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Impairment detection with biological considerations

Abstract

A method and system for monitoring impairment indicators. The method includes, during a first time window, measuring a first movement signal related to movement of the person with a movement sensor associated with the person, and measuring a first biological signal of the person with a biological sensor attached to the person. The method further includes electronically storing at least one numerical descriptor derived from the first movement signal and at least one numerical descriptor derived from the first biological signal as reference data for the person. The method includes during a second time window, measuring a second signal related to movement of the person with the movement sensor, and measuring a second biological signal of the person with the biological sensor. The method further includes comparing at least one numerical descriptor derived from the second signal and at least one numerical descriptor derived from the second biological signal to the reference data to identify an impairment indicator.

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Background/Summary

TECHNICAL FIELD

(1) The present invention relates to the field of recognizing or classifying movement, and more specifically, to identifying impairment indicators using both data from a movement sensor and data from a biological sensor attached to a person.

BACKGROUND

(2) Detection of cognitive, physical, mental, sensory, emotional, or developmental impairment is critically important in healthcare, law enforcement, or other applications. Detection techniques may be specific to an individual impairment (such as physical) or any combination of impairments (such as cognitive and sensory). For example, detecting alcohol or controlled substance use or abuse by workers, individuals on parole, or in other contexts is important for safety and compliance with various restrictions. Detecting physical impairment, such as an injury, is important for workers who require full physical capabilities to perform their duties. Mental impairment detection is important in potentially diagnosing patients with the early onset of mind debilitating conditions such as dementia and/or Alzheimer's disease. Detecting other impairments such as tiredness, distraction, and vestibular confusion play an important role for safety and compliance purposes. Improved method for effectively monitoring for the presence of impairment without being invasive would be welcome.

SUMMARY

(3) The present disclosure provides a new method of detecting impairment indicators using data from both a movement sensor and a biological sensor. The present invention provides for non-intrusive continuous detection of impairment indicators using multiple inputs. Upon detection of an

impairment indicator, a person may be required to perform further testing activities, thus reducing the overall need for and cost of types of impairment testing such as drug or alcohol screening. Impairment detection is also useful to proactively identify and mitigate potential safety situations. Identification and notification when an individual is impaired may reduce the amount of injuries or accidents that could occur otherwise. Additionally, using impairment detection for identifying diseases may lead to more effective treatment. Use of a biological sensor in combination with a movement sensor improves impairment detection by calibrating the device based on movement parameters with ranges of biological factors, which eliminates false positives in impairment detection.

(4) In one aspect, the present disclosure includes a method for monitoring impairment indicators. The method includes, during a first time window, measuring a first movement signal related to movement of the person with a movement sensor associated with the person, and measuring a first biological signal of the person with a biological sensor attached to the person. The method further includes electronically storing at least one numerical descriptor derived from the first movement signal and at least one numerical descriptor derived from the first biological signal as reference data for the person. The method includes during a second time window, measuring a second signal related to movement of the person with the movement sensor, and measuring a second biological signal of the person with the biological sensor. The method further includes comparing at least one numerical descriptor derived from the second signal and at least one numerical descriptor derived from the second biological signal to the reference data to identify an impairment indicator.

(5) In some embodiments, the first time window occurs during a training activity performed by the person.

(6) In some embodiments, the method further includes collecting location information and using the location information as a second factor to identify an impairment indicator.

(7) In some embodiments, the impairment indicator is indicative of at least one of mental impairment, visual impairment and physical impairment.

(8) In some embodiments, the biological sensor is at least one of an electrocardiography, electroencephalography, electromyography, galvanic skin response, pulse oximeter, pressure transducer, photo resister, and thermistor sensors.

(9) In some embodiments, the biological signal is at least one of heart rate, respiratory rate, body temperature, skin conductance, sweat rate, neural activity and muscle activity. In some instances, impairment includes at least one of physical injury, vestibular confusion, distraction and prohibited substance abuse.

