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(54) **METHOD AND SYSTEM FOR CONTINUOUS MONITORING OF A MEDICAL CONDITION IN PATIENTS**

(71) Applicant: **Smart Monitor Corp**, San Jose, CA (US)

(72) Inventor: **Anoo Nathan**, San Jose, CA (US)

(73) Assignee: **Smart Monitor Corp**

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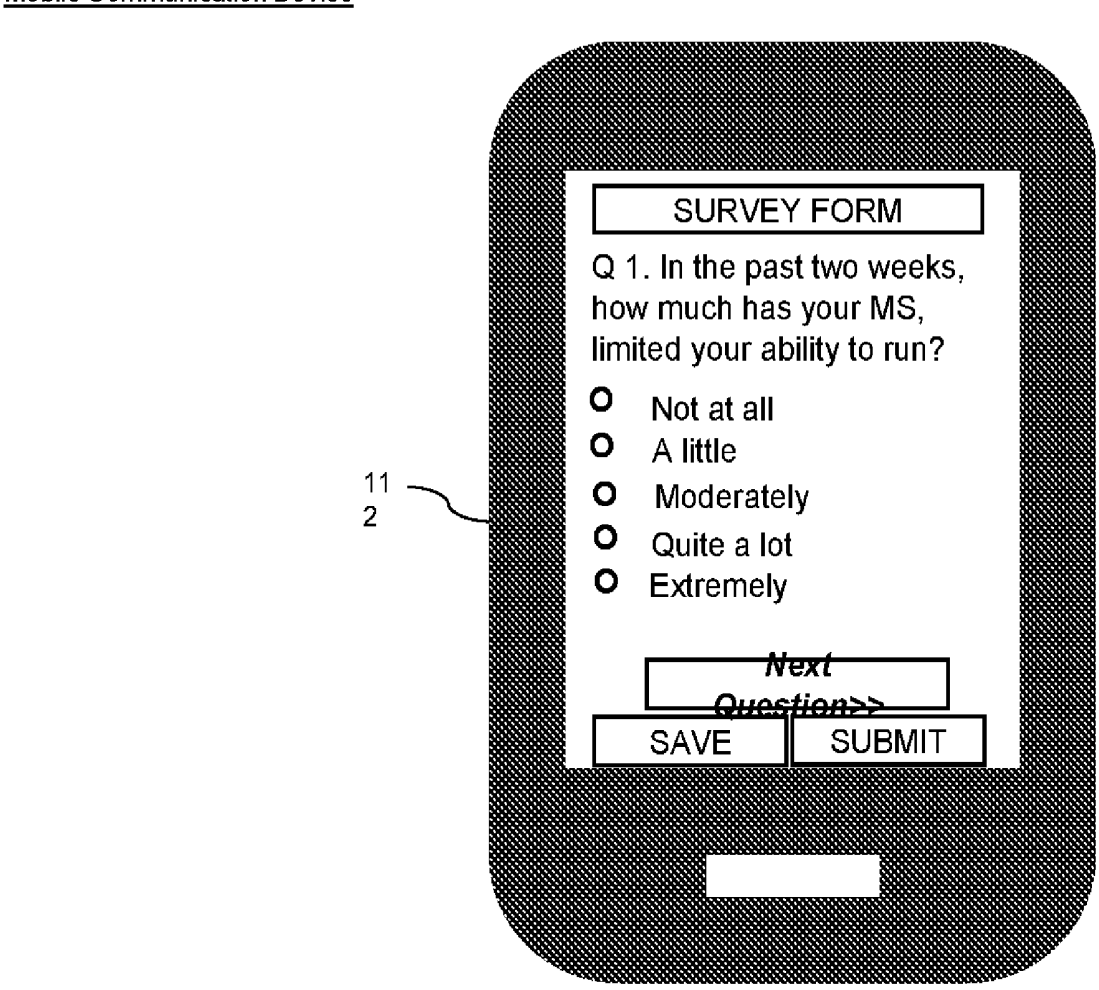
(57) **ABSTRACT**

The present invention describes methods and systems to enable a concerned party to continuously monitor the progression of a medical condition in one or more patients. The progression of the medical condition is determined by processing sensor data obtained from one or more physiological and/or motion sensors and survey data obtained from the patients. Further, environmental data such as air quality, temperature and humidity may also be used along with the sensor data and the survey data to monitor/track the progression of the medical condition.



