Title: METHODS AND SYSTEMS FOR VEHICLES-BASED WELLNESS MONITORING

Abstract: Methods and systems for monitoring wellness of a vehicle occupant are described. A method and a system may involve monitoring biophysical data of the occupant and determining the wellness information thereof. The method and the system may also involve determining whether the occupant is in a potential impairment state. The method and the system may also involve performing precautionary actions in response to the determining that the occupant is in the potential impairment state. The method and the system may also involve providing lifestyle recommendations to the occupant. The method and the system may further involve transmitting the wellness information to a second processor located within the vehicle or remotely from the vehicle.
Methods and Systems for Vehicles-Based Wellness Monitoring

TECHNICAL FIELD

[0001] The present disclosure generally relates to human health and, more particularly, to methods and systems for wellness monitoring for automobile drivers and occupants.

BACKGROUND

[0002] When it comes to personal health and wellness, it is of crucial importance to keep a daily record that tracks personal fitness parameters and/or wellness information such as weight, waistline, body temperature, heart rate, respiratory rate, oxygen saturation level, blood pressure, and so forth. To keep a reliable and faithful daily record of the personal wellness information, it requires measurement of the fitness parameters to be performed on a daily basis and the measurement results be entered into a database or otherwise logged or recorded. The measurement is preferably performed at or around a specific time of the day each day, and it takes a dedicated period of time, a dedicated space and relevant instruments or equipment to perform the measurement. These requirements, however, may be difficult to meet considering a busy or otherwise dynamic lifestyle of modern-day living.

[0003] People today tend to spend a considerable amount of time in a car or a transportation vehicle, which may adversely affect personal health or wellness at least due to being confined within a limited space of the vehicle for a prolonged period of time, and/or due to stress and tiredness of driving in heavy traffic. The situation may become more dangerous or even deadly if the wellness of a vehicle driver changes adversely while driving. A traffic
accident or a road hazard may result and greatly affect the traffic safety. Thus, personal wellness monitoring is important for a driver or a passenger of an automobile vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Non-limiting and non-exhaustive embodiments of the present disclosure are described with reference to the following figures, wherein like reference numerals refer to like parts throughout the various figures unless otherwise specified.

[0005] FIG. 1 is a diagram depicting an example implementation in accordance with an embodiment of the present disclosure.

[0006] FIG. 2 is a diagram depicting another example implementation in accordance with an embodiment of the present disclosure.

[0007] FIG. 3 is a diagram depicting yet another example implementation in accordance with an embodiment of the present disclosure.

[0008] FIG. 4 is a flowchart of an example process in accordance with an embodiment of the present disclosure.

[0009] FIG. 5 is a diagram depicting an example system in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0010] In the following description, reference is made to the accompanying drawings that form a part thereof, and in which is shown by way of illustrating specific exemplary embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the concepts disclosed herein, and it
is to be understood that modifications to the various disclosed embodiments may be made, and 
other embodiments may be utilized, without departing from the scope of the present disclosure. 
The following detailed description is, therefore, not to be taken in a limiting sense.

[0011] The present disclosure aims to monitor the wellness of an occupant, either a driver 
or a passenger, of a vehicle that may be either a car, a sedan, a truck, a passenger bus, a train, or 
the like (hereinafter "a vehicle"), while he or she is using the vehicle. Depending on the 
monitoring result, preventive or precautionary actions may be taken with or in the vehicle 
according to the present disclosure. The general health condition of a person may be profiled or 
tracked using a set of parameters associated with the fitness/wellness of the person (hereinafter 
referred to as "wellness information"), such as weight, waistline, body temperature, heart rate, 
respiratory rate, oxygen saturation level, blood pressure, and so forth, in conjunction with the 
height, the gender and/or the age of the person. It is especially valuable if the wellness 
information can be recorded day after day over a long period of time. A vehicle may provide an 
ideal environment for the wellness information of an occupant of the vehicle to be measured, 
monitored and recorded automatically and continuously.

[0012] FIG. 1 depicts an example implementation 100 through which fitness or wellness 
of a driver of a vehicle may be monitored. Under implementation 100, a driver of a vehicle may 
lay his or her hands 120 on a rim 111 of a steering wheel 110 of the vehicle as shown in FIG. 1. 
Although not shown in FIG. 1, the driver may alternatively lay hands 120 on other parts of 
steering wheel 110 while operating the vehicle, such as on one or more spokes 112 of steering 
wheel 110 or on a center part 113 of steering wheel 110. As at least one of hands 120 may 
constantly lay on at least a part of steering wheel 110 while maneuvering the vehicle, wellness of 
the driver may be continuously monitored through a part of steering wheel 110 where at least one
of hands 120 touches. As shown in FIG. 1, one or more sensors 130 may be embedded or otherwise disposed on various parts of steering wheel 110 and configured to sense, measure or otherwise pick up biophysical data 170 of the driver through one or both of hands 120 that lay thereon. Biophysical data 170 may be sent or otherwise communicated to a processor 180 that is embedded or disposed in the vehicle. Based on the biophysical data 170 received from the one or more sensors 130, processor 180 may determine wellness information 190 of the driver. Wellness information 190 may be an indication of one or more aspects of wellness of the driver.

[0013] As steering wheel 110 is a three-dimensional object having multiple surfaces that hands 120 of the driver may touch, disposition locations of the one or more sensors 130 may not be limited to the surfaces of steering wheel 110 that face the driver, as seemingly the case shown in FIG. 1. Rather, the one or more sensors 130 may be disposed on, or embedded in, any part of steering wheel 110, including every surface, edge, groove, undercut, body and solid part of steering wheel 110. In some embodiments, at least one of the one or more sensors 130 may not require physical contact with hands 120 to sense biophysical data 170. That is, merely a close proximity of hands 120 with respect to at least one of the one or more sensors 130 may be sufficient for the generation of biophysical data 170. Therefore, at least one of the one or more sensors 130 may be embedded underneath a surface of steering wheel 110 or buried in a solid part of steering wheel 110.