(10) In some embodiments, the movement sensor is at least one of: an accelerometer, a gyroscope, a piezoelectric vibration sensor, a geographical positioning sensor and a magnetic switch.

(11) In some embodiments, the movement of the person during the first time window is walking.

(12) In some embodiments, when an impairment indicator is detected, at least one of a local alarm and a remote alarm is triggered.

(13) The present disclosure further includes a device for monitoring impairment indicators. The device includes a housing configured to be attached to a person; and a processing unit disposed in the housing comprising a processor, a movement sensor and a biological sensor. During a first time window, the movement sensor measures a first signal related to movement of the person and the biological sensor measures a first biological signal of the person. The processor stores at least one numerical descriptor derived from the first movement signal and at least one numerical descriptor derived from the first biological signal with the activity label as reference data for the person. During a second time window, the movement sensor measures a second signal related to movement of the person during a second time window and the biological sensor measures a second biological signal of the person. The processor compares at least one numerical descriptor derived from the second movement signal and at least one numerical descriptor derived from the second biological signal to the reference data as a factor to identify an impairment indicator.

(14) In some embodiments, the housing is one of: a safety garment, a harness, a head-worn piece, a device to be attached to a limb of the person or a device used by the person.
(15) In some embodiments, the device further includes a location module, and the processor is configured to estimate a location of the person using at least both of a signal from the movement sensor and data from the location module.
(16) In some embodiments, the device uses the location of the person as a second factor to identify an impairment indicator.
(17) In some embodiments, the impairment indicator is indicative of at least one of mental impairment, visual impairment and physical impairment.
(18) In some embodiments, the movement sensor is at least one of: an accelerometer, a gyroscope, a piezoelectric vibration sensor, a geographical positioning sensor and a magnetic switch.
(19) In some embodiments, the device of claim **11**, wherein the device comprises more than one movement sensor.
(20) In some embodiments, the movement of the person during the first time window is walking.
(21) In some embodiments, when an impairment indicator is detected, at least one of a local alarm and a remote alarm is triggered.
(22) In some embodiments, wherein the biological sensor is at least one of an electrocardiography, electroencephalography, electromyography, galvanic skin response, pulse oximeter, pressure transducer, photo resister, and thermistor sensors.
(23) In some embodiments, the biological signal is at least one of heart rate, respiratory rate, body temperature, skin conductance, sweat rate, neural activity and muscle activity.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) The following figures provide illustrations of the present invention. They are intended to further describe and clarify the invention, but not to limit scope of the invention.
(2) FIG. **1** is an example of a device for monitoring impairment indicators attached to a person.
(3) FIGS. **2***a* and **2***b* are examples of housings for a device for monitoring impairment indicators.
(4) FIG. **3** is a flow chart representing a method of monitoring impairment indicators.
(5) FIG. **4** is a block diagram of a device for monitoring impairment indicators.
(6) Like numbers are generally used to refer to like components. The drawings are not to scale and are for illustrative purposes only.
DETAILED DESCRIPTION
(7) FIG. **1** is an example of a device **10** for monitoring impairment indicators attached to a person's ankle **12**. Device **10** is attached to person's ankle **12** or other limb with strap **14**. The housing **16** for device **10** includes or contains a variety of components such as a processing unit **17**, including a processor, a movement sensor, and a biological sensor and a communication unit **18** for communicating wirelessly with an external device. The processing unit may also include a location unit for determination a location of the user of device **10**. A processor in the processing unit **17** may also include memory for storing data received from the movement sensor, numerical descriptors, reference data, and other necessary information to identify impairment indicators. The movement sensor may include at least one of a variety of sensors, including an accelerometer, gyroscope, piezoelectric vibration sensor, geographical positioning sensor and a magnetic switch. The biological sensor may include at least one of a variety of sensors, including electrocardiography, electroencephalography, electromyography, galvanic skin response, pulse oximeter, pressure transducer, photo resister, and thermistor sensors.
(8) A movement sensor may be configured to measure a signal related to movement of the person during a first time window. The movement sensor may collect data at a variety of rates, for