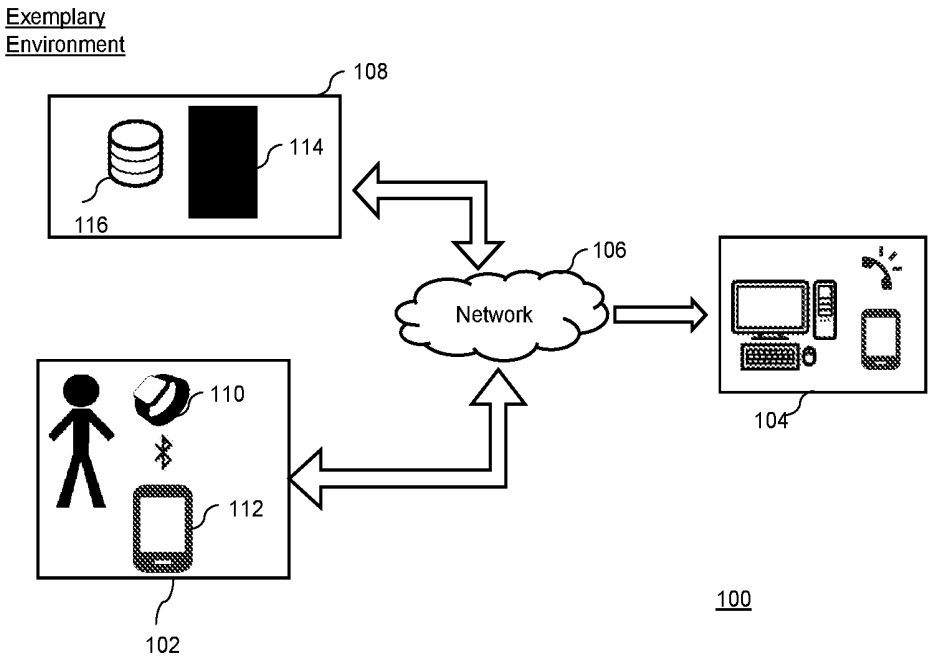

Exemplary
Environment
108
114
116
106
Network
110
112
104
102
100

FIG.1

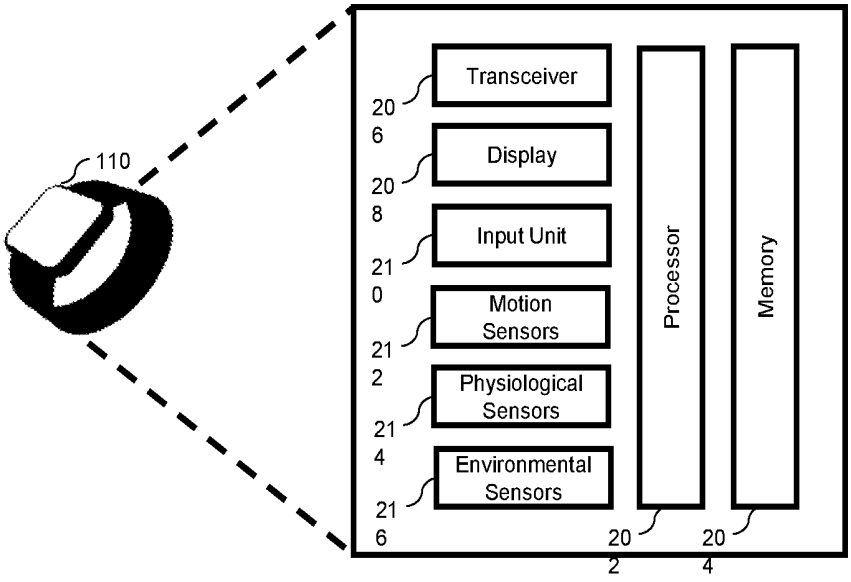

110
Transceiver
206
Display
208
Input Unit
210
Motion Sensors
212
Physiological Sensors
214
Environmental Sensors
216
Processor
202
Memory
204

