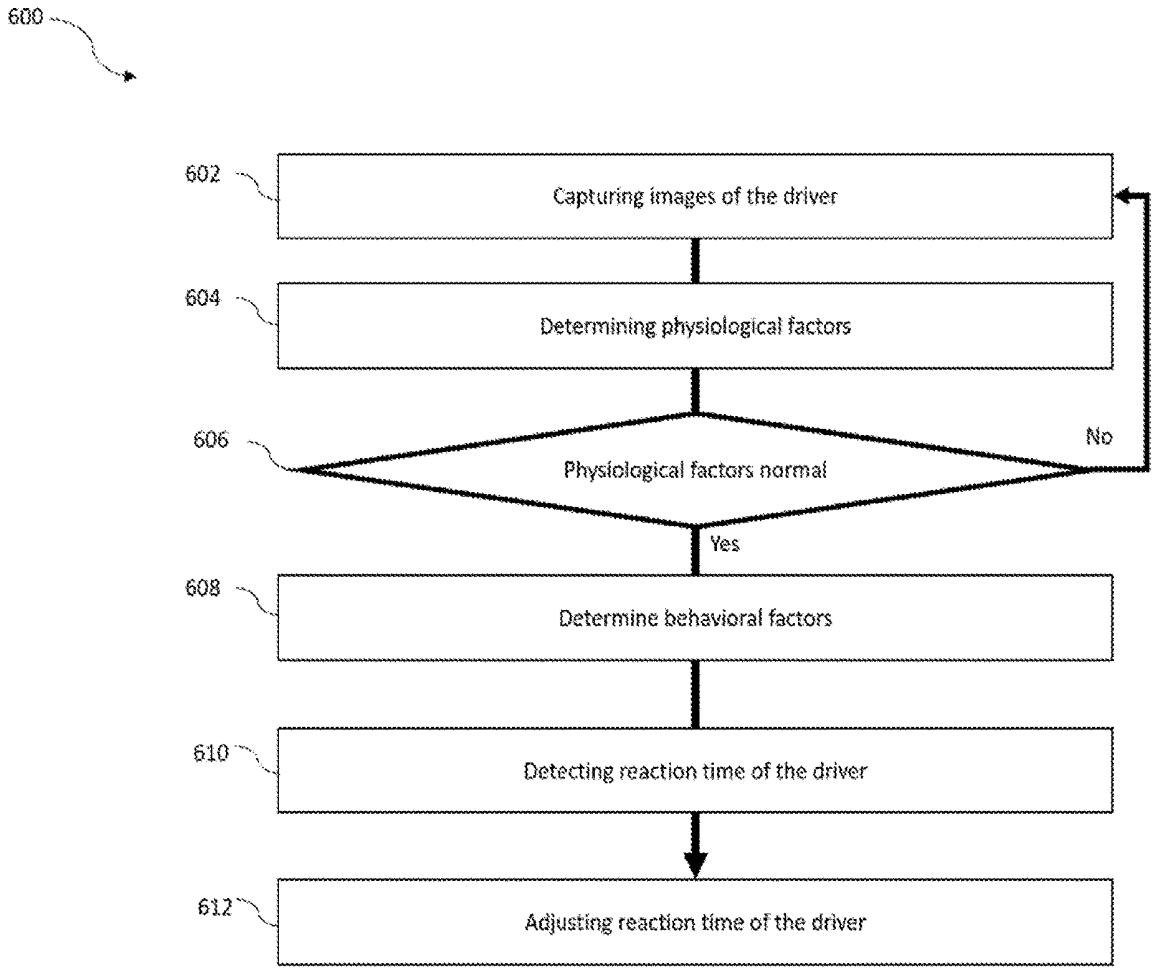

600
602
Capturing images of the driver
604
Determining physiological factors
606
Physiological factors normal
No
Yes
608
Determine behavioral factors
610
Detecting reaction time of the driver
612
Adjusting reaction time of the driver

FIG. 6

SYSTEM AND METHOD FOR DETECTING REACTION TIME OF A DRIVER

[0001] This application claims the benefit of Indian patent application Nos. 201811050067 and 201813050098, filed Dec. 31, 2018, which are hereby incorporated by reference in their entirety.