example, the rate may be in the range of one (1) Hz to sixty (60) Hz. The rate may be, for example, 5 Hz, 10 Hz, 20 Hz, 30 Hz, 40 Hz, 50 Hz or 60 Hz or more. The length of the time window may be any desired range. For example, a time window may be in the range of two (2) seconds to ten (10) seconds. A time window may be, for example, 2 seconds, 5 seconds, 6 seconds, 10 seconds, or more or less. The number of samples taken by a movement sensor in the device varies based on the length of the time window and the sampling rate. The number of samples may range, for example, from 8 to 1024 samples. A processor may then electronically store at least one numerical descriptor derived from the first movement signal as reference data for the person. The numerical descriptor may be represented as a scalar such as a voltage, current, power, or energy measurement.

(9) The biological sensor can be configured to measure a biological signal of the person during the first time window. The biological signal may be, for example, respiratory rate, body temperature, skin conductance, sweat rate, neural activity and muscle activity. The biological sensor may collect data at a variety of rates, for example, 0.5-150 Hz, but can be collected up to 2000 Hz or as just a DC signal. The biological sensor may collect that data during the same time window that the movement sensor is collecting data, or during a time window that differs in time or length from the movement sensor data collection. A processor may then electronically store at least one numerical descriptor derived from the first biological signal along with the numerical descriptor derived from the first movement signal as reference data.

(10) The movement sensor may then measure a second signal related to movement of the person during a second time window. The biological sensor may then measure a second signal related to person. The processor may then compare at least one numerical descriptor derived from the second movement signal and at least one numerical descriptor derived from the second biological signal to the reference data to identify an impairment indicator.

(11) In one configuration, the first time window occurs during a training activity performed by the person. In some embodiments training activity may include, but is not limited to, a person completing a series of prescribed or predetermined movements to establish baseline performance data. In another configuration, the first time window is during normal use of the device **10** by the person.

(12) Device **10** may also include other components such as a location unit that enables the device to receive satellite signals and determine location using, for example, GPS or the Global Navigation Satellite System (GLONASS) as discussed in U.S. Pat. No. 6,853,304 to Reisman et al., incorporated herein by reference. A location unit may use other location technologies such as triangulation using local WiFi signals or other known location technologies to estimate location of the activity recognition device **10**, and thereby the location of the person wearing the device.

(13) While device **10** is shown as having a housing of a device to be attached to a limb of the person, the housing may be a variety of embodiments. For example, the housing may also be a safety garment, safety equipment, a harness, a head-worn piece, and article of clothing or incorporated into a handheld or portable device to be used by the person such as a mobile phone.

(14) While the housing for device **10** shows the movement sensor, biological sensor, processor and other device components being located in close proximity to each other, in other housing configurations, the biological sensor, the movement sensor, or multiple biological or movement sensors, may be located in multiple locations in the housing, and located at a distance from other components, including being located at a distance from the processor and communication unit. In this configuration, the movement sensor and the biological sensor are still able to communicate with the other components through a wired or wireless communication connection.

(15) FIGS. **2***a* and **2***b* are examples of housings for a device for monitoring impairment indicators. FIG. **2***a* shows a high visibility safety vest **22**. Vest **22** is a typical component of personal protective equipment (PPE) for many occupations and tasks, including construction, mining, road work, and in other fields and contexts. Vest **22** ensures that the wearer can be easily seen by, for example, other workers, oncoming vehicles and drivers of equipment. Vest **22** may also be a housing for a