FIG. 2

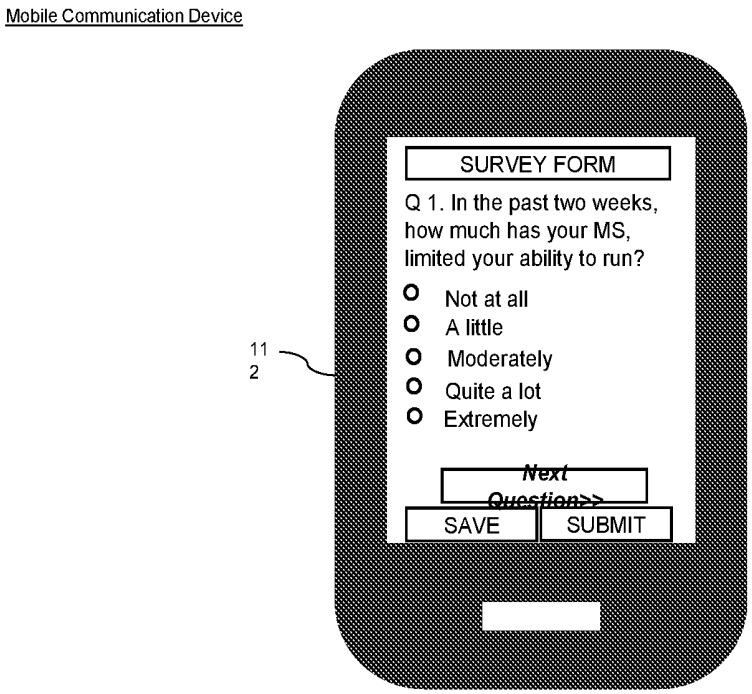

Mobile Communication Device
SURVEY FORM
Q 1. In the past two weeks, how much has your MS, limited your ability to run?
Not at all
A little
Moderately
Quite a lot
Extremely
Next Question>>
SAVE
SUBMIT
112

FIG. 3

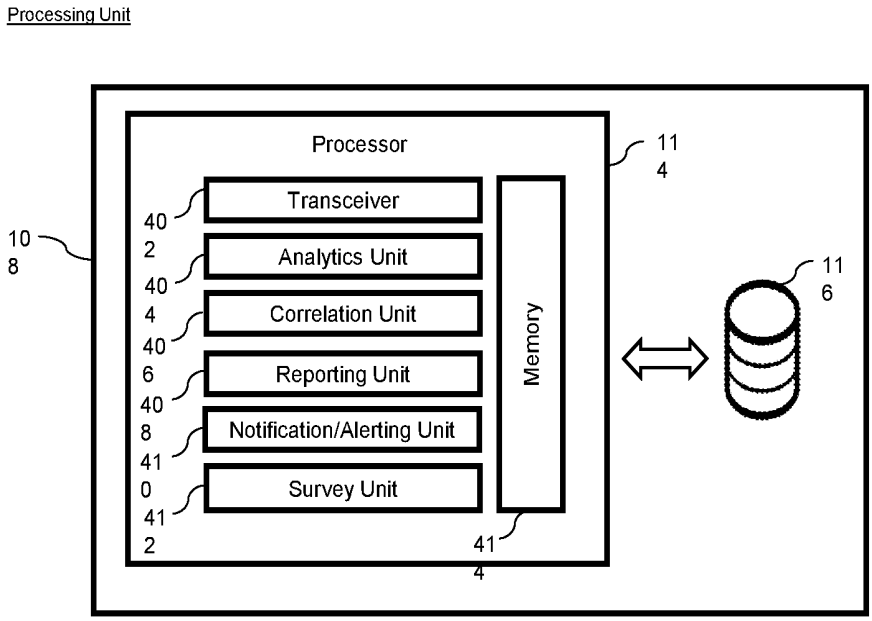

Processing Unit
Processor
114
Transceiver
402
Analytics Unit
404
Correlation Unit
406
Reporting Unit
408
Notification/Alerting Unit
410
Survey Unit
412
Memory
414
108
116