FIELD OF INVENTION

[0002] The present invention relates to autonomous driving vehicles and more particularly related to monitoring drivers during vehicle driving and capturing various physiological factors to identify driver state or predict driver state.

BACKGROUND OF THE INVENTION

[0003] Modern vehicles are generally equipped with various types of monitoring systems, such as cameras, or video recorders to monitor surrounding environment of vehicles and provide a driver of a vehicle with useful data regarding the surrounding environment for improved driving. Such monitoring systems may be installed, for instance, on a roof of the vehicle or on the front portion, back portion of the vehicle to have a broad view of the surrounding environment and capture data associated with objects, pedestrians or vehicles within the surrounding environment.

[0004] In addition, the monitoring systems may also monitor the driver of the vehicle for facial pose and gaze. For instance, the driver may be monitored for orientation of the face and the gaze to be in a forward direction and determine if the driver is paying attention on the road. The collected data is then subjected to processing to derive meaningful information that may be used in assisting the driver for navigation, changing lanes, and averting a potential collision. An event, such as an approaching vehicle, a pedestrian on the road may be detected and a warning may be issued to the driver to help the driver initiate a precautionary action.

[0005] However, such monitoring systems, on many occasions, fail to detect events with accuracy due to various factors such as incomplete data or incorrect data, and issue false or irrelevant warnings to the driver. These warnings are generally issued at high volumes to alert the driver that on many instances may startle or distract the driver, thereby inciting a sudden action that could be potentially harmful for the safety of the driver. Further, such irrelevant warnings issued regularly at high volumes may cause a general discomfort, and impact driving of the driver. Therefore, the monitoring systems are not efficient in detecting events and issuing warning to the drivers for enhancing driving experience and safety.

[0006] Therefore, there is a need of an efficient system for maintaining driver attentiveness even while the driver is not participating in the controlling of the vehicle.

SUMMARY OF THE INVENTION

[0007] This summary is provided to introduce concepts related to monitoring driver inattentiveness using physiological factors. This summary is not intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

[0008] In an example implementation of the present subject matter, a method for monitoring the inattentiveness of a vehicle driver is provided. The method includes steps of capturing and storing the images of the driver. Further, the method includes simultaneous analysis of the stored images of the driver is used in the next step of the method to generate a predictive warning of the inattentiveness of the driver based on the captured images.

[0009] Thereafter, the analysis of the captured images is used to extract the plurality of physiological factors of the driver. The inattentiveness of the driver is determined based on a first physiological factor from the plurality of physiological factors. Further, the second physiological factor is determined to support the first physiological factor. By way of example, physiological factors such as heart rate variability and pupillary light reflex are potentially interrelated, and it can be simultaneously measured for physiological analysis of the driver.

[0010] Although the present subject matter has been described with reference to an integrated system comprising the modules, the present subject matter may also be applicable to provide a warning to an inattentive driver of the vehicle by the modules placed at different areas within an autonomous vehicle, wherein the modules are communicatively coupled to each other.

[0011] In an example implementation of the present subject matter, an ADAS includes a drive mode monitoring module, driver monitoring module, an environment condition module, a vehicle information module, a processor coupled to the different monitoring modules, and a warning generating module coupled to the processor. In accordance with an embodiment of the invention, driver monitoring module captured various images and/or videos to determine the plurality of physiological factors of the driver which further stored in the memory. In the system, the processing unit is analyzed the captured images continuously to determine the plurality of physiological factors of the driver. Further, the processing unit may use any physiological factor as a first physiological factor to determine the inattentiveness of the driver. Furthermore, the second physiological factor is also analyzed to support the first physiological factor to determine the inattentiveness of the driver. The physiological factors enable early prediction of drowsiness and inattentiveness of the drivers.

[0012] Thus, the present subject matter provides efficient techniques for detecting the inattentiveness of a driver using different physiological factors. The techniques provide an adaptive warning to the driver of the vehicle, wherein the intensity level of the warning is varied based on the analyzed level of inattentiveness.