device for detecting impairment indicators. Movement sensors may be embedded at various locations in the vest, for example, at locations **24***a*, **24***b*, **24***c*, and **24***d*. The variety of locations allows for increased reliability of movement data. Biological sensors **21***a*, **21***b* and **21***c* can also be embedded within the vest **22**, or otherwise worn by the user. In some configurations, biological sensors may be worn around a user's wrist, chest, or in another location where the sensor is able to come into direct contact with the user's skin for accurate sensing of the particular biological parameter. Vest **22** may be designed to include a pocket or other holding mechanism to carry other components of an impairment monitoring device. Pocket **23** provides an exemplary accessible enclosure for components such as the processor, communication unit, battery and other components that may be enclosed in a single unit **25**. Unit **25** may communicate with movement sensors at locations **22***a*-**22***d* and biological sensors at **21***a*-**21***c* through a wired connection embedded or enclosed in vest **22**, or through a wireless connection.
(16) FIG. **2***b* shows a hard hat **26** that also includes ear protection. Hard hat **26** is an important piece of PPE that may be worn for many occupations and tasks, including construction, mining, road work, along with other fields and contexts. Hard hat **26** includes hearing protection muffs **27***a* and **27***b*. In some instances, muffs **27***a* and **27***b* may include noise cancellation capabilities and/or a speaker or other communication-related components. Hard hat **26** may be a housing for an impairment monitoring device. For example, movement sensors may be located at various locations **28***a*, **28***b*, and **28***c* throughout hardhat **26** to allow for increased movement data reliability. Biological sensors may be located at various locations throughout hardhat **26** such as at locations **21***d*, **21***e* and **21***f*.
(17) Hard hat **26** may have a unit **29** including components such as a processor, communication unit, battery, and other components that may be enclosed in a single unit **29**. Unit **29** may be in communication with movement sensors through a wired or wireless connection. In some instances, unit **29** is integrated into the structure of hard hat **26** and in other instances (as illustrated in FIG. **2***b*) it may be in a physically separate structure from hard hat **26**, and connected to the movement sensors embedded in hard hat **26** by a wired or wireless connection.
(18) FIG. **3** is a flow chart representing a method of monitoring impairment indicators. The method includes, in step **31** measuring, with a movement sensor attached to a person, a first signal related to movement of the person during a first time window and measuring a biological signal of the person with a biological sensor attached to the person during the first time window. The first movement signal and the first biological signal may include a variety of information. For example, the signals may be the output of a capacitive accelerometer measured as a scalar voltage. The signals may also be the output of a piezoelectric accelerometer measured as a scalar current or voltage. The time window may be any given period of time over which to measure the first signal. As described above, the time window may be in the range of two seconds to ten seconds, and may be between those numbers, shorter or longer. In some instances, the accelerometer may measure the first signal over multiple time windows to increase the sample size which increases the accuracy of the measurement. In other instances, multiple sensors may each measure a signal related to movement of the person or multiple sensors may each measure a signal related to a biological signal of the person over the same time window. The plurality of data sets may increase reliability of measurement.
(19) In some instances, the first time window occurs during a training activity performed by the person. A training activity may be completed through a series of prescribed motions while the device is placed into a special training mode. The training could be performed by an authorized trainer (e.g., a parole officer or a safety manager), and the trainer could show the person wearing the device a video instructing them on the types of movements to perform during the training period. After the training period is complete, the trainer returns the device to a normal monitoring mode.
(20) In other instances, the movement of the person during the first time window occurs during

their initial use of the impairment indicator device. In this case, the device begins detecting the movements of the person to capture the signals associated the user defined movement. The device then can detect anomalies when they are compared to previously detected signals. In some instances, the movement of the person during the first time window is walking, and in other instances, the movement may be another designated movement.

(21) In step **32**, the processor stores at least one numerical descriptor derived from each of the first movement signal and the first biological signal as reference data for the person. In some configurations, the processor may combine the first movement signal and the first biological signal to create a single numerical descriptor for the combined signal. The numerical descriptor is a number computed based on the data sampled from a signal measured by the movement sensor or by the biological sensor. The numerical descriptor for each of the movement signal and the biological signal may be based on a single measured signal or on multiple measured signals. For example, when the movement sensor detects inertial movement along three axes, the numerical descriptor may be calculated based on the data associated with one axis, any combination of two axes, a computation involving each of the three axes, or any combination thereof. The numerical descriptor may be determined for each data point related to the measured signal(s) or may be based on a lower sampling rate than the data from the measured signals. In some instances, two or more numerical descriptors may be associated with each time window.