FIG. 4

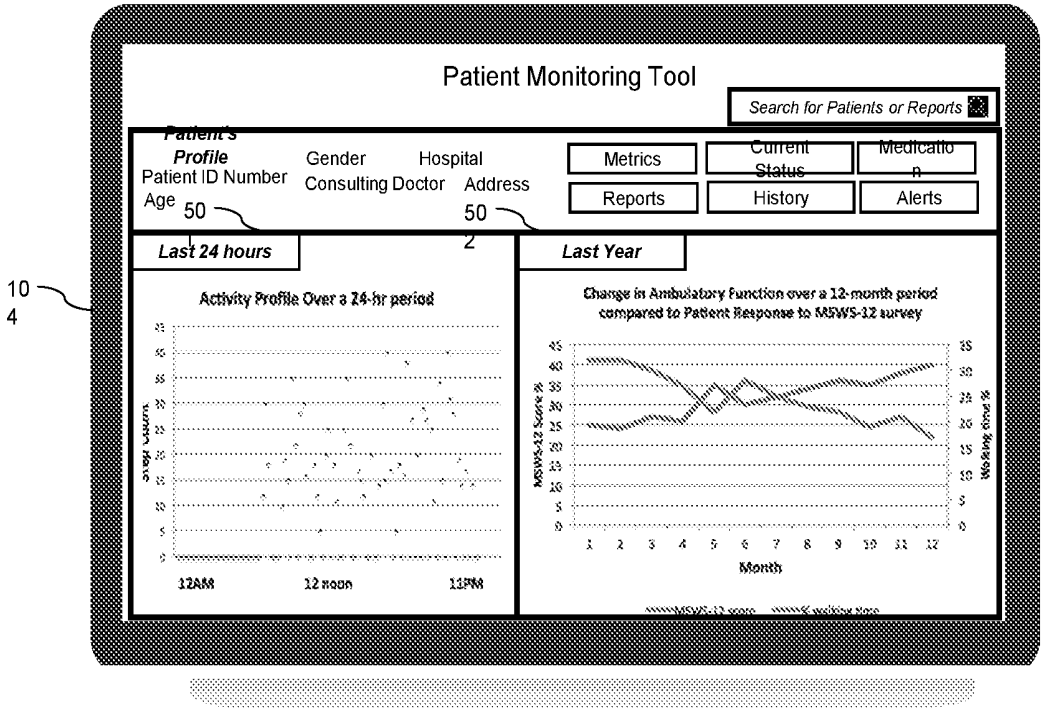

Patient Monitoring Tool
Search for Patients or Reports
Patient's Profile
Patient ID Number
Age
Gender
Consulting Doctor
Hospital Address
Metrics
Current Status
Medication
Reports
History
Alerts
Last 24 hours
Last Year
Activity Profile Over a 24-hr period
12AM
12 noon
11PM
Change in Ambulatory Function over a 12-month period compared to Patient Response to MSWS-12 survey
Month
104
50
50
2

FIG. 5

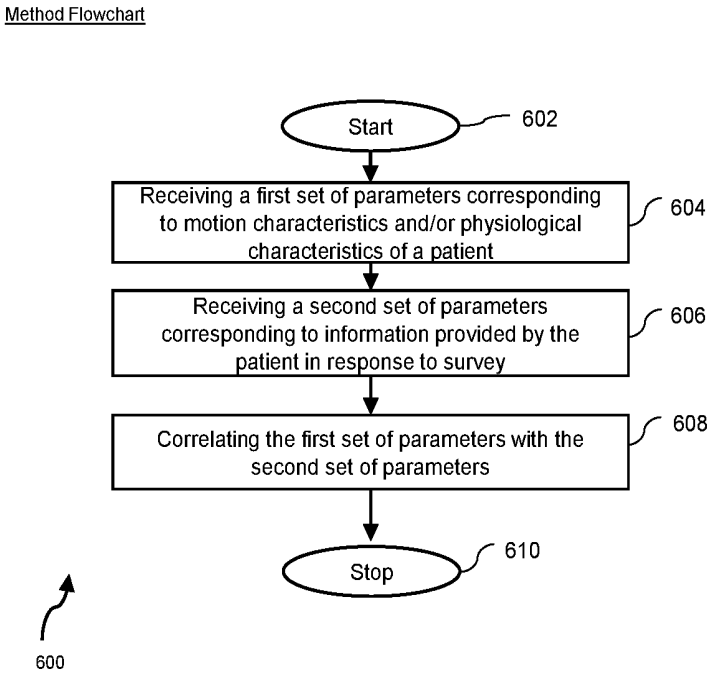

Method Flowchart
Start
602
Receiving a first set of parameters corresponding to motion characteristics and/or physiological characteristics of a patient
604
Receiving a second set of parameters corresponding to information provided by the patient in response to survey
606
Correlating the first set of parameters with the second set of parameters
608
Stop
610
600

