METHOD, SYSTEM AND DEVICE FOR MONITORING A SLEEP CONDITION IN USER

TECHNICAL FIELD

[0001] Embodiments of the present disclosure relate generally to computing system, and more specifically to method, system and device for monitoring a sleep condition in user.

BACKGROUND

[0002] Sleep is an important part of our daily routine, where people spend approximately one-third of their time. The quality of sleep and getting enough sleep at right times is essential as equivalent to food and water. Sleep is important and supports a number of brain functions, including how nerve cells (neurons) communicate with each other. Further, while sleeping, brain and body stay active and the brain removes toxins which accumulate when people are awake. Sleep affects almost every type of tissues and system in the body such as brain, heart, lungs, body metabolism, immune function, mood, and disease resistance.

[0003] Sleeplessness lead to loss of memory, poor concentration, and the brain cannot form or maintain links between neurons, which indeed helps us in learning or creating new memories. Further, chronic lack of sleep, or getting poor quality sleep, increases the risk of disorders such as high blood pressure, cardiovascular disease, diabetes, depression, and obesity. Nowadays, people undergo a less sleep condition which is primarily caused by age, poor lifestyle, work life balance, reduced social interactions, excessive use of mobiles, non-balanced food intake, non-exercising, psychological conditions (stress, anxiety etc) and general wellbeing issues.

[0004] Hence, there is a need and requirement to monitor the sleep condition in people, necessarily tracking whether the person is sleeping (deep or light) properly during the sleep time or awake (active). The following description provide a novel method, system and device for monitoring the sleep condition in user.

SUMMARY

[0005] In one aspect, a system to monitor a sleep condition, the system comprising, a wearable unit, when in operation, is configured to generate a first data, wherein the first data comprises a plurality of parameters associated with a user, an electronic device communicatively coupled to the wearable unit, wherein the electronic device is configured to: analyse each parameter of the plurality of parameters in the first data, monitor and detect a deviation in at least one of the parameters from a predefined range of subject parameter; and alert the user of detected deviation in the value of at least one of the parameters, indicative of a level of sleep condition, a first communication network communicatively coupled to the electronic device through a wearable unit, wherein the first communication network is configured to receive a second data

from the electronic device, and wherein the second data comprises a partially processed first data and a Global Positioning System (GPS) value associated with the GPS location of the user, a server communicatively coupled to the first communication network, wherein the server is configured to: analyse the second data received from the first communication network, invoke a status associated with the user, if the sleep condition is abnormal exceeds a threshold limit and generate an alert notification for the user based on the subject abnormal status of the user and a database communicatively coupled to the server, wherein the database is configured to store at least one of: the first data, and the second data of user.

DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a sleep monitoring system 100 in an embodiment of the present invention.

[0007] FIG. 2 illustrates the sensors 200 configured in the wearable unit 110.

[0008] FIG. 3 is a flowchart 300 illustrating the steps involved in monitoring the sleep condition in user through wearable unit.

[0009] FIG. 4A is a flowchart 400 illustrating the condition C1 of sleep algorithm in an embodiment of the present invention.

[0010] FIG. 4B is a flowchart 450 illustrating the condition C2 of sleep algorithm in an embodiment of the present invention.

[0011] FIG. 5A, 5B and 5C are example flowcharts describing the steps involving the detection of sleep condition in user, identification of variation in sleep data and filtering the sleep data in an embodiment of the present invention.

[0012] FIG. 6 is a flowchart 600 illustrating sleep filtering algorithm when the start minute of sleep is determined from the start hour of sleep in an embodiment of the present invention.

[0013] FIG. 7 is a flowchart 700 illustrating sleep filtering algorithm when the end minute of sleep is determined from the end hour of sleep in an embodiment of the present invention.

[0014] FIG. 8 illustrates the example table of sleep data represented in 0, 1 and 2 received from the wearable unit.

DETAILED DESCRIPTION OF THE PREFERRED EXAMPLES

[0015] FIG. 1 is a sleep monitoring system 100 in an embodiment of the present invention. The figure is shown comprising components that include a wearable unit 110, an electronic device 120, a first communication network 130, an application server 140 and a database 150. The following paragraphs describe the above components in detail.

[0016] The wearable unit 110, when in operation, is configured with one or more sensors to generate a first data. The first data comprises a plurality of parameters associated with the user.

The wearable unit 110 which is worn by the user is connected to the electronic device 120, through a second communication network (not shown), for example, Bluetooth or BLE.