(22) The numerical descriptor may be stored as reference data, forming a baseline for the particular type of movement for the individual. For example, when the activity performed by the person during the first time window is walking, the numerical descriptor for their activity during at least the first time window is compared to future collected data to identify indication of impairment of the person at that future time.

(23) In step **33**, the movement sensor measures a second signal related to movement of the person during a second time window and the biological sensor measures a second signal related to a biological signal of the person. The second time window may be chronologically adjacent to the first time window, or may be later in time. In some instances, the movement sensor and the biological sensor may measure the second signal over multiple time windows to increase the sample size to provide a broader sample set for comparison to reference data. In other instances, multiple sensors may each measure a signal related to movement of the person over the same time window. The plurality of data sets may increase reliability of measurement.

(24) In step **34**, the processor compares at least one numerical descriptor derived from the second movement signal and at least one numerical descriptor derived from the second biological signal to the reference data as a factor to identify an impairment indicator. In another embodiment, the movement signal and the biological signal may be combined such that a single numerical descriptor is derived from the combined signal and then compared with the reference data. If there is alignment (within a tolerance) between the numerical descriptor and the reference data, the processor identifies normal behavior. Alignment may be determined by a simple thresholding process and may also be determined by using a multi-dimensional classification algorithm, in which case multiple numerical descriptors would be required. In step **35**, the processor determines if a match exists between the two signals within a tolerance. If there are sufficient differences between the reference data and second signal and a match does not occur as defined in the “no” path of step **35**, then the processor identifies an impairment indicator as shown in step **36**. The parameters of detection of an impairment indicator can be tuned based on the application. Further, a tolerance may be tighter where accurate identification of impairment is critical or where there is a higher cost of impairment is mis-identified. An impairment indicator is indicative of at least one of mental impairment, visual impairment and physical impairment. These types of impairments may include specific impairments. For example, mental impairment includes at least distraction. Visual impairment includes at least prohibited substance abuse. And physical impairment includes at least physical injury and vestibular confusion.

(25) If a match exists between the two signals as identified in the "yes' path of step **35** or no impairment indicator is identified as defined in step **36**, the device continues to measure movement by returning to step **33**. If an impairment indicator is detected, the device stores that result and in some instances, at least one of a local alarm and a remote alarm is triggered. The device then continues to measure movement as shown in step **33**.
(26) FIG. **4** is a block diagram of a device **40** for monitoring impairment indicators. The device includes a processor **43**, a movement sensor **44** and a biological sensor **49**. Processor **43** may be any type of processor or microprocessor commonly used to process information or to control a variety of other electronic components. Processor **43** interacts with movement sensor **44** to receive data from movement sensor **44**, such as a signal related to the movement of the person wearing impairment monitoring device **40**. Movement sensor **44** may be configured to measure such a signal during a time window as defined by processor **43**. Processor **43** interacts with biological sensor **49** to receive data from biological sensor **49**. Such as a signal related to a biological signal of the person wearing impairment monitoring device **40**. Biological sensor **49** may be configured to measure such a signal during a time window as defined by processor **43**.
(27) Movement sensor **44** may be at least one of: an accelerometer, a gyroscope, a piezoelectric vibration sensor, a geographical positioning sensor and a magnetic switch. Movement sensor **44** may include more than one movement sensor. Movement sensor **44** measures a first signal related to movement of the person wearing impairment monitoring device **40** during a first time window. The processor **43** stores at least one numerical descriptor derived from the first signal as reference data for the person. In some embodiments, the processor **43** may store the reference data with an assigned activity label, such as walking, running, or biking.
(28) Biological sensor **49** may be at least one of: electrocardiography, electroencephalography, electromyography, galvanic skin response, pulse oximeter, pressure transducer, photo resister, and thermistor sensors. Biological sensor **49** may include more than one biological sensor. Biological sensor **49** measures a first signal related to a biological signal of the person wearing impairment monitoring device **40** during a first time window. The processor **43** stores at least one numerical descriptor derived from the first biological signal as reference data for the person.
(29) An exemplary time window may be in the range of 2 (two) seconds to 10 (ten) seconds and may contain a number of samples in the range of 8 (eight) to 1024 samples, as an example, not as a limitation. Each of biological sensor **49** and movement sensor **44** may also be configured to operate in a very low power mode where sampling takes place occasionally over a longer time period, for example, once every five minutes, when the individual is sleeping or doing some other sedentary and longer-term activity. In general, data collection by the movement sensor **44** or biological sensor **49** could range between 0.2 Hz and 50 Hz in frequency, but is not limited to previously defined range. The data collection frequency may be dependent upon the type of activity being detected. For example, faster moving activities, such as running, may require a higher sample rate (closer to 50 Hz) than slower moving activities such as sleeping. The size of a time window may also be related to data collection rate. A time window should have enough samples for the data collected to store as reliable reference data.
(30) Movement sensor **44** then measures a second signal related to movement of the person during a second time window and processor **43** compares at least one numerical descriptor derived from the second movement signal to the reference data to identify an impairment indicator. Comparison may include an algebraic sum or difference or other statistical variation such as mean, standard deviation, or variance. In an embodiment, the first signal (or reference data) may be a voltage represented numerically as 3.3 volts and the second signal may be recorded (also numerically) as a voltage of 1.3 volts. Processor **43** may compute the absolute difference between the first and second signal as 2.0 volts and determine whether the variation is above or below a threshold that indicates impairment and triggers an alarm.
(31) Biological sensor **49** then measures a second signal related to movement of the person during a