[0014] In some embodiments, the one or more sensors 130 may include a heart rate detector disposed on rim 111 of steering wheel 110, generating a reading of a pulse signal of the driver as biophysical data 170 that is sent to processor 180. Based on the reading, processor 180 may determine a heart rate measurement, manifested in how many pulses per minute, as wellness information 190 of the driver. The heart rate detector may be of inductive electrode type or of
other types. In some embodiments, the one or more sensors 130 may include a pulse oximeter disposed in a groove or cut-out on the back side of rim 111 of steering wheel 110, in a groove or cut-out on one of spokes 112, or in a groove or cut-out on center part 113 of steering wheel 110. The pulse oximeter may generate a reading as biophysical data 170 that is sent to processor 180. Based on the reading, processor 180 may determine an oxygen saturation level, manifested in a percentage, as wellness information 190 of the driver. The pulse oximeter may be of transmissive type, reflective type, or other types of pulse oximetry. In some embodiments, the one or more sensors 130 may include a grip force sensor disposed on rim 111 of steering wheel 110, generating a reading of a grip force of the driver as biophysical data 170 that is sent to processor 180. Based on the reading, processor 180 may determine a grip force measurement, manifested in pounds or kilograms, as wellness information 190 of the driver. The grip force sensor may be of force-sensitive resistor (FSR) type, mechanical spring type, or other types of force measurement.

[0015] In some embodiments, processor 180 may be equipped with (or coupled to) a transceiver 182 that is configured to transmit and receive data or information. In some embodiments, transceiver 182 may transmit either or both of biophysical data 170 and wellness information 190 of the driver to another processor (not shown) located either within the vehicle or remotely away from the vehicle. In some embodiments, transceiver 182 may receive either a manual input or a machine input. The manual or machine input may contain one or more commands or one or more instructions for processor 180 to correct or otherwise override at least a part of wellness information 190. The manual or machine input may also contain one or more commands or one or more instructions for processor 180 to perform other function(s) such as giving a lifestyle recommendation to the driver, issuing a warning to the driver, and maneuvering
the vehicle on behalf of the driver. More details of such other function(s) will be given in later parts of the present disclosure.

[0016] To achieve proper wellness monitoring with accuracy and efficiency, the driver or a passenger of the vehicle (hereinafter generally referred to as "occupant") should be in a "measurement-ready" position with respect to sensors 130 throughout the monitoring process. However, during operation of the vehicle, the driver may not always have hands 120 placed properly with respect to sensor 130, thereby impeding the wellness monitoring process. In some embodiments, processor 180 may instruct or otherwise remind the driver to maintain the measurement-ready position. For example, processor 180 may be equipped with a communication console 184, via which processor 180 may instruct the driver. Specifically for example implementation 100, processor 180 may instruct the driver to place hands 120 on rim 11] of steering wheel 110 and hold rim 111 such that at least one of hands 120 may cover one or more of sensors 130. Communication console 184 may communicate to the driver by way of text, audio and/or video message(s). Processor 180 may determine whether the driver is in a measurement-ready position and, upon a determination that the driver is in the measurement-ready position (e.g., having at least one hand positioned on or near steering wheel 110), receive biophysical data 170 from the one or more sensors 130.

[0017] FIG. 2 depicts another example implementation 200 through which fitness or wellness of an occupant of a vehicle may be monitored. In some embodiments, a processor 280 equipped in the vehicle may instruct the occupant to sit squarely in a seat 220 with feet of the occupant placed on a floor 222 of the vehicle. The vehicle may be equipped with one or more sensors, such as a pressure sensor 231 disposed on seat 220 of the vehicle and a pressure sensor 232 disposed on floor 222 of the vehicle. Each of pressure sensors 231 and 232 may measure or
otherwise generate a respective pressure reading as biophysical data of the occupant, such as a reading 271 measured by pressure sensor 231 and a reading 272 measured by pressure sensor 232. Biophysical data of readings 271 and 272 may be sent or otherwise communicated to processor 280 that is embedded or disposed in the vehicle. Processor 280 may determine a weight measurement as wellness information 290 of the occupant based on biophysical data of readings 271 and 272 received from pressure sensors 231 and 232.

[0018]  In some embodiments, the vehicle may further be equipped with one or more position sensors, such as position sensors 233 and 234 disposed on seat 220, as well as one or more height sensors, such as multiple height sensors 235 disposed on or near a ceiling 224 of the vehicle. Similar to processor 180 of example implementation 100, processor 280 may instruct the occupant through a communication console 284 to sit straight in seat 220 and face forward with respect to the vehicle. Position sensors 233 and 234 as well as height sensors 235 may each measure or otherwise generate a respective reading as biophysical data of the occupant. For example, position sensor 233 may generate a reading with regards to how far seat 220 is pushed back from steering wheel 210, and position sensor 234 may generate a reading with regards to how much seat 220 is tilted backward. Likewise, height sensors 235 may generate a reading with regards to how close the head of the occupant is to ceiling 224. The biophysical data of the readings generated by sensors 233, 234 and 235 may be sent or otherwise communicated to processor 280. Based on the readings collectively, processor 280 may determine an estimation of the height of the occupant as wellness information 290. Processor 280 may determine whether the occupant is in a measurement-ready position and, upon a determination that the occupant is in the measurement-ready position (e.g., sitting straight in seat 220 and facing forward with respect to the vehicle), receive biophysical data from sensors 233, 234 and 235.
In some embodiments, the vehicle may also be equipped with one or more cameras, such as camera 236 disposed on the dashboard of the vehicle. Camera 236 may have a lens head that is able to swivel around, and may be able to provide a view of the interior of the vehicle as well as a view of the exterior of the vehicle. Alternatively, camera 236 may have multiple lenses facing different orientations, thus able to provide, for example, 360-degree views continuously. The height of an occupant of the vehicle may be determined more accurately with camera 236 facing the exterior of the vehicle. Specifically, processor 280 may instruct the occupant to stand outside the vehicle, preferable in the front of the vehicle, at a predetermined distance from the exterior-facing camera 236. Camera 236 may thus take or produce a picture of the occupant standing at the predetermined distance as the biophysical data to be sent to processor 280. Based on the picture and the predetermined distance, processor 280 may determine an estimation of the height of the occupant as wellness information 290. Processor 280 may determine whether the occupant is in a measurement-ready position and, upon a determination that the occupant is in the measurement-ready position (e.g., standing in front of the vehicle at the predetermined distance from camera 236), receive biophysical data from camera 236.