[0013] In an embodiment of the invention, the driving behavior is determined from data received from the driver monitoring module, environment condition module, and vehicle information module. Also, the information of historical reactions may also be fetched from memory for reaction time calculation. Determination of reaction time is done based on what state the driver is currently in, what are the physiological readings for the same and how the driver has been reacting to situations in the current journey. The reaction time may be utilized to better equip the system for any situations that may come up in the journey. The processing module may predict reaction time adjustments from historical data stored that it may fetch from a remote server connected to it. Early predictive reaction time adjustments may be provided to the driver based on his current physiological and driving behavior.

[0014] Other and further aspects and features of the disclosure will be evident from reading the following detailed description of the embodiments, which are intended to illustrate, not limit, the present disclosure.

BRIEF DESCRIPTION OF ACCOMPANYING DRAWINGS

[0015] The foregoing summary, as well as the following detailed description of various embodiments, is better understood when read in conjunction with the drawings provided herein. For the purpose of illustration, there is shown in the drawing's exemplary embodiments; however, the presently disclosed subject matter is not limited to the specific methods and instrumentalities disclosed.

[0016] FIG. **1** is a block diagram of an autonomous vehicle and its subsystems, in accordance with an embodiment of the invention;

[0017] FIG. **2**A is a line diagram of a vehicle dashboard, in accordance with an embodiment of the invention;

[0018] FIG. **2**B is a line diagram of a driver monitoring module, in accordance with an embodiment of the invention;

[0019] FIG. **3** is a block diagram of a system for monitoring driver during a drive session and generate a predictive warning of inattentiveness, in accordance with an embodiment of the invention;

[0020] FIG. **4** is flow chart depicting an overall method of providing early warning, in accordance with an embodiment of the invention;

[0021] FIG. **5** is a flow chart illustrating a method of providing early warning, in accordance with an embodiment of the invention.

[0022] FIG. **6** is flow chart depicting an overall method of determining and adjusting reaction time of a driver, in accordance with an embodiment of the invention;

DETAILED DESCRIPTION OF INVENTION

[0023] FIG. **1** shows a block diagram of an autonomous vehicle **100** (termed as vehicle **100** interchangeably within the description) and its various subsystems, in accordance with an embodiment of the invention. According to an embodiment of the invention, the autonomous vehicle **100** may be a fully or a semi-autonomous vehicle. The autonomous vehicle **100** includes multiple sub systems to control various important processes and functions. The autonomous vehicle **100** may include Engine control module **102**, Steering control module **104**, Brake control module **106**, Alerts control module **108**, Lights control module **110**, Handoff control module **112**, Processing module **114**, Sensor control module **116**, Navigation control module **118**, Lane control module **120**, Driver monitoring module **122**, and Drive monitoring module **124**.

[0024] Engine control module **102** controls various functions and processes of an engine of the vehicle **100**. Functions and processes to be controlled may be speed of rotation, engine condition, servicing requirements, load on engine, power of engine, etc.

[0025] Steering control module **104** may help in movement of the vehicle **100**. The steering control module **104** helps vehicle **100** to be driven and controlled in transverse and longitudinal direction. Steering module **104** may include actuators that may control the steering module **104** in autonomous mode.

[0026] Brake control module **106** of the autonomous vehicle **100** may help in braking function of the vehicle **100**. Brake control module **106** may control brakes of all four wheels using disc or horse-shoe brake parts. The brake control module **106** may also include actuators connected to brake parts in order to control braking while in autonomous drive mode.

[0027] Alerts control module **108** may control various alerts to be provided during various situations. The alerts may include ranging from servicing requirement of the vehicle **100** to lane change assist alerts during manual mode.

[0028] Lights control module **110** may control various lighting functions of the vehicle **100**. The lighting functions may be for example, switching on lights while ambient light is below a threshold or changing low beam to high beam while road is empty and high beam is required due to night lighting conditions on road.

[0029] Handoff control module **112** takes care of drive handling control of the vehicle **100**. The handoff control module **112** may be responsible for switching control of the vehicle **100** to autonomous from manual or vice versa. The handoff control module **112** takes over full control function of the vehicle **100** while switching to autonomous mode.