second time window and processor **43** compares at least one numerical descriptor derived from the second biological signal to the reference data to identify an impairment indicator.
(32) Movement sensor **44** and biological sensor **49** may either be contained in the same physical unit as processor **43** or may be connected to processor **43** in a wired or wireless configuration.
(33) Device **40** may further include a location unit **47**. The location unit **47** may be any device that provides an estimated geographical location for impairment monitoring device **40**. Examples of a location unit **47** include the following technologies: GPS, Cellular Triangulation, WiFi triangulation and GNSS. In some configurations, processor **43** may be configured to estimate a location of the person using at least both of the signal from the movement sensor and data from the location unit. In some configurations, device **40** may use the location of the person as estimated by location unit **47** as a second factor to identify an impairment indicator.
(34) Device **40** may also include a communications unit **46** to allow device **40** to communicate with external devices **48**. For example, when an impairment indicator is detected, a local alarm or a remote alarm in external device **48** may be triggered.
(35) While not shown in FIG. **4**, impairment monitoring device **40** may further include an emergency notification component. Emergency notification component may be triggered manually, such as by a button or switch. When emergency notification component is triggered, communication unit **46** may transmit information to external device **48**. External device **48** may be a central monitoring system, an emergency alert system, or other location. The information transmitted may include the location of device **40**, the time the emergency notification is transmitted, and the reason that the emergency notification is transmitted.
(36) The signal from the movement sensor **44** is a digital representation (for example, a number between 0 and 1023) of an analog voltage output from the sensor describing the motion
(37) The techniques of this disclosure may be implemented in a wide variety of computer devices, such as servers, laptop computers, desktop computers, notebook computers, tablet computers, hand-held computers, smart phones, and the like. Any components, modules or units have been described to emphasize functional aspects and do not necessarily require realization by different hardware units. The techniques described herein may also be implemented in hardware, software, firmware, or any combination thereof. Any features described as modules, units or components may be implemented together in an integrated logic device or separately as discrete but interoperable logic devices. In some cases, various features may be implemented as an integrated circuit device, such as an integrated circuit chip or chipset. Additionally, although a number of distinct modules have been described throughout this description, many of which perform unique functions, all the functions of all of the modules may be combined into a single module, or even split into further additional modules. The modules described herein are only exemplary and have been described as such for better ease of understanding.
(38) If implemented in software, the techniques may be realized at least in part by a computer-readable medium comprising instructions that, when executed in a processor, performs one or more of the methods described above. The computer-readable medium may comprise a tangible computer-readable storage medium and may form part of a computer program product, which may include packaging materials. The computer-readable storage medium may comprise random access memory (RAM) such as synchronous dynamic random access memory (SDRAM), read-only memory (ROM), non-volatile random access memory (NVRAM), electrically erasable programmable read-only memory (EEPROM), FLASH memory, magnetic or optical data storage media, and the like. The computer-readable storage medium may also comprise a non-volatile storage device, such as a hard-disk, magnetic tape, a compact disk (CD), digital versatile disk (DVD), Blu-ray disk, holographic data storage media, or other non-volatile storage device.
(39) The term “processor,” as used herein may refer to any of the foregoing structure or any other structure suitable for implementation of the techniques described herein. In addition, in some aspects, the functionality described herein may be provided within dedicated software modules or