The height estimation of the occupant may not be as accurate as desired, and more often than not the occupant may know his or her own exact height, and may want to provide the exact height to aid the wellness monitoring process. To achieve the purpose, in some embodiments, processor 280 may be equipped with a transceiver 282 that is configured to transmit and/or receive data or information to and from another processor (not shown) located either within the vehicle or remotely away from the vehicle. Accordingly, processor 280 may receive a manual input from the occupant of the exact height of the occupant via transceiver 282.
Alternatively or additionally, processor 280 may receive a machine input from a remote database of the exact height of the occupant via transceiver 282. The received exact height of the occupant, whether through human or machine input, may be used to override, correct, calibrate or otherwise self-train the estimated height determined by processor 280. Processor 280 may thus become capable of providing a more accurate height estimation of an occupant of the vehicle after a few iterations.

[0021] In some embodiments, camera 236 may be utilized to provide a gender indication of the occupant of the vehicle. Specifically, camera 236 may be swiveled to face the interior of the vehicle, and processor 280 may instruct the occupant through communication console 284 to sit in seat 220 and face camera 236. Camera 236 may thus take or otherwise produce a picture of the occupant to be sent to processor 280. Based on the picture, processor 280 may determine a gender indication of the occupant as wellness information 290, indicating whether the occupant is a male or a female. In some embodiments, camera 236 may send a continuous video as the biophysical data to processor 280, and processor 280 may determine whether the occupant may be drowsy, sleepy or even dozing off. If the occupant is the driver of the vehicle, processor 280 may determine that the occupant/driver is in a potential impairment state, and may accordingly take precautionary actions by issuing one or more human perceivable warning signals such as an audible signal or a visual signal through communication console 284 to wake up the driver. In some embodiments, processor 280 may take further precautionary actions by issuing other human perceivable warning signals such as causing a vibration of seat 220 where the driver sits or applying a low-grade electric shock to the occupant via some stimulating electrodes (not shown in FIG. 2) disposed on seat 220 and/or on steering wheel 210.
FIG. 3 depicts yet another example implementation 300 where fitness or wellness of an occupant of a vehicle may be monitored. In some embodiments, a processor 380 equipped in the vehicle may instruct the occupant through a communication console 384 to sit in a seat 320 of the vehicle with a seatbelt 340 pulled over the chest 310 of the occupant and buckled up. Seatbelt 340 may be equipped with one or more sensors, such as a heart rate detector 331 and a respiratory rate detector 332. Preferably, heart rate detector 331 and heart respiratory detector 332 may be located on or near the chest 310 of the occupant. In some embodiments, heart rate detector 331 may measure or otherwise sense a sound from chest 310 as biophysical data of the occupant. Biophysical data of the sound sensed by heart rate detector 331 may be sent or otherwise communicated to processor 380 that is embedded or disposed in the vehicle, and processor 380 may determine a heart rate measurement as wellness information 390 of the occupant based on the biophysical data of the sound sensed by heart rate detector 331. Likewise, in some embodiments, respiratory rate detector 332 may measure or otherwise sense a movement of chest 310 as biophysical data of the occupant. Biophysical data of the movement sensed by respiratory rate detector 332 may be sent or otherwise communicated to processor 380 that is embedded or disposed in the vehicle. Processor 380 may determine a respiratory rate measurement as wellness information 390 of the occupant based on the biophysical data of the movement sensed by respiratory rate detector 332. Processor 380 may determine whether the occupant is in a measurement-ready position and, upon a determination that the occupant is in the measurement-ready position (e.g., sit in seat 320 with seatbelt 340 pulled over the chest of the occupant and buckled up), receive biophysical data from detectors 331 and 332.

In some embodiments, seat 320 of the vehicle may have an armrest 350, and one or more sensors, such as a blood pressure monitor 333 or a heart rate detector 334, may be
provided on or near armrest 350. Processor 380 may instruct the occupant through communication console 384 to sit in seat 320 with an arm 315 of the occupant placed on or near armrest 350 and touching either or both of blood pressure monitor 333 and heart rate detector 334. Preferably, blood pressure monitor 333 may be located near the upper arm of arm 315 of the occupant. Also preferably, heart rate detector 334 may be located on or near the elbow or wrist of arm 315 of the occupant. Blood pressure monitor 333 and heart rate detector 334 may each measure or otherwise generate a reading, such as reading 373, as biophysical data of the occupant. The readings of blood pressure monitor 333 and heart rate detector 334 may be sent or otherwise communicated to processor 380. Processor 380 may determine a blood pressure measurement and a heart rate measurement, respectively, as wellness information 390 of the occupant based on the biophysical data of the readings generated by blood pressure monitor 333 and heart rate detector 334. Processor 380 may determine whether the occupant is in a measurement-ready position and, upon a determination that the occupant is in the measurement-ready position (e.g., sitting in seat 320 with an arm of the occupant placed on or near armrest 350 and touching either or both of blood pressure monitor 333 and heart rate detector 334), receive biophysical data from detectors 333 and 334.

[0024] In some embodiments, seatbelt 340 may be partially stored in a spring-loaded spool 345 when not in use. When seatbelt 340 is applied to or otherwise pulled over the occupant of the vehicle who is sitting in seat 320, an extra length of seatbelt 340 may be released from spool 345 and exposed outside spool 345, due to the thickness of the body of the occupant. Therefore, there may be a correlation between a waistline measurement of the occupant and the extra length of seatbelt 340 released from spool 345. In some embodiments, spool 345 may be equipped with either or both of a rotation counter (not shown in FIG. 3) and a linear counter (not
shown in FIG. 3), by which the extra length of seatbelt 340 released from spool 345 may be measured. The rotation counter may count a number of rotations of spool 345 when the extra length of seatbelt 340 is released, thereby measuring the extra length of seatbelt 340 released.