[0017] The wearable unit 110 covers the wrist portion of hand wherein which consists of one or more sensors to primarily monitor the hand actions of the user, heart rate of the user, or activity of the user etc. In an embodiment, the wearable unit 110 may be a t-shirt, wherein the chest portion of t-shirt having an electronic module and set of sensors (for example, heart rate sensor) to detect and monitor heart rate of the user. The sensors include a heart rate monitoring sensor or wrist oximeter, tri axial accelerometer, a gyroscope, and a GPS module.

[0018] In another embodiment, one or more similar type of sensors is used to accurately detect any movement, and appropriately capture and record the variation during the activities. The heart rate monitoring sensor records the heart rate of the user, during any activity such as walking, running, jogging and so forth. The wearable unit is configured to monitor the sleep of the user, by analyzing the sensor values, change in values, and variation or difference in values obtained through the one or more sensors. The variation in sensor values, is basically able to determine a 'state' (condition) whether the user is in light sleep, deep sleep or awake. The sensors such as tri axial accelerometer and gyroscope are employed and values from them are used to identify a pattern and to determine the current condition (light sleep, deep sleep or awake) of user. The data received from these sensors are put in a machine learning algorithm, so as to accurately identify the change in sensor values and its reflection in condition of user.

[0019] The tri axial accelerometer provides dynamic output in three orthogonal planes simultaneously (X, Y, & Z), in reference to all of the vibrations being experienced by a structure. Each unit incorporates three separate sensing elements that are oriented at right angles with respect to each other. Gyroscope used for measuring or maintaining orientation and angular velocity. Oximeter is a small device to measure the proportion of oxygenated hemoglobin in the blood. GPS sensor is used to determine the location information of the user.

[0020] The tri axial accelerometer and gyroscope records the sleep conditions of user, such as deep sleep or light sleep and active. In another embodiment, the wearable unit 110 transmits a first data from one or more sensors to the mobile device 120 for further processing. The first data includes accelerometer data, gyroscope data, heart rate and GPS data. The mobile device 120 is configured with an application to receive and read the first data from the wearable 110. The mobile application process and analyze the first data with one or more algorithms and methods to find sleep pattern and any change in pattern of sleep.

[0021] The sleep data of the user is typically analyzed to determine average sleep time, duration of deep sleep, light sleep and active (awake). Further, to analyze the heart rate during such

sleep condition. The sleep data varies person to person. In one embodiment, the user may schedule a convenient sleep time in the mobile application, for example, 10pm to 6am. The wearable may monitor the sleep activity only during such preconfigured time. In another embodiment, the wearable unit may schedule a sleep time and monitor the sleep activity of user based on the data relating to the past sleep activity of the user.

[0022] The tri axial accelerometer detects magnitude and direction of the proper acceleration as 'vector quantity', sense orientation (change in direction of weight), co-ordinate acceleration, vibration, shock, and falling in a resistive medium. In an embodiment, the data values from tri axial accelerometer is identified and termed as 'awake' value, 'light sleep' value and 'deep sleep' value based on or more differentiation in values. The awake, light sleep and deep sleep values may vary depending on the type and make of wearable unit. However, the mobile device receives the values in the format 'awake' value, 'light sleep' value and 'deep sleep' value.

[0023] In another embodiment, the data from tri axial accelerometer may be denoted in the form of 0, 1 and 2, whereas, 0 denotes 'active or awake' state, 1 denotes 'light sleep' state and 2 denotes 'deep sleep' state. The server is configured to invoke a status associated with the user, if the sleep condition is abnormal and exceeds a threshold limit and generate an alert notification for the user based on the subject abnormal status of the user.

[0024] FIG. 2 illustrates the sensors 200 configured in the wearable unit 110. The sensors include a tri axial accelerometer 210, a gyroscope 220, a heart rate sensor or wrist oximeter 230 and a GPS 240.

[0025] FIG. 3 is a flowchart 300 illustrating the steps involved in monitoring the sleep condition in user through wearable unit. In step 310, the wearable unit monitors and records one or more user actions/activities through one or more sensors configured, between time 19:00 to 11:00 hrs. In an embodiment, the wearable unit monitors the user actions, for 24 hours for example 12:00PM to 11:59AM. In step 320, the wearable unit analyzes and retrieves the tri-axial accelerometer data for said one or more actions. In an embodiment, the tri-axial accelerometer is capable of recoding the log data of any activity such as walking, running, sleeping etc. In step 330, the wearable unit further determines and allocate a unit (0, 1, 2) for accelerometer data log recorded in reference to movement during the sleep activity. In an embodiment, the wearable unit transmits the accelerometer data to the electronic device. In step 340, the electronic device organizes the identified units into a pattern of values (in 0, 1 and 2), through one or more filtering techniques for the time between 19:00PM and 11:00AM. In step 350, the electronic device determines at least three activities awake, light sleep, and deep sleep matching the pattern of values 0, 1 and 2. The wearable unit, mobile device, application

server, employs an algorithm which involves two main conditions C1 and C2, in which should be satisfied to determine the sleep data of user.