[0030] Processing module **114** provides computing power to the vehicle **100**. The processing module **114** helps the vehicle **100** in all the calculations required for autonomous, or semi-autonomous driving modes as well. It may also be useful in manual driving mode as well wherein the processing module **114** may process route calculations, fuel requirements, etc. In autonomous mode, the processing module **114** may take in data from various sensors and use the sensor data for efficient drive control during autonomous drive mode.

[0031] Sensor control module **116** collects data from the physical sensors provided all over the vehicle **100**. The sensors may be RADAR sensors, ultrasonic sensors, LiDAR sensor, proximity sensors, weather sensors, heat sensors, tire pressure sensors, etc. the sensor control module **116** in association with the processing module **114** may also calibrate the sensors regularly due to dynamic environment around the vehicle **100**.

[0032] Navigation control module **118** helps the autonomous vehicle **100** during active autonomous drive mode in navigation. In general, the navigation control module **118** may include route calculation, maps, road sign identification etc. for efficient navigation of the vehicle **100**.

[0033] Lane control module **120** may help the vehicle **100** to control lane changing and drive within a lane as marked on the road. Lane control module **100** may be take input data from image and RADAR sensors to identify lanes and help the vehicle to change lanes during an active autonomous drive mode.

[0034] Driver monitoring module **122** collects data about driver during an active autonomous drive mode, semiautonomous mode and manual mode. It collects data about driver like expressions, eye gaze, emotions, facial identity etc. Data about driver may be collected using various cameras facing into a cabin of the vehicle **100**.

[0035] Drive monitoring module **124** collects data about drive of the vehicle **100**. The drive may be autonomous drive or manual drive. Data collected may be like drive behavior in various situations, various conditions, confidence level, stress induced mistakes etc. Drive monitoring module **124** may help in ascertaining drive behavior during the drive that

may be kept for records and utilized for improving future drive interactions, and mistakes while driving the vehicle **100**. Furthermore, collected data, such as the deviation of behavioral trends, spoken words, gaze monitoring and/or environmental conditions within the vehicle are used to provide useful data regarding the state of the driver.

[0036] It is to be noted, that the vehicle **100** may further include some more modules that may help in functioning of the vehicle **100** and some modules as mentioned above may be combined to perform similar functions.

[0037] FIG. **2**A is a line diagram of a dashboard **200** of a vehicle, in accordance with an embodiment of the invention. The dashboard **200** includes an instrument cluster **202**, an infotainment system **204**, Air conditioning vents **206**, steering space **208**, and a central console **210**.

[0038] The instrument cluster **202** may include indicators (not shown in figure) for speed, distance, rotations per minute, fuel indications, heating indications, etc. The infotainment system **204** provides various entertainment features like music system, navigation, various alerts, etc. to the driver of the vehicle. Air conditioning vents **206** may be provided in order to control climate of a cabin of the vehicle. As depicted there may be multiple air conditioning vents provided within the dashboard **200**. The dashboard **200** may also include a steering space **208** wherein steering wheel of the vehicle is accommodated. Further, there may also be provided a central console **210** for driver's use like storage, bottle holders, etc.

[0039] FIG. **2**B is a line diagram of the dashboard **200** of the vehicle including a driver monitoring module **252** placed near roof of the vehicle **200** in accordance with an embodiment of the invention. The driver monitoring module **252**, may be configured to take images of the driver while driving and during various situations faced during the journey.

[0040] FIG. **3**A is a block diagram of a system **300** for monitoring a driver during a drive session and generate a predictive warning of inattentiveness, in accordance with an embodiment of the invention. The system **300** may include multiple modules like a drive mode monitoring module **302**, a driver monitoring module **304**, an environment condition module **306**, a vehicle information module **308**, a processing module **310**, a warning module **312**, a memory **314**, and a display **316**.

[0041] In an implementation, some of the modules such as the drive mode module **302**, the driver monitoring module **304**, the environment condition module **306**, the vehicle information module **308**, the processing module **310**, the training module **312** may include routines, programs, objects, components, data structure and the like, which perform particular tasks or implement particular abstract data types. The modules may further include modules that supplement applications on the processing module **310**, for example, modules of an operating system. Further, the modules can be implemented in hardware, instructions executed by a processing unit, or by a combination thereof.