Alternatively, seatbelt 340 may be marked with a plurality of length marks along the length of seatbelt 34, and the linear counter may measure the extra length of seatbelt 340 released by counting how many marks have been released. The linear counter may operate optically, magnetically, electrically or mechanically. Processor 380 may instruct the occupant through communication console 384 to sit in seat 320 of the vehicle with seatbelt 340 pulled over the occupant and buckled up. Either or both of the rotation counter and the linear counter of spool 345 may count or otherwise measure a spool release count 375 as biophysical data of the occupant, which may be sent or otherwise communicated to processor 380. Processor 380 may determine an estimation of the waistline measurement of the occupant as wellness information 390 of the occupant based on the biophysical data of the spool release count 375. Processor 380 may determine whether the occupant is in a measurement-ready position and, upon a determination that the occupant is in the measurement-ready position (e.g., sitting in seat 320 with seatbelt 340 pulled over the occupant and buckled up), receive biophysical data from spool 345.

[0025] Similar to example implementations 100 and 200, in some embodiments, processor 380 of FIG. 3 may be equipped with a transceiver 382 that is configured to transmit and/or receive data or information to and from another processor (not shown) located either within the vehicle or remotely away from the vehicle. In some embodiments, processor 380 may transmit via transceiver 382 wellness information 390 of the occupant, such as the blood pressure measurement, to another processor of a remote health database that holds a medical history of the
occupant. The processor of the remote health database may then log or otherwise add the transmitted blood pressure measurement into the medical history of the occupant in the remote health database. A doctor at a remote hospital may read the newly added blood pressure measurement and take necessary actions. For example, the doctor may find the blood pressure measurement of the occupant being dangerously high as compared to his or her historical medical records, and send a doctor's order asking the occupant to go to a nearby hospital immediately for certain check-ups. The doctor's order may be received by processor 380 via transceiver 382 and displayed or otherwise relayed to the occupant through communication console 384. In some embodiments, processor 380 may further provide the occupant a fastest route map to a nearby hospital by showing the route map on communication console 384.

[0026] In some embodiments, processor 380 of FIG. 3 may be capable of taking specific actions in view of the wellness of the occupant while in the vehicle. In some embodiments, processor 380 may determine that the occupant may be in a potential impairment state based on the wellness information 390 of the occupant. For example, based on the biophysical data generated by either or both of heart rate detectors 331 and 334, processor 380 may determine that the occupant's heart rate may be dropping to a dangerously low level, and determine that the occupant may be in a potential impairment state. In some embodiments, processor 380 may accordingly take precautionary actions by issuing one or more human perceivable warning signals such as an audible signal or a visual signal through communication console 384. In some embodiments, processor 380 may take further precautionary actions by issuing other human perceivable warning signals such as causing a vibration of seat 320 where the occupant sits or applying a low-grade electric shock to the occupant via some stimulating electrodes (not shown) disposed on seat 320 and/or on a steering wheel (in the case of the driver
of the vehicle). In some embodiments, example implementation 300 may have an automated
defibrillator (AED) integrated with seat 320. The AED may have electrodes 361 and 362 disposed on suitable portion(s) of seat 320 and configured to receive one or more commands from processor 380 to defibrillate the occupant sitting in seat 320 when necessary. Processor 380 may determine to defibrillate the occupant via electrodes 361 and 362 of AED in response to a determination by processor 380 that the occupant is in a potential impairment state.

[0027] Processor 380 may further contact a hospital, a police department, an emergency service, and one or more predetermined emergency contact persons, in the form of phone calls or text messages through transceiver 382, and notify the recipients of the potential impairment state of the occupant. Processor 380 may also provide a location of the occupant based on a global positioning system (GPS) that may be equipped in the vehicle. In some embodiments, especially when the occupant is the driver of the vehicle and provided that the vehicle is an autonomous vehicle, processor 380 may blink the turn signal lights of the vehicle and maneuver the vehicle to a safe location on behalf of the occupant. For example, processor 380 may autonomously maneuver the vehicle to a side of the road, a road shoulder, a parking lot or even directly to a hospital.

[0028] Even if processor 380 may not determine whether the occupant is immediately in a potential impairment state, in some embodiments, processor 380 may provide the occupant with some soft warnings or lifestyle recommendations based on the wellness information determined. For example, processor 380 may suggest, through communication console 384 or any other communication means, a lighter meal plan based on an increase in the weight measurement as compared to yesterday's weight measurement. As another example, processor 380 may suggest a certain number of steps per day as walking exercise based on an increasing
waistline estimation in the past one month. As yet another example, processor 380 may suggest
the occupant to lower sodium intake for the day or send a reminder for taking medicine based on
a higher-than-average blood pressure measurement of the occupant.

[0029] FIG. 4 illustrates an example process 400 for providing vehicle-based wellness
monitoring service to an occupant of a vehicle in accordance with the present disclosure. Process
400 may include one or more operations, actions, or functions shown as blocks such as 410, 420,
430, 440, 445, 450 and 455. Although illustrated as discrete blocks, various blocks of process
400 may be divided into additional blocks, combined into fewer blocks, or eliminated, depending
on the desired implementation. Process 400 may be implemented by any of example
implementations 100, 200 and 300. Process 400 may begin with block 410.