[0026] FIG. 4A is a flowchart 400 illustrating the condition C1 of sleep algorithm in an embodiment of the present invention. As shown there, the processing unit of application server is capable of implementing, formulating one or more algorithms and analyzing the sleep data of user to determine the sleep condition in a user. The sleep conditions are differentiated into awake (or active), light sleep and deep sleep states. The wearable unit collects the sleep data of the user and send to the application server through the connected mobile device of user. In an embodiment of the sleep data in application server is processed at the processing unit, stored in the subject user profile in the database. In step of 405, processing unit of application server retrieves the sleep data relating to awake, light sleep and deep sleep, from the database. In an embodiment, the data which is collected by the sensors in wearable unit is represented by 0, 1, and 2 against awake, light sleep and deep sleep states (sleep conditions) respectively. In step of 410, the processing unit of application server, after obtaining the data, checks for the time stamp and availability of the data in a time range, that is, whether the hour to check the sleep data is between the 23:00 and 5:00. If the hour is between 23:00 and 5:00, then the control is transferred to step 415, otherwise, the control is transferred to step 425. In an embodiment, the processing unit is capable of differentiating the sleep data in to ‘awake’ value, ‘light sleep’ value and ‘deep sleep’ value and counts when the presence of any such value is present in an hour (the hour between 23:00 and 5:00).

[0027] In step of 415, processing unit of application server checks whether the count of ‘light sleep’ value in current hour is greater than or equal to 15. If the count of ‘light sleep’ value is greater than or equal to 15, then the control is transferred to step 430, otherwise, the control is transferred to step 420.

[0028] In step of 420, processing unit of application server checks two sub conditions, wherein, the first sub condition is to check whether the count of ‘light sleep’ value in current hour is greater than or equal to ‘0’ mins. Wherein, the second sub condition is to check whether the count of ‘light sleep’ value in previous hour (current hour-1) is greater than or equal to 15, along with satisfying the condition C2. When, sleep data satisfies these two sub conditions combinedly are true, then the control is transferred to step 430, otherwise, the control is transferred to step 435. In step of 425, processing unit of application server checks whether count of ‘light sleep’ value in current hour is greater than or equal to 15, if it greater than 15, then the control is transferred to step 430, otherwise, the control is transferred to step 435.

[0029] In step of 430, the processing unit of application server confirms that the condition C1 is true and satisfied and relevant sleep data is present in the hours (for example, current hour and previous hour) analyzed by the processing unit. In step of 435, the processing unit of application server ends the algorithm, since none of the steps in validating the condition C1 is satisfied.

[0030] FIG. 4B is a flowchart 450 illustrating the condition C2 of sleep algorithm in an embodiment of the present invention. In step of 455, processing unit of application server retrieves the sleep data relating to awake, light sleep and deep sleep, from the database, in order to check the steps relating to condition C2. In step of 460, the processing unit of application server, after obtaining the data, checks for the time stamp and availability of the data in a time range, that is, whether the hour to check the sleep data is between the 23:00 and 5:00. If the hour is between 23:00 and 5:00, then the control is transferred to step 465, otherwise, the control is transferred to step 470. In step of 465, processing unit of application server checks whether the count of 'awake' value (active state), in current hour is less than or equal to '20' mins. If the value is less than or equal to 20 mins, then the control is transferred to step 475, otherwise the control is transferred to step 480.

[0031] In step of 470, processing unit of application server checks whether the count of 'awake' value (active state), in current hour is less than or equal to '15' mins. If the value is less than or equal to 15 mins, then the control is transferred to step 475, otherwise the control is transferred to step 480.

[0032] In step of 475, the processing unit of application server confirms that the condition C2 is true and satisfied and relevant sleep data is present in the hours (for example, current hour) analyzed by the processing unit. In step of 480, the processing unit of application server ends the algorithm, since none of the steps in validating the condition C2 is satisfied.