[0042] In another aspect of the present subject matter, the modules may be machine-readable instructions which, when executed by a processor/processing module, perform any of the described functionalities. The machine-readable instructions may be stored on an electronic memory device, hard disk, optical disk or other machine-readable storage medium or non-transitory medium. In an implementation, the machine-readable instructions can also be downloaded to the storage medium via a network connection.

[0043] Memory **314** may be without limitation, memory drives, removable disc drives, etc., employing connection protocols such as serial advanced technology attachment (SATA), integrated drive electronics (IDE), IEEE-1394, universal serial bus (USB), fiber channel, small computer systems interface (SCSI), etc. The memory drives may further include a drum, magnetic disc drive, magneto-optical drive, optical drive, redundant array of independent discs (RAID), solid-state memory devices, solid-state drives, etc.

[0044] Drive mode monitoring module **302** determines, the active driving mode. Driving mode may be manual, semi-autonomous or autonomous. The drive mode module **302** may accept input from user to activate any of the three drive modes. The drive mode module **302** may be a touch button or a physical button or the like. A driver may provide input to the drive mode module **302** to initiation of the driving mode as required by the driver.

[0045] Driver monitoring module **304** is positioned to face the driver of a vehicle and monitors presence of the driver. The driver monitoring module **304** may be a combination of image sensors, occupancy sensors, thermal sensors etc. In operation, the driver monitoring module **304** may sense presence or absence of the driver. The driver's presence may be determined using techniques like motion detection, occupancy sensing, thermal vision etc. The driver monitoring module **304**, extracts attributes of the driver, once it is established that the driver is present, within the vehicle to identify the driver. Extracted attributes may include, but not limited to a facial scan, a retinal scan, thermal signatures, a fingerprint scan etc. In another example, the user's picture may be taken by the driver monitoring module **304**. In yet another example, the driver's driving behavior may be used as an attribute. Furthermore, data related driver's driving behavior, such as the deviation of behavioral trends, spoken words, gaze monitoring and/or environmental conditions within the vehicle, etc. are used to provide useful data regarding the state of the driver.

[0046] Further in an embodiment of the invention, the driver monitoring module **304** helps in identifying driver profile and monitor driver's state. driver monitoring module **304** is a camera which can identify the driver whether it's an old person, a woman, a young boy, etc. Also, the module **304** has ability to identify various kinds of reactions of the driver. Whether the driver is happy, angry, sad, worried, tensed etc. The module **304** is also equipped with features to identify whether driver is attentive or not, is the driver sleepy, or looking at phone etc.

[0047] The environment condition module **306** acquires information from nearby surroundings of the vehicle. Various sensors, like RADAR, LiDAR, image sensors, ultrasonic sensors, infrared sensors, rain sensors, may be employed within the environment condition module **306**. Information like traffic, lane markings, pavement, road signs, position of the vehicle with respect to surroundings, other objects around the vehicle, upcoming bad road conditions, vehicle to server communication, vehicle to vehicle communication etc. may be collected by the environment condition module **306**.

[0048] The vehicle information module **308** acquires information regarding speed of the vehicle, or position of the vehicle, etc. Position of the vehicle may be sensed using a Global Positioning System (GPS) whereas speed may be ascertained by utilizing speed sensors affixed on the vehicle.

[0049] The processing module **310** gathers information from the drive mode module **302**, the driver monitoring module **304**, the environment condition module **306** and the vehicle information module **308** and processes the information for further usage. The processing module **310** processes information from the driver monitoring module **304** and determines whether to activate the warning module **312** or not. The activation is determined based on the analysis of the driver information received from the driver monitoring module **304**. The processing module **310** determines plurality of physiological factors from the images captured and further analyzes the physiological factors.

[0050] In accordance with an embodiment of the invention, the processing module **310** analyzes the captured images and/or videos to determine the inattentiveness of the driver based on the first physiological factor from the plurality of physiological factors. Further, the second physiological factor is independently and/or simultaneously analyzed by the processing module **310** to support the first physiological factor. The plurality of physiological factors maybe heart rate readings, pupillary light reflex, skin conductance, pulse rate, respiratory rate, and breathing volume, etc. In an example, the heart rate of the driver is analyzed as the first physiological factor and pupillary light reflex, as the second physiological factor in a system to determine the alertness and inattentiveness of the driver. The physiological factors enable early prediction of drowsiness and inattentiveness of the drivers.