hardware modules configured for performing the techniques of this disclosure. Even if implemented in software, the techniques may use hardware such as a processor to execute the software, and a memory to store the software. In any such cases, the computers described herein may define a specific machine that is capable of executing the specific functions described herein. Also, the techniques could be fully implemented in one or more circuits or logic elements, which could also be considered a processor.

(40) Variations on the disclosure described above will be apparent to one of skill in the art upon reading the present disclosure, and are intended to be included within the scope of the present disclosure. A wide range of activities may be detected in addition to those discussed explicitly herein, and are within the scope of the present disclosure. Further, a variety of analysis methods may be used consistent with the disclosed analysis steps and processes.

Claims

1. A method comprising: during a first time window, measuring a first movement signal related to movement of a worker with multiple movement sensors associated with the worker, and measuring a first biological signal of the worker with multiple biological sensors attached to the worker, wherein a processing unit is disposed in a housing, which is a high visibility safety vest that is a component of personal protective equipment (PPE), which ensures that the wearer can be easily seen by other workers, oncoming vehicles and drivers of equipment; the processing unit comprising a processor, a communication unit, the multiple movement sensors, and the multiple biological sensors; wherein the multiple movement sensors are located at a distance from each other and from the processor within the housing; wherein the housing includes a pocket that encloses the processor and communication unit, and wherein at least one of the multiple movement sensors and at least one of the multiple biological sensors are located on a right side of the vest and at least one of the multiple movement sensors and at least one of the multiple biological sensors are located on a left side of the vest; wherein the first time window occurs during a training activity comprising a series of prescribed movements performed by the worker, wherein the first movement signal and the first biological signal define normal behavior; electronically storing at least one numerical descriptor derived from the first movement signal and at least one numerical descriptor derived from the first biological signal as reference data for the worker; wherein an activity label defining a type of movement of the worker is stored with the at least one numerical descriptor derived from the first movement signal and the at least one numerical descriptor derived from the first biological signal; during a second time window, measuring a second movement signal related to movement of the worker with the multiple movement sensors, and measuring a second biological signal of the worker with the multiple biological sensors, wherein a sampling rate during the second time window of the multiple movement sensors and the multiple biological sensors is the same and is dependent on the type of activity being detected, and the size of the second time window for the multiple movement sensors and the multiple biological sensors is set based on the sampling rate to ensure having enough samples; comparing at least one numerical descriptor derived from the second movement signal and at least one numerical descriptor derived from the second biological signal to the reference data to identify an impairment indicator, which proactively identifies and mitigates potential safety situations; and wherein the communication unit enables communication of the processor with the multiple biological sensors and the multiple movement sensors.
2. The method of claim 1, further comprising collecting location information and using the location information as a second factor to identify the impairment indicator.
3. The method of claim 1, wherein the impairment indicator is indicative of at least one of mental impairment, visual impairment and physical impairment.
4. The method of claim 1, wherein the biological sensor is at least one of an electrocardiography,