[0033] FIG. 5A, 5B and 5C are example flowcharts describing the steps involving the detection of sleep condition in user, identification of variation in sleep data and filtering the sleep data in an embodiment of the present invention. FIG. 5A illustrate the example first section of sleep algorithm flowchart 500 in an embodiment of the present invention. As shown there, in step of 502, processing unit of application server retrieves the sleep data relating to awake, light sleep and deep sleep, from the database, in order to identify the sleep and intensity of sleep. In step of 504, processing unit of application server counts the 'light sleep' value in each hour between 19:00 to 11:00. In step of 506, processing unit of application server finds the hour with highest 'light sleep' value, between hours 22:00 to 06:00. In step of 508, processing unit of application

server checks whether multiple hours have highest ‘light sleep’ value, if it is found, then the control is transferred to step 510, otherwise, the control is transferred to step 512.

[0034] In step of 510, processing unit of application server selects the first hour with highest ‘light sleep’ value and mark that hour as ‘Hour with Highest Light Sleep’ values (HWHLS).

[0035] In step of 512, processing unit of application server selects the hour with highest ‘light sleep’ value and mark that hour as ‘Hour with Highest Light Sleep’ values (HWHLS). In step of 514, processing unit of application server checks whether the count of ‘light sleep’ value in HWHLS is less than 15. If it is less than 15, then the control is transferred to step 516, otherwise, the control is transferred to step 518.

[0036] In step of 516, processing unit of application server identifies that there is no sleep data is found for entire day and ignores all sleep data, with respect to that day. In step of 518, processing unit of application server parse backwards hour wise from HWHLS.

[0037] FIG. 5B illustrate the example second section of sleep algorithm flowchart 540, wherein, the sleep data is analyzed backwards hour wise from HWHLS. As shown there, the application server first determines the hour with maximum light sleep value and mark that hour as a reference hour to perform validation of sleep data, for other hours. In step of 542, processing unit of application server parse backwards hour wise from HWHLS. In step of 544, processing unit of application server checks whether condition 1 and 2 are true, if both conditions are true, then the sleep data is detected in the previous hour and control is transferred to step 546, otherwise, the control is transferred to step 548.

[0038] In step of 546, processing unit of application server confirms and marks that sleep is detected in the current hour. In step of 548, processing unit of application server processing unit of application server checks whether, count of ‘light sleep’ value in the current hour is greater than or equal to 5, if it greater than or equal to 5, then the control is transferred to step 550, otherwise, the control is transferred to step 552.

[0039] In step of 550, processing unit of application server marks the current hour when the condition is satisfied as ‘start hour of sleep’. Then, the control is transferred to step 562. In step of 552, processing unit of application server marks the hour as ‘start hour of sleep’, where count of ‘light sleep’ value is greater than or equal to 5 is last succeeded. The control is transferred to step 562.

[0040] FIG. 5C illustrate the example third section of sleep algorithm flowchart 560, wherein, the sleep data is analyzed ahead hour wise from HWHLS. As shown there, in step of 562, processing unit of application server parse ahead hour wise from HWHLS. In step of 564, processing unit of application server checks whether condition 1 and 2 are true, if both

conditions are true, then the sleep data is detected in the previous hour and control is transferred to step 566, otherwise, the control is transferred to step 568.

[0041] In step of 566, processing unit of application server confirms and marks that sleep is detected in the current hour. In step of 568, processing unit of application server processing unit of application server checks whether, count of 'light sleep' value in the current hour is greater than or equal to 5, if it greater than or equal to 5, then the control is transferred to step 570, otherwise, the control is transferred to step 572.

[0042] In step of 570, processing unit of application server marks the current hour when the condition is satisfied as 'end hour of sleep'. Then, the control is transferred to step 574. In step of 572, processing unit of application server marks the hour as 'end hour of sleep', where count of 'light sleep' value is greater than or equal to 5 is last succeeded. The control is transferred to step 574. In step 574, the processing unit of application server ends the algorithm since, one or more steps of the algorithms are satisfied.

[0043] FIG. 6 is a flowchart 600 illustrating sleep filtering algorithm when the start minute of sleep is determined from the start hour of sleep in an embodiment of the present invention. As shown there, in step 605 of, processing unit of application server takes the start hour of sleep determined from the previous steps of sleep algorithm.

[0044] In step 610 of, processing unit of application server check whether last transition of 'awake' to 'light sleep' value is found in start hour. If it is found, then the control is transferred to 615, otherwise, the control is transferred to step 620. In step 615 of, processing unit of application server marks the minute transition from 'awake' to 'light sleep' value as 'start minute of sleep'.