[0051] Further in an embodiment of the invention, the driver may pre-register his own profile with a server to provide base-line data to the processing module **310**. The data may consist driver specific heart rate readings, skin conductance, pulse rate, respiratory rate and breathing volume, age, sex, eyesight, etc. The server of the system according to the present invention can store the created user profile and reuse it later in order to optimize the driving behavior of the vehicle. This data may also be used to compare and determine changes in driver physiological and behavioral factors.

[0052] In an embodiment of the invention, the driving behavior is determined from data received from the driver monitoring module **304**, environment condition module **306**, and vehicle information module **308**. Also, the information of historical reactions may also be fetched from memory **314** for reaction time calculation. Determination of reaction time is done based on what state the driver is currently in, what are the physiological readings for the same and how the driver has been reacting to situations in the current journey. The reaction time may be utilized to better equip the system for any situations that may come up in the journey. The reaction time may also be compared to general reaction time of the driver as stored in the memory **314** to determine any anomalies and flag such situations to the system **300**.

[0053] Further, the processing module **310** may initiate a warning to the driver for adjusting his reaction time based on the determined reaction time. The adjustment may be in the form of early reactions to certain situations or may be eased out reaction based on vehicle performance. For example if the driver has been pushing the brakes too hard then he may be provided an assistance to soften the brake controls or if the driver has been reacting late to curves, he may be provided a warning in next upcoming turns to act early in braking and steering control etc.

[0054] Further in an embodiment, the processing module **310** may identify certain sections of road, certain timings of the day, certain whether, certain environment, etc. wherein generally other drivers may have felt drowsy or sleepy or may have met some accident or may have affected the reaction times of the drivers. The processing module **310** may predict this from historical data stored that it may fetch from a remote server connected to it. Early predictive reaction time adjustments may be provided to the driver based on his current physiological and driving behavior.

[0055] The warning module **312**, receives activation or deactivation instructions from the processing module **310**. The warning module **312**, on activation may display or present a warning to the driver through the display **316** that may be a screen of an infotainment system of the vehicle. The display **316** may be configured to receive inputs of the driver. The inputs may be through a touch, physical button, a remote control, voice input, or gesture recognition. The display **316** may include a circuitry (not shown in figure) like a printed circuit board (PCB) or an integrated circuit containing appropriate components for receiving and recognizing the driver inputs. In accordance with another embodiment of the invention the warning may be provided through any other means like audio or visual.

[0056] FIG. **4** is a flow chart of a method **400** for providing early warning to the driver. The order in which the method is described is not intended to be construed as a limitation, and any number of the described method blocks can be combined in any order to implement the method or alternate methods. Additionally, individual blocks may be deleted from the method without departing from the spirit and scope of the subject matter described herein. Furthermore, the method can be implemented in any suitable hardware, software, firmware, or combination thereof. However, for ease of explanation, in the embodiments described below, the method may be considered to be implemented in the above described system and/or the apparatus and/or any electronic device (not shown).

[0057] The method starts at step **402** at which images of the driver are continuously captured using a camera. In another embodiment of the invention, short video segments may be taken at regular intervals of time. At step **404**, the first physiological factor of the driver is determined using captured images and/or video of the driver at step **402**. Further at step **406**, the system determines whether the first physiological factor of the driver is within a threshold limit. If yes, then the method is returned to step **402** in order to keep monitoring the same. However, in case the first physiological factor is above the threshold limit then at step **408** the monitoring second physiological factor of the driver is initiated. Further, at step **410**, it is determined, whether the first and second physiological factors are aligned within the threshold limit or not. If yes, then the method is returned to step **408** in order to re-monitor the second physiological factor of the driver. However, in case the first and second physiological factor of the driver are below the threshold then the method at step **412** initiates the warning module **312**. Further to this, at step **410** the warning is provided to the driver.