[0030] At 410, process 400 may involve a processor determining whether the occupant is
in a measurement-ready position. For example, processor 180 may determine whether the
occupant has hands 120 placed on rim 111 of steering wheel 110 and holds rim 111 such that at
least one of hands 120 may cover one or more of sensors 130. As another example, processor
280 may determine whether the occupant sits squarely in seat 220 with feet of the occupant
placed on floor 222 of the vehicle. As yet another example, processor 380 may determine
whether the occupant sits in seat 320 of the vehicle with seatbelt 340 pulled over the chest 310 of
the occupant and buckled up. Process 400 may proceed from 410 to 420 in response to a
determination that the occupant is in a measurement-ready position. Otherwise, process 400 may
continue at 410 to determine whether the occupant has adjusted his/her position to be in the
measurement-ready position.

[0031] At 420, process 400 may involve one or more sensors measuring or otherwise
monitoring biophysical data of the occupant. The one or more sensors may be disposed or
otherwise embedded at various locations of the vehicle. For example, heart rate detector 130 may be disposed on rim 111 of steering wheel 110 to measure or monitor a pulse reading of the occupant. As another example, pressure sensors 231 and 232 may be disposed on seat 220 and floor 222, respectively, to each measure or monitor a pressure reading from the occupant. As yet another example, blood pressure monitor 333 may be disposed on or near armrest 350 of seat 320 to measure or monitor a blood pressure reading. Process 400 may proceed from 420 to 430.

[0032] At 430, process 400 may involve the processor determining wellness information of the occupant based on the biophysical data of the occupant as measured or monitored by the one or more sensors. For example, based on the pulse reading generated by heart rate detector 130, processor 180 may determine a heart rate measurement, manifested in how many pulses per minute, as wellness information 190 of the occupant. As another example, based on the readings generated by pressure sensors 231 and 232, processor 280 may determine a weigh measurement of the occupant as wellness information 290 of the occupant. As yet another example, based on the readings generated by blood pressure monitor 333, processor 380 may determine a blood pressure measurement of the occupant as wellness information 390 of the occupant. Process 400 may proceed from 430 to 440.

[0033] At 440, process 400 may involve the processor determining whether the occupant is in a potential impairment state based on the wellness information determined by the processor. For example, based on wellness information 190 of occupant's heart rate, measurement processor 180 may determine that the occupant's heart rate may be dropping to a dangerously low level, and determine that the occupant may be in a potential impairment state. As another example, based on wellness information 290 of occupant's weight measurement, processor 280 may determine that the occupant has gained roughly 3 pounds of weight in the last week, but
determine that the occupant may not be in a potential impairment state. Process 400 may proceed from 440 to 445 in response to the determining that the occupant is in a potential impairment state. Alternatively, process 400 may proceed from 440 to 450 in response to the determining that the occupant is not in a potential impairment state.

[0034] At 445, process 400 may involve the processor performing one or more precautionary actions. For example, if the occupant is the driver of the vehicle, processor 380 may blink the turn signal lights of the vehicle and maneuver the vehicle to a safe location on behalf of the occupant/driver, such as a side of the road, a road shoulder, a parking lot or a hospital. As another example, processor 380 may administer an AED to the occupant via electrodes 361 and 362. Process 400 may proceed from 445 to 410.

[0035] At 450, process 400 may involve the processor determining whether the occupant may need some lifestyle recommendations based on the wellness information determined by the processor. Process 400 may proceed from 450 to 455 in response to the determining that the occupant needs one or more lifestyle recommendations. Alternatively, process 400 may proceed from 450 to 410 in response to the determining that the occupant does not need a lifestyle recommendation.

[0036] At 455, process 400 may involve the processor providing one or more audible or visual lifestyle recommendations to the occupant. For example, processor 380 may suggest the occupant to take certain number of steps per day as walking exercise based on an increasing waistline estimation in the past one month. As another example, processor 380 may suggest the occupant to lower sodium intake for the day based on a higher-than-average blood pressure measurement of the occupant.
[0037] FIG. 5 illustrates an example vehicle-based wellness monitoring system 500 in which example embodiments of the present disclosure, such as example implementations 100, 200 and 300, may be realized. System 500 may monitor the fitness or wellness of an occupant of the vehicle with any suitable method, including example process 400. Sensor data generation system 500 may be embodied as hardware, software, or a combination thereof. In some implementations, sensor data generation system 500 may be a computing apparatus such as, for example and not limited to, a laptop computer, a tablet computer, a notebook computer, a desktop computer, a server, a smartphone and a wearable device.

[0038] In some embodiments, wellness monitoring system 500 may include a memory 510, one or more sensors 530, one or more processors 580, a transceiver 582 and a communication console 584. Memory 510 may be operably connected to or otherwise accessible by the one or more processors 580, and may be configured to store one or more computer software components for execution by the one or more processors 580.

[0039] Processor 580 may determine whether the occupant of the vehicle is in a measurement-ready position such that biophysical data 570 may be measured or otherwise generated by one or more sensors 530 disposed at various locations of the vehicle. One or more sensors 530 may be utilized to monitor or otherwise measure various biophysical data 570 of the occupant. Biophysical data 570 may be sent or otherwise communicated to processor 580 and may also be stored in memory 510. Memory 510 may also store, in an analysis module 588, software algorithms for processor 580 to analyze or otherwise determine wellness information 590 of the occupant based on biophysical data 570 of the occupant. Wellness information 590 may be stored in memory 510 as well. Analysis module 588 may also include software algorithms for processor 580 to determine, based on wellness information 590, whether the
occupant is in a potential impairment state. In response to the determining that the occupant is in a potential impairment state, processor 580 may utilize software algorithms stored as an intervention module 550 in memory 510 to perform one or more precautionary actions. Alternatively, in response to the determining that the occupant is not in a potential impairment state, processor 580 may utilize software algorithms stored as a recommendation module 560 in memory 510 to provide lifestyle recommendations to the occupant through communication console 584.