[0045] In step 620 of, processing unit of application server check whether last transition of 'awake' to 'deep sleep' value is found in start hour. If it is found, then the control is transferred to 625, otherwise, the control is transferred to step 630. In step 625 of, processing unit of application server marks the minute transition from 'awake' to 'deep sleep' as 'start minute of sleep'.

[0046] In step 630 of, processing unit of application server check whether minute of first 'light sleep' is found in start hour. If it is found, then the control is transferred to 635, otherwise, the control is transferred to step 640. In step 635 of, processing unit of application server marks the minute of first 'light sleep' as 'start minute of sleep'. In step 640 of, processing unit of application server marks the 59th minute of start hour as 'start minute of sleep'.

[0047] FIG. 7 is a flowchart 700 illustrating sleep filtering algorithm when the end minute of sleep is determined from the end hour of sleep in an embodiment of the present invention. As

shown there, in step 705 of, processing unit of application server takes the end hour of sleep determined from the previous steps of sleep algorithm.

[0048] In step 710 of, processing unit of application server checks whether last transition of 'light sleep' to 'awake' value is found in end hour. If it is found, then the control is transferred to step 715, otherwise, the control is transferred to step 720. In step 715 of, processing unit of application server mark the minute transition from 'light sleep' to 'awake' value in the end hour as 'end minute of sleep'.

[0049] In step 720 of, processing unit of application server checks whether last transition of 'deep sleep' to 'awake' value is found in end hour. If it is found, then the control is transferred to step 725, otherwise, the control is transferred to step 730. In step 725 of, processing unit of application server marks the minute transition from 'deep sleep' to 'awake' value in end hour as 'end minute of sleep'.

[0050] In step 730 of, processing unit of application server checks whether minute of first 'awake' is found in end hour. If it is found, then the control is transferred to step 735, otherwise, the control is transferred to step 740. In step 735 of, processing unit of application server marks the minute of first 'awake' value in end hour as 'end minute of sleep'.

[0051] In step 740 of, processing unit of application server check whether minute of last 'light sleep' value is found in end hour. If it is found, then the control is transferred to step 745, otherwise, the control is transferred to step 750. In step 745 of, processing unit of application server marks the minute of last 'light sleep' value in end hour as 'end minute of sleep'. In step 750 of, processing unit of application server marks the 0th minute of end hour as 'end minute of sleep'.

[0052] FIG. 8 illustrates the example table of sleep data represented in 0, 1 and 2 received from the wearable unit. As shown there, the table is given with respect to the hour and minutes and the sleep data is related to awake (0), light sleep (1) and deep sleep (2). In an embodiment, the data is hour wise (0^{th} minute to 59^{th} minute) sleep data for the entire day of the user. In one example, the wearable unit monitors and records the sleep data between 12PM to 6AM. Following example embodiment describe one or more sleep related algorithms wherein which the start and end hour of sleep and start and end minute of sleep of user, is accurately determined by the processing unit of application server.

[0053] In an embodiment, the processing unit of application server is capable of differentiating the awake, light sleep and deep sleep values in the sleep data and capable of counting those values for further processing. As shown there, the values of awake, light sleep and deep sleep are displayed for each and every hour in the form of 0, 1 and 2. As per the algorithm, the

processing unit retrieve all sleep data relating to awake, light sleep and deep sleep. In the next step, the processing unit counts the 'light sleep' value in each hour between 19:00 to 11:00. Further, the processing unit find the hour with highest 'light sleep' value, between hours 22:00 to 06:00. Here, the hour with highest 'light sleep' value is 0^{th} hour (0AM-1AM), which has a maximum of 60 'light sleep' value. Hence, the 0^{th} hour is termed as Hour with highest light sleep values (HWHLS). After that, the processing unit also checks for the number of counts of 'light sleep' value in HWHLS, in order to further proceed with the analysis and calculation. In one example, the number of counts of 'light sleep' value in HWHLS should be more than 15, if it is less than 15, then the entire sleep data is ignored by the processing unit for the entire day and stops the further calculation. Then, the sleep data is analyzed and parsed backwards and ahead to determine start and end hour of sleep by the user. While parsing backwards and ahead, the values and counts of 'light sleep', 'deep sleep' and 'awake' are continuously checked. Then, the condition C1 and C2 are checked for the sleep data between 23:00 and 05:00 and to analyze whether any change in data is pattern is observed, and only when C1 and C2 are true, then the sleep data is valid and can be further processed.