FIG. 6

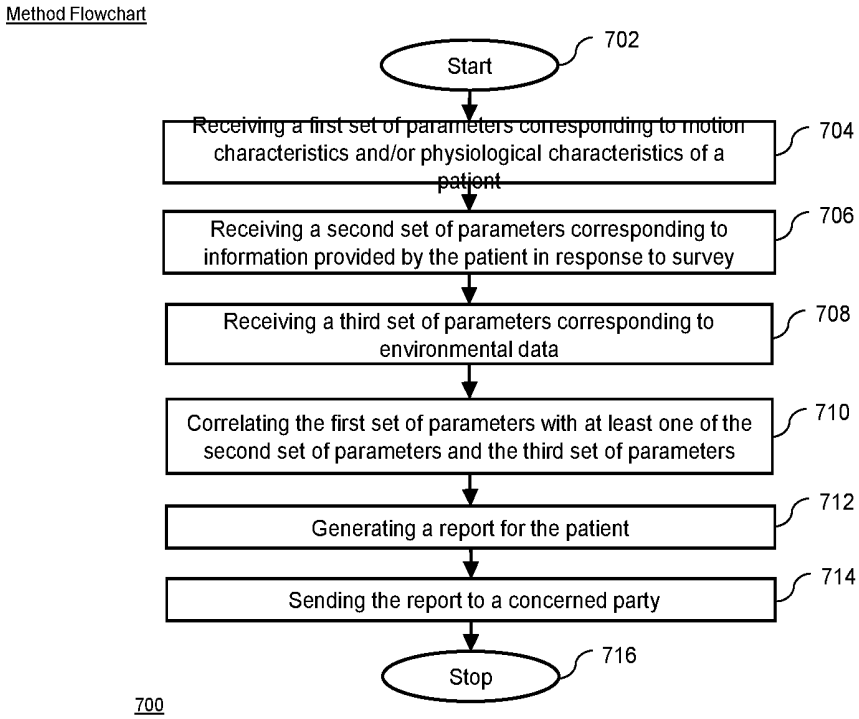

Method Flowchart
Start
702
Receiving a first set of parameters corresponding to motion characteristics and/or physiological characteristics of a patient
704
Receiving a second set of parameters corresponding to information provided by the patient in response to survey
706
Receiving a third set of parameters corresponding to environmental data
708
Correlating the first set of parameters with at least one of the second set of parameters and the third set of parameters
710
Generating a report for the patient
712
Sending the report to a concerned party
714
Stop
716
700