[0040] In some embodiments, sensors 530 may include one or more of a pressure sensor (such as pressure sensors 231 and 232 of FIG. 2), a heart rate detector (such as heart rate detector 130 of FIG. 1 as well as 331 and 334 of FIG. 3), a respiratory rate detector (such as respiratory rate detector 332 of FIG. 3), a seatbelt spool rotation counter (such as the spool rotation counter embedded in seatbelt spool 345 of FIG. 3), a seatbelt spool linear counter (such as the spool linear counter embedded in seatbelt spool 345 of FIG. 3), a pulse oximeter (such as pulse oximeter 130 of FIG. 1), a grip force sensor (such as grip force sensor 130 of FIG. 1), a blood pressure monitor (such as blood pressure monitor 333 of FIG. 3), a position sensor (such as position sensors 233 and 234 of FIG. 2), a height sensor (such as height sensors 235 of FIG. 2), an interior-facing camera (such as camera 236 of FIG. 2) and an exterior facing camera (such as camera 236 of FIG. 2).

[0041] In some embodiments, biophysical data 570 may include one or more of a reading generated by the pressure sensor, a reading generated by the heart rate detector, a reading generated by the respiratory rate detector, a spool release count detected by the seatbelt spool rotation counter, a spool release count detected by the seatbelt spool linear counter, a reading generated by the pulse oximeter, a reading generated by the grip force sensor, a reading
generated by the blood pressure monitor, a reading generated by the position sensor, a reading generated by the height sensor, a picture of the occupant produced by the interior-facing camera and a picture of the occupant generated by the exterior-facing camera.

[0042] In some embodiments, wellness information 590 of the occupant may include one or more of a weight measurement, a heart rate measurement, a respiratory rate measurement, a waistline estimation, an oxygen saturation level, a grip force measurement, a blood pressure measurement, a height estimation and a gender identification of the occupant.

[0043] In some embodiments, processor 580 may perform one or more precautionary actions through actuators 540. For example, actuators 540 may include an AED having electrodes 361 and 362 embedded in seat 320 of FIG. 3, and processor 580 may administer the AED to the occupant as a precautionary action. As another example, actuators 540 may include autonomous driving features of the vehicle, and processor 580 may control the autonomous driving features of the vehicle to maneuver the vehicle to an emergency service location on behalf of the occupant. As yet another example, actuators 540 may include vibrators (not shown) embedded in seat 220 of FIG. 2, and processor 580 may issue a vibration warning through the vibrators to the occupant of the vehicle, especially if the occupant is the driver of the vehicle and processor determines the driver is dozing off based on biophysical data 570 which may be a video captured by camera 236 of FIG. 2.

[0044] In some embodiments, processor 580 may transmit, through transceiver 582, either or both of biophysical data 570 and wellness data 590 of the occupant to another processor located either in the vehicle or remotely from the vehicle. For example, processor 580 may transmit via transceiver 582 the blood pressure measurement of the occupant to another processor of a remote health database that holds a medical history of the occupant. In some
embodiments, processor 580 may receive, through transceiver 582, either or both of a human input or a machine input to override, correct or otherwise update at least a part of wellness information 590. For example, processor 580 may receive via transceiver 582 an input directly from the occupant to override the estimated height of the occupant as stored in wellness information 590.

[0045] The present disclosure provides convenient, reliable, versatile and well-rounded systems and methods for monitoring wellness of an occupant (either a driver or a passenger) in an automobile vehicle. The wellness of the occupant may be constantly monitored and relayed to a remote location, and precautionary actions may be taken autonomously accordingly to the present disclosure, thereby greatly improve not only the personal wellness of the occupant but also the general traffic safety around the vehicle.

[0046] In the above disclosure, reference has been made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific implementations in which the disclosure may be practiced. It is understood that other implementations may be utilized and structural changes may be made without departing from the scope of the present disclosure. References in the specification to "one embodiment," "an embodiment," "an example embodiment," etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.
Implementations of the systems, devices, and methods disclosed herein may comprise or utilize a special purpose or general-purpose computer including computer hardware, such as, for example, one or more processors and system memory, as discussed herein. Implementations within the scope of the present disclosure may also include physical and other computer-readable media for carrying or storing computer-executable instructions and/or data structures. Such computer-readable media can be any available media that can be accessed by a general purpose or special purpose computer system. Computer-readable media that store computer-executable instructions are computer storage media (devices). Computer-readable media that carry computer-executable instructions are transmission media. Thus, by way of example, and not limitation, implementations of the disclosure can comprise at least two distinctly different kinds of computer-readable media: computer storage media (devices) and transmission media.

Computer storage media (devices) includes RAM, ROM, EEPROM, CD-ROM, solid state drives ("SSDs") (e.g., based on RAM), Flash memory, phase-change memory ("PCM"), other types of memory, other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store desired program code means in the form of computer-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer.

An implementation of the devices, systems, and methods disclosed herein may communicate over a computer network. A "network" is defined as one or more data links that enable the transport of electronic data between computer systems and/or modules and/or other electronic devices. When information is transferred or provided over a network or another communications connection (either hardwired, wireless, or a combination of hardwired or
wireless) to a computer, the computer properly views the connection as a transmission medium. Transmissions media can include a network and/or data links, which can be used to carry desired program code means in the form of computer-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer. Combinations of the above should also be included within the scope of computer-readable media.

[0050] Computer-executable instructions comprise, for example, instructions and data which, when executed at a processor, cause a general purpose computer, special purpose computer, or special purpose processing device to perform a certain function or group of functions. The computer executable instructions may be, for example, binaries, intermediate format instructions such as assembly language, or even source code. Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the described features or acts described above. Rather, the described features and acts are disclosed as example forms of implementing the claims.

[0051] Those skilled in the art will appreciate that the disclosure may be practiced in network computing environments with many types of computer system configurations, including, an in-dash vehicle computer, personal computers, desktop computers, laptop computers, message processors, hand-held devices, multi-processor systems, microprocessor-based or programmable consumer electronics, network PCs, minicomputers, mainframe computers, mobile telephones, PDAs, tablets, pagers, routers, switches, various storage devices, and the like. The disclosure may also be practiced in distributed system environments where local and remote computer systems, which are linked (either by hardwired data links, wireless
data links, or by a combination of hardwired and wireless data links) through a network, both perform tasks. In a distributed system environment, program modules may be located in both local and remote memory storage devices.