[0054] The condition C1 is true only when, the count of 'light sleep' value in current hour is greater than or equal to 15 and also, when the count of 'light sleep' value in current hour is greater than or equal to '0' mins AND in the previous hour (current hour -1), the count of 'light sleep' value is greater than or equal to 15 AND Condition C2 is true. When, the data is analyzed other than between 23:00 and 05:00, C1 becomes true, when, the count of 'light sleep' value in current hour is greater than or equal to 15. The condition C2 is true only when, the count of 'awake' value in current hour is less than or equal to '20' if the current hour is between 23:00 and 05:00, and, the count of 'awake' value in current hour is less than or equal to '15' when the current hour is beyond 23:00 and 05:00. The parsing of sleep data backwards is used to determine the start hour and start minute of the sleep. In the current example, the processing unit parse backwards from HWHLS and identifies that hour 22:00 (which is 22:00 and 23:00) is the start hour of sleep. Further, the parsing the sleep data ahead is used to determine the end hour and end minute of the sleep. The processing unit parse ahead from HWHLS and identifies that hour 06:00 (which is 06:00 and 07:00) is the end hour of sleep. From start and end hour of sleep, the start and end minute of sleep is determined. To determine start minute of sleep, start hour of sleep is considered and analyzed for one or more conditions, in the current example, the transition from awake to light sleep (that is transition from 0 to 1) is identified at 18^{th} minute of hour 23:00 (start hour), so the start hour and minute of sleep is 23:18. Similarly, to determine end minute of sleep, end hour of sleep is considered and analyzed for one or more conditions,

in the current example, the transition from light sleep to awake (that is transition from 1 to 0) is identified at 50th minute of hour 06:00 (end hour), so the end hour and minute of sleep is 06:50. The total duration of sleep is the difference between the time at which the user awakes from sleep and time at which the user falls into sleep. In this example, the total sleep time (duration) of the user is 07 hours and 32 minutes. In the similar way, the sleep duration of each and every user of the network is determined and average sleep data is calculated for a week, bimonthly, monthly, quarterly, half yearly and yearly, to identify and check whether the user is having a proper sleep or not. There are several optimal sleep ranges calculated based on sleep duration and age.

[0055] The application server employs all sleep ranges and asks the user to feed the stress level (or fatigue data), and heart rate of the user. In an embodiment, the wearable unit through the values from the one or more configured sensors, is also capable of recording, and helps in determining the stress level (fatigue data) and heart rate of user. In an embodiment, the application server is configured to analyze stress level, heart rate, sleep data (for example, e sleep data over a period of time) and to determine one or more medical conditions of user, for example, chronic sleep deprivation, insomnia etc. The application server through, the wearable unit, also informs and notifies the user to take the enough sleep in a day, and capable of marking the sleep data every day for the user along with the average stress level (fatigue data) and average heart rate of user for the current day.

[0056] In one aspect of the present invention, a system for monitoring a sleep condition comprising, a wearable unit, an electronic device, a first communication network, an application server and a database. The wearable unit which is worn by the user, is capable of recording the activities performed by the user, through one or more sensors and further configured to generate a first data, wherein, the first data comprises a plurality of parameters associated with activities performed by the user. In an embodiment, the sensors may be at least one of, accelerometer (or tri-axial accelerometer), gyroscope and so on. The electronic device communicatively coupled to the wearable unit, wherein the electronic device is configured to, analyse each parameter of the plurality of parameters in the first data, monitor and detect a deviation in at least one of the parameters from a predefined range of subject parameter and alert and notify the user of detected deviation in the value of at least one of the parameters, indicative of a level of sleep condition. The first communication network communicatively coupled to the electronic device and the application server, wherein the first communication network is configured to transmit a second data from the electronic device to the application server, and further the second data comprises a partially processed first data and a Global

Positioning System (GPS) value associated with the GPS location of the user. The application server communicatively coupled to the first communication network, wherein the application server is configured to, analyse the second data received from the first communication network, invoke a status associated with the user, if the sleep condition is abnormal exceeds a threshold limit and generate an alert notification for the user based on the subject abnormal status of the user and the database communicatively coupled to the application server, wherein the database is configured to store at least one of the first data, the second data and one or more user details.