FIG. 7

FIG. 8

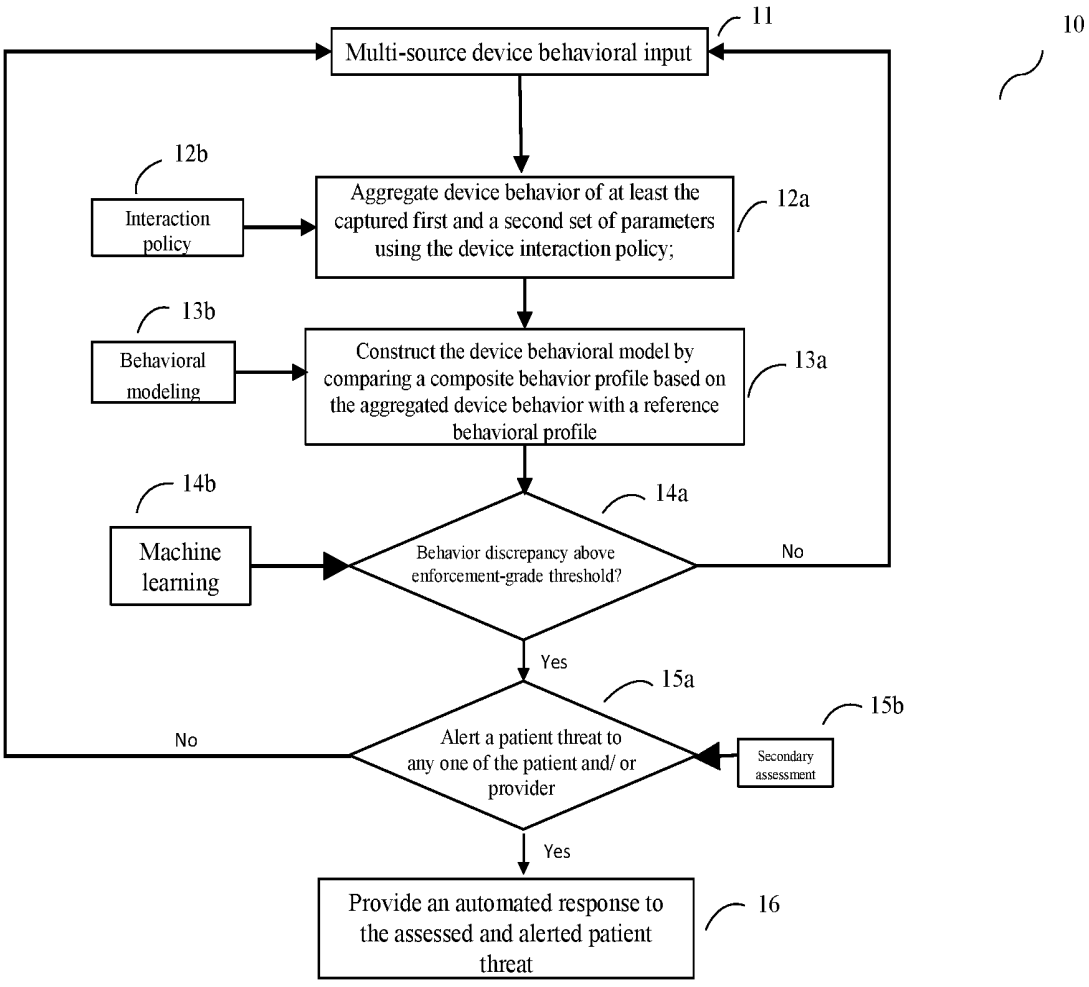

10
11
Multi-source device behavioral input
12b
Interaction policy
Aggregate device behavior of at least the captured first and a second set of parameters using the device interaction policy;
12a
13b
Behavioral modeling
Construct the device behavioral model by comparing a composite behavior profile based on the aggregated device behavior with a reference behavioral profile
13a
14b
Machine learning
Behavior discrepancy above enforcement-grade threshold?
14a
No
Yes
15a
15b
Alert a patient threat to any one of the patient and/ or provider
Secondary assessment
No
Yes
Provide an automated response to the assessed and alerted patient threat
16