[0058] FIG. **5** is a flow chart of a method **500** for providing early warning to the driver, in accordance with an embodiment of the invention. The method **500** analyzes the heart rate and pupillary light reflex of the driver of the vehicle to monitor the driver's inattentiveness. The method starts at

step **502** at which images of the driver are continuously captured using a camera. In another embodiment of the invention, short video segments may be taken at regular intervals of time. At step **504**, the heart rate variability of the driver is determined using captured images and/or video of the driver at step **502**. Further at step **506**, the system determines whether the heart rate of the driver is within a threshold limit. If yes, then the method is returned to step **502** in order to keep monitoring the same. However, in case the heart rate is above the threshold limit then at step **508** the monitoring pupillary light reflex of the driver is initiated. Further, at step **510**, it is determined, whether the heart rate and pupillary light reflex are aligned within the threshold limit or not. If yes, then the method is returned to step **508** in order to re-monitor the pupillary light reflex of the driver. However, in case the heart rate and pupillary light reflex of the driver are below the threshold then the method at step **512** initiates the warning module **312**. Further to this, at step **514** a warning is also provided to the driver. The warning may be an audio warning, a visual warning, an audio-visual warning, haptic warning like vibration, etc.

[0059] In an embodiment of the invention the FIG. **6** is a flow chart of a method **600** for detecting reaction time of driver during the drive. At step **602**, images of the driver are captured using a camera. In another embodiment of the invention short video segments may be taken at regular intervals of time. At step **604**, the processing module **310** analyzes the images of the driver to determine physiological factors i.e. heart rate readings of the driver. At step **606**, it is determined whether the physiological factors are within normal range. If yes, then the method is returned to step **602** in order to keep monitoring the same. However, in case the physiological factors are not within the normal limits then the method at step **608** determines behavioral factors of the driver. Further to this, at step **610** reaction time of the driver is determined based on the physiological factors and the behavioral factors. At step **612**, the reaction time of the driver is adjusted based on the determination. This may be done by providing a gentle warning to the driver.

[0060] It will be appreciated that, for clarity purposes, the above description has described embodiments of the present subject matter with reference to different functional units and processors. However, it will be apparent that any suitable distribution of functionality between different functional units, processors or domains may be used without detracting from the present subject matter.

[0061] The methods illustrated throughout the specification, may be implemented in a computer program product that may be executed on a computer. The computer program product may comprise a non-transitory computer-readable recording medium on which a control program is recorded, such as a disk, hard drive, or the like. Common forms of non-transitory computer-readable media include, for example, floppy disks, flexible disks, hard disks, magnetic tape, or any other magnetic storage medium, CD-ROM, DVD, or any other optical medium, a RAM, a PROM, an EPROM, a FLASH-EPROM, or other memory chip or cartridge, or any other tangible medium from which a computer can read and use.

[0062] Alternatively, the method may be implemented in transitory media, such as a transmittable carrier wave in which the control program is embodied as a data signal using transmission media, such as acoustic or light waves, such as those generated during radio wave and infrared data communications, and the like.

[0063] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the disclosure. It will be appreciated that several of the above-disclosed and other features and functions, or alternatives thereof, may be combined into other systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may subsequently be made by those skilled in the art without departing from the scope of the present disclosure as encompassed by the following claims.

We claim:

1. A method for monitoring a driver comprising:
- capturing, a plurality of images of the driver, by a driver monitoring module (**304**);
- storing the plurality of images of the driver in a memory (**314**);
- determining a plurality of physiological factors of the driver to a plurality of situations experienced by the driver, based on the plurality of images of the driver by a processing module (**310**);
- determining a plurality of behavioral factors of the driver to a plurality of situations experienced by the driver, based on the plurality of images of the driver by the processing module (**310**); and
- detecting a reaction time of the driver by the processing module (**310**), to the plurality of situations experienced, based on the physiological factors and the behavioral factors.

2. The method of claim **1**, wherein the plurality of physiological factors includes heart rate readings, pupillary light reflex, skin conductance, pulse rate, respiratory rate and breathing volume determined from captured images.

3. The method of claim **1**, wherein the behavioral factors include braking time, steering turning time, deceleration initiation time determined from captured images.