electroencephalography, electromyography, galvanic skin response, pulse oximeter, pressure transducer, photo resister, and thermistor sensors.
5. The method of claim 1, wherein the biological signal is at least one of heart rate, respiratory rate, body temperature, skin conductance, sweat rate, neural activity and muscle activity.
6. The method of claim 1, wherein the multiple movement sensors are at least one of: an accelerometer, a gyroscope, a piezoelectric vibration sensor, a geographical positioning sensor and a magnetic switch.
7. The method of claim 1, wherein the movement of the worker during the first time window is walking.
8. The method of claim 1, wherein, when the impairment indicator is detected, at least one of a local alarm and a remote alarm is triggered.
9. A device comprising: a housing configured to be attached to a worker; wherein the housing is a high visibility safety vest that is a component of personal protective equipment (PPE), which ensures that the wearer can be easily seen by other workers, oncoming vehicles and drivers of equipment; a processing unit disposed in the housing comprising a processor, a communication unit multiple movement sensors, and multiple biological sensors; wherein the multiple movement sensors and multiple biological sensors are located at a distance from each other and from the processor within the housing; wherein the housing includes a pocket that encloses the processor and communication unit, and wherein at least one of the multiple movement sensors and multiple biological sensors are located on a right side of the vest and at least one of the multiple movement sensors and the multiple biological sensors are located on a left side of the vest; wherein during a first time window, the multiple movement sensors measure a first movement signal related to movement of the worker and the multiple biological sensors measure a first biological signal of the worker, wherein the first time window occurs during a training activity comprising a series of prescribed movements performed by the worker, wherein the first movement signal and the first biological signal define normal behavior; wherein the processor stores at least one numerical descriptor derived from the first movement signal and at least one numerical descriptor derived from the first biological signal as reference data for the worker; wherein an activity label defining a type of movement of the worker is stored with the at least one numerical descriptor derived from the first movement signal and the at least one numerical descriptor derived from the first biological signal; wherein, during a second time window, the multiple movement sensors measure a second movement signal related to movement of the worker during the second time window and the multiple biological sensors measure a second biological signal of the worker; wherein a sampling rate during the second time window of the multiple movement sensors and the multiple biological sensors is the same and is dependent on the type of activity being detected, and the size of the second time window for the multiple movement sensors and the multiple biological sensors is set based on the sampling rate to ensure having enough samples; wherein the processor compares at least one numerical descriptor derived from the second movement signal and at least one numerical descriptor derived from the second biological signal to the reference data as a factor to identify an impairment indicator, which proactively identifies and mitigates potential safety situations; and wherein the communication unit enables communication of the processor with the multiple biological sensors and the multiple movement sensors.
10. The device of claim 9, wherein the device further includes a location module, and wherein the processor is configured to estimate a location of the worker using at least both of a signal from the multiple movement sensors and data from the location module.
11. The device of claim 10, wherein the processor uses the location of the worker as a second factor to identify an impairment indicator.
12. The device of claim 9, wherein the impairment indicator is indicative of at least one of mental impairment, visual impairment and physical impairment.
13. The device of claim 9, wherein the multiple movement sensors are at least one of: an

accelerometer, a gyroscope, a piezoelectric vibration sensor, a geographical positioning sensor and a magnetic switch.

14. The device of claim 9, wherein the movement of the worker during the first time window is walking.

15. The device of claim 9, wherein, when the impairment indicator is detected, at least one of a local alarm and a remote alarm is triggered.

16. The device of claim 9, wherein the one or more biological sensors are at least one of an electrocardiography, electroencephalography, electromyography, galvanic skin response, pulse oximeter, pressure transducer, photo resister, and thermistor sensors.

17. The device of claim 9, wherein the biological signal is at least one of heart rate, respiratory rate, body temperature, skin conductance, sweat rate, neural activity and muscle activity.

18. The device of claim 9, wherein the impairment indicator indicates prohibited substance abuse.

19. The device of claim 9, wherein the at least one numerical descriptor derived from the first movement signal and the at least one numerical descriptor derived from the second movement signal represent voltage of a sensor.

20. The device of claim 9, wherein the multiple movement sensors are located symmetrically on opposite sides of the housing.