[0057] In an embodiment, the electronic device is a mobile device of the user, wherein which analyses each parameter of the plurality of parameters in the first data and detect the deviation by identifying an abnormal sleep condition in the value with respect to the predefined range of the sleep. In an embodiment, the sleep condition or state are identified as awake (or active), light sleep and deep sleep. The values relating to one or more sleep conditions are analysed and any change in sleep pattern is monitored and identified by the electronic device or by the application server. In an embodiment, the parameters of the first data are a tri-axial accelerometer data and heart rate exertion of the user. In another embodiment, the wearable unit is capable of identifying a fatigue condition (or a stress condition) in the user through the one or more sensor data. In yet another embodiment, the electronic device is capable of identifying the pattern in tri-axial accelerometer data values and determining a sleep data as ‘awake’, ‘light sleep’ and ‘deep sleep’ within a specific time interval (or sleep time) set by the user.

[0058] In an embodiment, the application server with the help of database is capable of monitoring sleep conditions of one or more users of the network. The processing unit of application server is capable of determining a sleep condition of user by analyzing the sleep data of subject user, and by implementing one or more algorithms and related calculations. The processing unit further alerts the user (through the wearable unit or mobile device) when the subject user does not have a proper sleep in a day. In another embodiment, the mobile device is configured a mobile application which may monitor the activities of user through the wearable unit and also transmits relevant sleep data and other sensor data to the application server, for further processing. The database stores the user profiles of all users of the system or network of users. The user profile data include at least one of name, age, height, weight, sleep data, heart rate data, fatigue data, stress level, blood pressure, blood group etc.

[0059] In another aspect of the present invention, a method to identify a sleep condition and maximum sleep hour comprising, receiving and identifying a tri- axial accelerometer data in the form of units or values or log values from the wearable unit, counting number of ‘awake’,

'light sleep' and 'deep sleep' values in tri- axial accelerometer data, for each hour between 19:00 to 11:00 hours, identifying the hour with highest number of 'light sleep' value between 22:00 to 06:00 hours, checking the hours between 22:00 to 06:00 for the highest count of 'light sleep' value, selecting the hour having the highest number of 'light sleep' value and marking subject hour as Hour with Highest Light Sleep (HWHLS) and parsing backwards AND ahead from as Hour with Highest Light Sleep (HWHLS) till conditions C1 and C2 are true and satisfied. The method further comprises, selecting the first hour with highest number of 1's, when, multiple hours between 22:00 to 06:00 hours have highest number of 'light sleep' values, marking the subject hour as hour as Hour with Highest Light Sleep and parsing backwards AND ahead from 'Hour with Highest Light Sleep' till conditions C1 and C2 are true and satisfied. In an embodiment, the hour with highest number of 'Light Sleep' value at least has a total value of 15. In another embodiment, a method for identifying sleep condition when parsing backwards from hour with highest Ones comprising, identifying total count of awake, light sleep, deep sleep values in previous hours from HWHO till 23:00 hours, identifying and checking whether the count of 'awake' values in current hour is less than or equal to 20 mins or 15 mins, when the current hour is between 23:00 hours to 05:00 hours and marking the subject current hour as 'Sleep'.

[0060] 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. Thus, the breadth and scope of the present disclosure should not be limited by any of the above-discussed embodiments but should be defined only in accordance with the following claims and their equivalents.

CLAIMS

We claim:

1. A system to monitor a sleep condition, the system comprising:
   - a wearable unit, when in operation, is configured to generate a first data, wherein the first data comprises a plurality of parameters associated with a user;
   - a electronic device communicatively coupled to the wearable unit, wherein the electronic device is configured to:
   - analyse each parameter of the plurality of parameters in the first data;
   - monitor and detect a deviation in at least one of the parameters from a predefined range of subject parameter; and
   - alert the user of detected deviation in the value of at least one of the parameters, indicative of a level of sleep condition;
   - a first communication network communicatively coupled to the electronic device through a wearable unit, wherein the first communication network is configured to receive a second data from the electronic device, and wherein the second data comprises a partially processed first data and a Global Positioning System (GPS) value associated with the GPS location of the user;
   - a server communicatively coupled to the first communication network, wherein the server is configured to:
     - analyse the second data received from the first communication network;
     - invoke a status associated with the user, if the sleep condition is abnormal exceeds a threshold limit; and
     - generate an alert notification for the user based on the subject abnormal status of the user; and
   - a database communicatively coupled to the server, wherein the database is configured to store at least one of: the first data, and the second data of user.
2. The system as claimed in claim 1, wherein the electronic device analyses each parameter of the plurality of parameters in the first data and detect the deviation by identifying an abnormal sleep condition in the value of at least one of the parameters from the predefined range of the parameter.
3. The system as claimed in claim 2, wherein, parameters of the first data are a tri-axial accelerometer data and heart rate exertion of the user.