FIG. 9

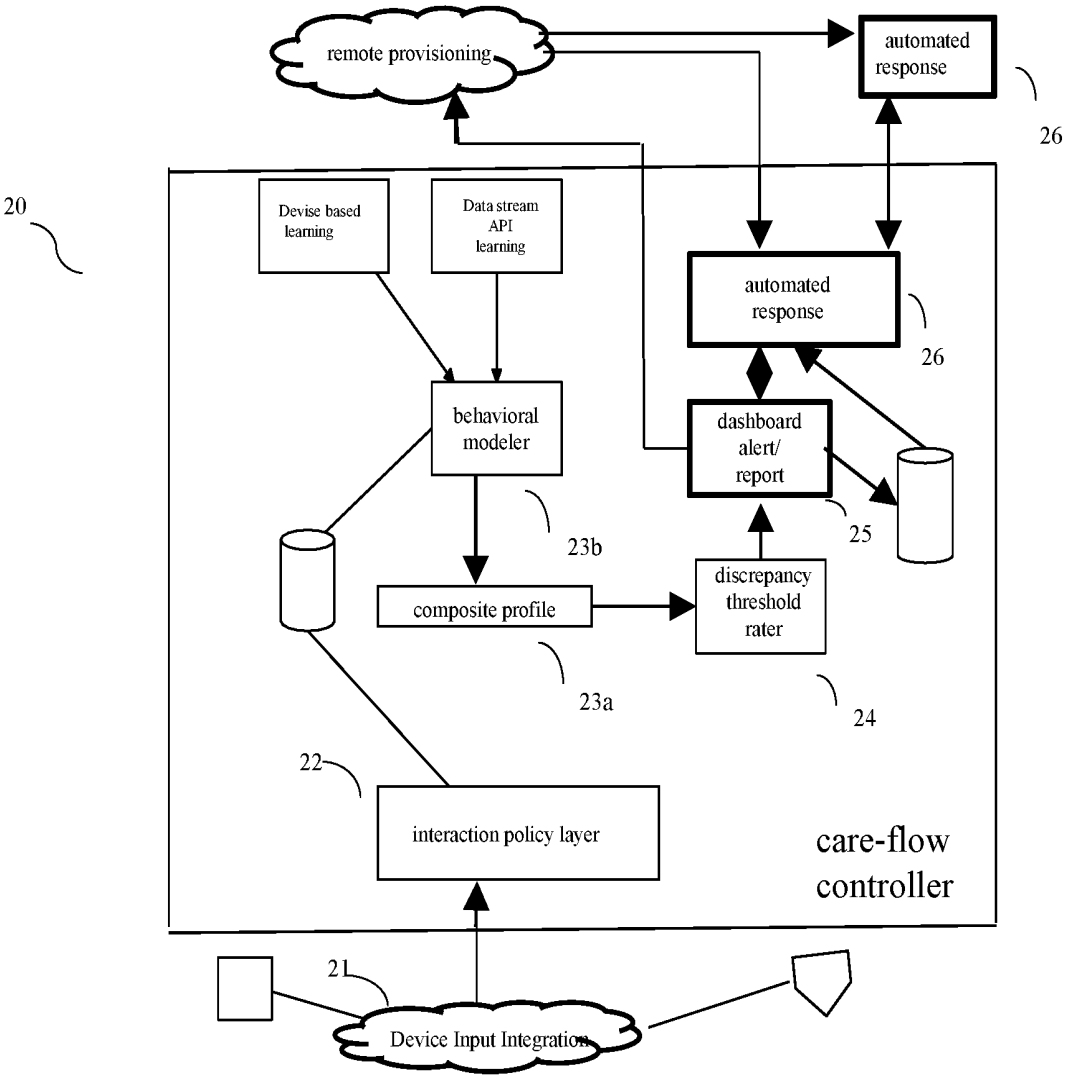

remote provisioning
automated response
26
20
Devise based learning
Data stream API learning
automated response
26
behavioral modeler
dashboard alert/ report
25
23b
composite profile
discrepancy threshold rater
23a
24
22
interaction policy layer
care-flow controller
21
Device Input Integration