[F0052] Further, where appropriate, functions described herein can be performed in one or more of: hardware, software, firmware, digital components, or analog components. For example, one or more application specific integrated circuits (ASICs) can be programmed to carry out one or more of the systems and procedures described herein. Certain terms are used throughout the description and claims to refer to particular system components. As one skilled in the art will appreciate, components may be referred to by different names. This document does not intend to distinguish between components that differ in name, but not function.

[F0053] It should be noted that the sensor embodiments discussed above may comprise computer hardware, software, firmware, or any combination thereof to perform at least a portion of their functions. For example, a sensor may include computer code configured to be executed in one or more processors, and may include hardware logic/electrical circuitry controlled by the computer code. These example devices are provided herein purposes of illustration, and are not intended to be limiting. Embodiments of the present disclosure may be implemented in further types of devices, as would be known to persons skilled in the relevant art(s).

[F0054] At least some embodiments of the disclosure have been directed to computer program products comprising such logic (e.g., in the form of software) stored on any computer useable medium. Such software, when executed in one or more data processing devices, causes a device to operate as described herein.

[F0055] While various embodiments of the present disclosure have been described above, it should be understood that they have been presented by way of example only, and not
limitation. It will be apparent to persons skilled in the relevant art that various changes in form and detail can be made therein without departing from the spirit and scope of the disclosure. Thus, the breadth and scope of the present disclosure should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents. The foregoing description has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. Further, it should be noted that any or all of the aforementioned alternate implementations may be used in any combination desired to form additional hybrid implementations of the disclosure.
CLAIMS

1. A method, comprising:
   determining, by a first processor, whether an occupant of a vehicle is in a measurement-ready position in or near the vehicle;
   receiving, by the first processor from one or more sensors communicatively coupled to the first processor, biophysical data of the occupant responsive to a determination that the occupant is in the measurement-ready position; and
   determining, by the first processor, wellness information of the occupant based on the biophysical data.

2. The method of claim 1, further comprising:
   transmitting, by the first processor, the wellness information to a second processor located within the vehicle or remotely from the vehicle.

3. The method of claim 1, further comprising:
   receiving, by the first processor, a manual input or a machine input to override or correct at least a part of the wellness information.

4. The method of claim 1, wherein:
   the one or more sensors comprise a first pressure sensor disposed on a seat of the vehicle and a second pressure sensor disposed on a floor of the vehicle,
   the measurement-ready position comprises the occupant sitting in the seat with feet of the occupant touching the floor,
the biophysical data comprises a first reading generated by the first pressure sensor and a second reading generated by the second pressure sensor, and

the wellness information of the occupant comprises a weight measurement of the occupant.

5. The method of claim 1, wherein:

the one or more sensors comprise a heart rate detector or a respiratory rate detector disposed on a seatbelt of a seat of the vehicle,

the measurement-ready position comprises the occupant sitting in the seat with the seatbelt pulled over a chest of the occupant and buckled up,

the biophysical data comprises a sound from or a movement of the chest of the occupant detected by the heart rate detector or the respiratory rate detector, and

the wellness information of the occupant comprises a heart rate measurement or a respiratory rate measurement of the occupant.

6. The method of claim 1, wherein:

the one or more sensors comprise a spool rotation counter or a spool linear counter disposed on a seatbelt of a seat of the vehicle,

the measurement-ready position comprises the occupant sitting in the seat with the seatbelt pulled over the occupant and buckled up,

the biophysical data comprises a spool release count detected by the spool rotation counter or the spool linear counter, and
the wellness information of the occupant comprises a waistline estimation of the occupant.

7. The method of claim 1, wherein:

the one or more sensors comprise one or more of a heart rate detector, a pulse oximeter and a grip force sensor disposed on a rim of a steering wheel of the vehicle,

the measurement-ready position comprises the occupant holding the rim of the steering wheel,

the biophysical data comprises one or more of a reading generated by the heart rate detector, a reading generated by the pulse oximeter and a reading generated by the grip force sensor, and

the wellness information of the occupant comprises one or more of a heart rate measurement, an oxygen saturation level and a grip force measurement of the occupant.

8. The method of claim 1, wherein:

the one or more sensors comprise one or more of a blood pressure monitor and a heart rate detector disposed on or near an armrest of the vehicle,

the measurement-ready position comprises the occupant sitting in a seat of the vehicle with an arm of the occupant touching one or more of the blood pressure monitor and the heart rate detector,

the biophysical data comprises one or more of a reading generated by the blood pressure monitor and a reading generated by the heart rate detector, and
the wellness information of the occupant comprises one or more of a blood pressure measurement and a heart rate measurement of the occupant.

9. The method of claim 1, wherein:
the one or more sensors comprise a plurality of position sensors disposed on a seat of the vehicle and a height sensor disposed on or near a ceiling of the vehicle,
the measurement-ready position comprises the occupant sitting straight in the seat facing forward with respect to the vehicle,
the biophysical data comprises a plurality of readings generated by the position sensors and the height sensor, and
the wellness information of the occupant comprises a height estimation of the occupant.

10. The method of claim 1, wherein:
the one or more sensors comprise an interior-facing camera disposed inside the vehicle,
the measurement-ready position comprises the occupant sitting in a seat of the vehicle facing the interior-facing camera,
the biophysical data comprises a picture of the occupant produced by the interior-facing camera, and
the wellness information of the occupant comprises a gender identification of the occupant.

11. The method of claim 1, wherein:
the one or more sensors comprise an exterior-facing camera,
the measurement-ready position comprises the occupant standing outside the vehicle at a predetermined distance from the exterior-facing camera,

the biophysical data comprises a picture of the occupant produced by the exterior-facing camera, and

the wellness information of the occupant comprises a height estimation of the occupant.