4. The system as claimed in claim 3, wherein, the electronic device is capable of identifying the pattern in tri-axial accelerometer data values and determining a sleep data as ‘awake’, ‘light sleep’ and ‘deep sleep’ within a specific time interval configured by the user.
5. The system as claimed in claim 1, wherein the plurality of parameters of the first data includes at least one of: a tri-axial accelerometer data, heart rate exertion of the user, a pace and steps of the user.
6. The system as claimed in claim 3, wherein the mobile device is configured to determine the sleep condition of the user by calculation of a light sleep, deep sleep and awake status of the user in a specific time period.
7. A method for identifying a sleep condition in a user comprising:
   monitoring and recording one or more user actions through one or more sensors configured in the wearable unit, between time 19:00 hrs to 11:00 hrs;
   analysing and retrieving the tri axial accelerometer data for said one or more actions;
   determining and allocating a value for tri-axial accelerometer data, in reference to the user’s state of activity every hour;
   organizing and arranging the obtained values; and
   determining at least three conditions from the pattern of values.
8. A method for identifying a sleep condition in user and to determine start and end hour of sleep comprising:
   receiving and identifying a tri- axial accelerometer data in the form of values or log values from the wearable unit;
   counting number of ‘awake’, ‘light sleep’ and ‘deep sleep’ values in tri- axial accelerometer data, for each hour between 19:00 to 11:00 hours;
   identifying the hour with highest number of ‘light sleep’ value between 22:00 to 06:00 hours;
   checking the hours between 22:00 to 06:00 for the highest count of number ‘light sleep’ value;
   selecting the hour having the highest number of ‘light sleep’ value and marking subject hour as Hour with Highest Light Sleep (HWHLS) values; and
   parsing backwards AND ahead from as Hour with Highest Light Sleep (HWHLS) till conditions C1 and C2 are satisfied.
9. The method of claim 8, further comprising:
   selecting the first hour with highest number of 1’s, when, multiple hours between 22:00 to 06:00 hours have highest number of ‘light sleep’ values;

marking the subject hour as hour as Hour with Highest Light Sleep; and

parsing backwards AND ahead from 'Hour with Highest Light Sleep' till conditions C1 and C2 are true and satisfied.

10. The method of claim 8, wherein, the hour with highest number of 'Light Sleep' value at least has a total value of 15.
11. The method of claim 8, further comprising:

identifying total count of awake, light sleep, deep sleep data values in previous hours from HWHLS till 23:00 hours, while parsing backwards;

identifying total count of awake, light sleep, deep sleep data values in previous hours from HWHLS till 05:00 hours, while parsing ahead;

12. The method of claim 11, further comprising:

identifying the count of 'awake' values in current hour is less than or equal to 20 mins or 15 mins.

13. The method of claim 11, further comprising:

checking the count of 'light sleep' value in current hour, is greater than or equal to 15; and

checking the count of 'light sleep' value in current hour, is greater than or equal to 0 mins AND count of 'light sleep' value in the previous hour, is greater than or equal to 15.

14. A method for identifying a sleep condition in user and to determine start minute of sleep comprising:

obtaining the sleep data relating to start hour of sleep;

identifying and marking a 'start minute of sleep' only when at least one minute transition from 'awake' to 'light sleep', 'awake' to 'deep sleep';

15. The method of claim 14, further comprising:

identifying and marking a minute of first 'light sleep' as a 'start minute of sleep' when the minute of light sleep is found in the start hour.

16. The method of claim 14, further comprising:

identifying and marking a 'start minute of sleep' as 59^{th} minute of start hour when no transition from 'awake' to 'light sleep' or 'awake' to 'deep sleep' or minute of first 'light sleep; is found.

17. A method for identifying a sleep condition in user and to determine end minute of sleep comprising:

obtaining the sleep data relating to end hour of sleep;

identifying and marking a 'end minute of sleep' only when at least one minute transition from 'light sleep' to 'awake', 'deep sleep' to 'awake';

18. The method of claim 17, further comprising:

    identifying and marking a minute of first ‘awake’ as a ‘end minute of sleep’ when the minute of awake is found in the end hour.

19. The method of claim 17, further comprising:

    identifying and marking a minute of last ‘light sleep’ as a ‘end minute of sleep’ when the minute of last light sleep is found in the end hour.

20. The method of claim 17, further comprising:

    identifying and marking a 0^{th} minute as a ‘end minute of sleep’ when no transition from ‘light sleep’ to ‘awake’, ‘deep sleep’ to ‘awake’, minute of first ‘awake’, and minute of last ‘light sleep’ is found.