4. A system (**300**) for monitoring a driver comprising;
- at least one driver monitoring module (**304**) configured to capture a plurality of images of the driver;
- a memory (**314**) connected to the driver monitoring module for storing the plurality of images of the driver;
- a processing module (**310**) connected to the driver monitoring module configured to analyze the plurality of images of the driver for:
  - determining a plurality of physiological factors of the driver to a plurality of situations experienced by the driver, based on the plurality of images of the driver;
  - determining a plurality of behavioral factors of the driver to the plurality of situations experienced by the driver, based on the plurality of images of the driver; and
  - detecting a reaction time of the driver, to the plurality of situations experienced, based on the physiological factors and the behavioral factors.

5. The system (**300**) of claim **4**, wherein the plurality of physiological factors includes heart rate readings, pupillary light reflex, skin conductance, pulse rate, respiratory rate and breathing volume determined from captured images.

6. The system (**300**) of claim **4**, wherein the plurality of behavioral factors includes braking time, steering turning time, deceleration initiation time determined from captured images.

7. The system (**300**) of claim **4**, wherein the driver monitoring module (**304**) is a charge coupled device (CCD) camera.

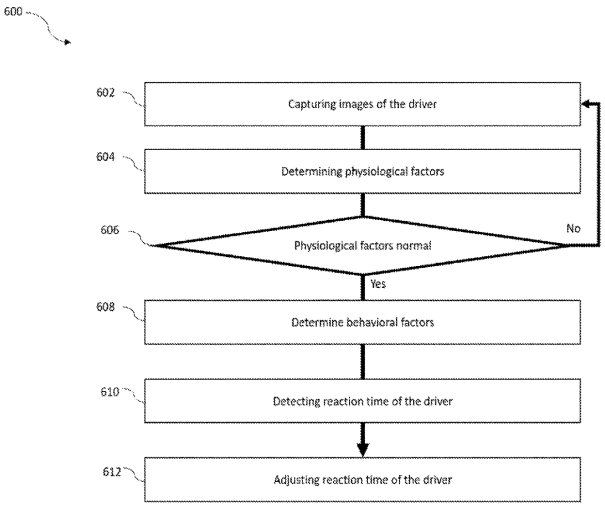
8. The system (**300**) of claim **7**, wherein the CCD camera monitors driver state based on eye gaze, blink rate of eyelids, change in skin tone, nostrils, jaw movements, frowning, baring teeth, movement of cheeks, movement of lips and head movements.

9. The system (**300**) of claim **4**, wherein the processing module (**310**) is configured to identify relative changes in the plurality of physiological and behavioral factors and predict a warning based on the relative changes in the plurality of physiological factors and the behavioral factors.

10. The system (**300**) of claim **4**, wherein the processing module (**310**) is connected to a remote server through a wireless communication protocol.

* * * * *

专利名称(译)	检测驾驶员反应时间的系统和方法		
公开(公告)号	US20200205716A1	公开(公告)日	2020-07-02
申请号	US16/731630	申请日	2019-12-31
[标]申请(专利权)人(译)	高科技机器人systz		
[标]发明人	KAPURIA ANUJ VIJAY RITUKAR		
发明人	KAPURIA, ANUJ VIJAY, RITUKAR		
IPC分类号	A61B5/18 A61B5/16 A61B5/0205 A61B5/053 A61B5/00 A61B5/103 A61B5/11 G06K9/00		
CPC分类号	A61B5/024 G06K9/00308 A61B5/18 A61B5/7275 A61B5/0531 A61B5/091 A61B5/0205 A61B5/0077 A61B5/163 A61B5/11 A61B5/162 A61B5/1032 G06K9/00315 A61B5/0002 A61B5/0816		
优先权	201811050067 2018-12-31 IN 201813050098 2018-12-31 IN		
外部链接	USPTO		

摘要(译)

本发明提供了一种用于使用驾驶员的多个生理因素来监视驾驶员注意力不集中的方法和系统。 在这种方法中,拍摄的图像和/或短视频被用于确定驾驶员的生理因素。 多个生理因素中的第一生理因素用于确定驾驶员的困倦和/或注意力不集中的水平,其进一步由第二生理因素支持。 从第一和第二生理因素的分析产生的数据被进一步用于向驾驶员产生预测性警告。 警告的强度级别根据所分析的驾驶员注意力不集中程度而变化。 该警告可以是音频警告,视觉警告,视听警告,诸如振动的触觉警告等。