12. A method for monitoring wellness of an occupant of a vehicle, comprising:

monitoring, by one or more sensors embedded in or on the vehicle, biophysical data of the occupant;

determining, by a processor, wellness information of the occupant based on the biophysical data;

determining, by the processor, whether the occupant is in a potential impairment state based on the wellness information; and

performing, by the processor, one or more precautionary actions in response to the determining that the occupant is in the potential impairment state.

13. The method of claim 12, wherein:

the one or more sensors comprise one or more of a pressure sensor, a heart rate detector, a respiratory rate detector, a seatbelt spool rotation counter, a seatbelt spool linear counter, a pulse oximeter, a grip force sensor, a blood pressure monitor, a position sensor, a height sensor, an interior-facing camera and an exterior facing camera,

the biophysical data comprises one or more of a reading generated by the pressure sensor, a reading generated by the heart rate detector, a reading generated by the respiratory rate
detector, a spool release count detected by the seatbelt spool rotation counter, a spool release
count detected by the seatbelt spool linear counter, a reading generated by the pulse oximeter, a
reading generated by the grip force sensor, a reading generated by the blood pressure monitor, a
reading generated by the position sensor, a reading generated by the height sensor, a picture of
the occupant produced by the interior-facing camera and a picture of the occupant generated by
the exterior-facing camera, and

the wellness information of the occupant comprises one or more of a weight
measurement, a heart rate measurement, a respiratory rate measurement, a waistline estimation,
an oxygen saturation level, a grip force measurement, a blood pressure measurement, a height
estimation and a gender identification of the occupant.

14. The method of claim 12, wherein the one or more precautionary actions comprise
issuing one or more human perceivable warning signals to the occupant.

15. The method of claim 14, wherein the one or more human perceivable warning
signals comprise one or more of an audible signal, a visual signal, a vibration of a seat of the
vehicle, a low-grade electric shock, a voice message and a strong wind generated by an air
conditioning system of the vehicle.

16. The method of claim 12, wherein the one or more precautionary actions comprise
autonomously maneuvering the vehicle to a safe location on behalf of the occupant.

17. The method of claim 16, wherein the safe location comprises a side of a road, a
shoulder of the road, a parking lot or a hospital.
18. The method of claim 12, wherein the one or more precautionary actions comprise administering an automated external defibrillator (AED) to the occupant.

19. The method of claim 12, wherein the one or more precautionary actions comprise contacting a hospital, a police department, an emergency service, one or more predetermined emergency contact persons, or a combination of two or more thereof, by making a phone call or sending a text message.

20. The method of claim 12, further comprising:

   receiving, by the processor, a manual input or a machine input to override or correct at least a part of the wellness information; or

   providing, by the processor, one or more audible or visual lifestyle recommendations to the occupant based on the wellness information.
START

Is the occupant in a measurement-ready position? 410

No

Measure/monitor biophysical data of occupant 420

Determine wellness information of occupant 430

Is the occupant in a potential impairment state? 440

Yes

Perform precautionary actions 445

No

Any lifestyle recommendation for the occupant? 450

No

Yes

Provide lifestyle recommendations 455

FIG. 4
Vehicle-based Wellness Monitoring System 500

Sensors 530
Actuators 540

Processor 580

Transceiver 582
Communication Console 584

Memory 510

Biophysical Data 570
Wellness Information 590

Analysis Module 588

Intervention Module 550
Recommendation Module 560

FIG. 5
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/41551

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61B 5/18; B60N 2/16 (2016.01)

CPC - A61B 5/18; B60N 2/16

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)

IPC(8) Classifications: A61B 5/18; B60N 2/16; B660R 21/015 (2016.01)

CPC Classifications: A61B 5/18; 5/6893; B60N 2/16; B660R 21/015; USPC Classifications: 180/272; 280/735

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)

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google; Google Scholar; EBSCO; IP.com; keywords: height sense, detect, monitor, measure, camera, imager, exterior, out, gender, sex, car, vehicle, automobile, wellness, biophysical

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 20140275834 A1 (BENNETT P) September 18, 2014; paragraphs [0024], [0025], [0033], [0040], [0055], [0060], [0071]</td>
<td>1, 2, 5, 7, 8, 12-15, 19, 20</td>
</tr>
<tr>
<td>Y</td>
<td>US 6,587,770 B1 (GRAY CA et al.) July 1, 2003; figure 1; column 2, lines 35-50; column 3, lines 10-20</td>
<td>6, 10, 11</td>
</tr>
<tr>
<td>X</td>
<td>US 8,874,301 B1 (FORD GLOBAL TECHNOLOGIES LLC.) October 28, 2014; column 4, lines 35-50; column 5, lines 1-10</td>
<td>1, 3, 4</td>
</tr>
<tr>
<td>Y</td>
<td>US 5,670,853 A (BAUER BJ) September 23, 1997; column 4, lines 5-10, 30-45; column 5, lines 40-50</td>
<td>18</td>
</tr>
<tr>
<td>Y</td>
<td>DE 198 56 129 A1 (VOLKSWAGEN AG.) 8.6.2000; page 5, paragraphs 6, 7</td>
<td>10</td>
</tr>
<tr>
<td>Y</td>
<td>US 8,370,030 B1 (GURIN MH) February 5, 2013; column 20, lines 10-20</td>
<td>11</td>
</tr>
<tr>
<td>Y</td>
<td>US 2015/0224329 A1 (WU CH) August 13, 2015; paragraphs [0007], [0032], [0033], [0037]</td>
<td>18</td>
</tr>
<tr>
<td>A</td>
<td>US 8,725,311 B1 (BREED DS) May 13, 2014; entire document</td>
<td>1-20</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "P" document published prior to the international filing date but later than the priority date claimed

\[ "T" \] later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
\[ "X" \] document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
\[ "Y" \] document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
\[ "&" \] document member of the same patent family

Date of the actual completion of the international search
12 September 2016 (12.09.2016)

Date of mailing of the international search report
04 OCT 2016

Name and mailing address of the ISA/
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-8300

Authorized officer
Shane Thomas
PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Form PCT/ISA/2 10 (second sheet) (January 2015)