Fig. 10

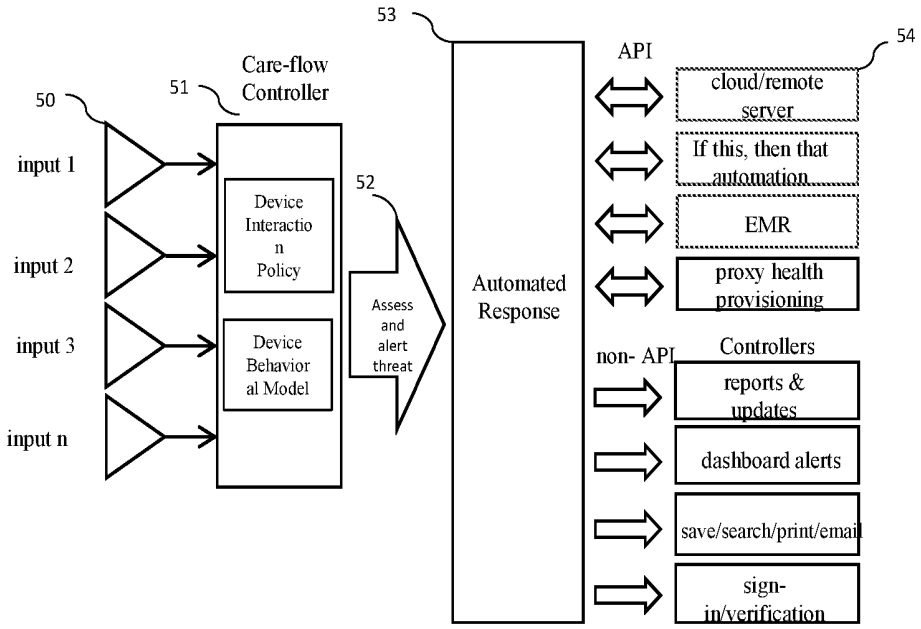

53
54
API
Care-flow Controller
51
50
input 1
input 2
input 3
input n
Device Interactio n Policy
Device Behavior al Model
52
Assess and alert threat
Automated Response
cloud/remote server
If this, then that automation
EMR
proxy health provisioning
non- API
Controllers
reports & updates
dashboard alerts
save/search/print/email
sign-in/verification

Fig. 11

Fig. 11A

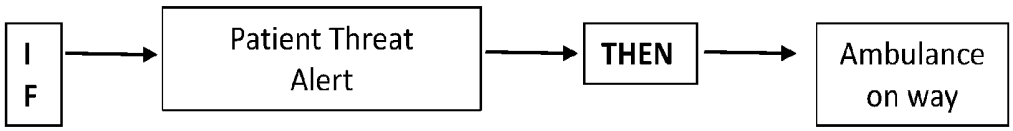
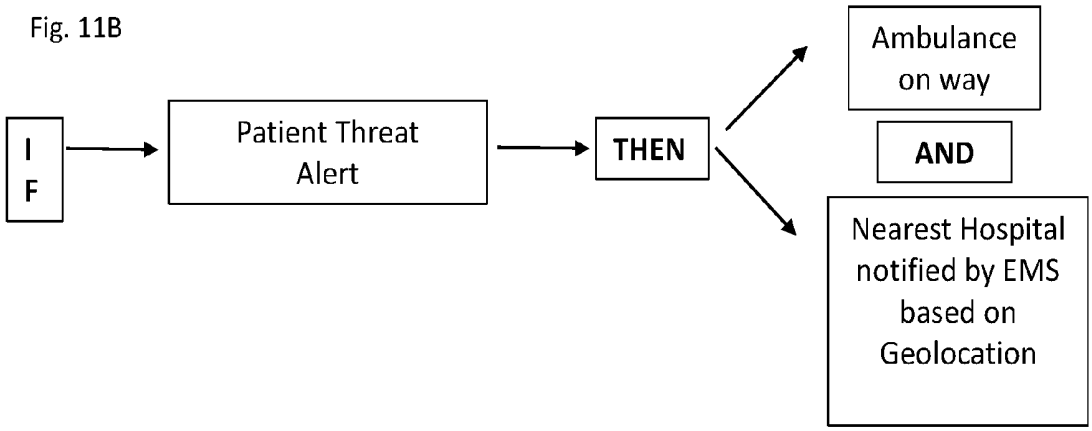


Fig. 11B



METHOD AND SYSTEM FOR CONTINUOUS MONITORING OF A MEDICAL CONDITION IN PATIENTS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation in part of and claims the priority benefit of U.S. Ser. No. 14/207,495 filed on Mar. 12, 2014 the complete contents of both applications are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention generally relates to the field of healthcare and medical information services, and in particular, the disclosure relates to methods and systems for continuously monitoring and real time tracking a medical condition in patients.

BACKGROUND

[0003] Continuous monitoring of medical conditions is of great significance for the wellbeing of patients, maintaining medical stability and responding to disastrous conditions (such as a stroke, an epileptic event). In case of chronic diseases, it is beneficial to continuously monitor a patient to detect both exacerbation and remission. However, this leads to an increase in the cost of hospitalization and other related expenses. Therefore, there is a growing demand to create solutions that can enable remote monitoring of the patients without putting their life in risk.

[0004] In the healthcare industry, a growing demand for technologies that may enable doctors/caregivers to access current medical status of patients is seen. Further, the evaluation of a patient's medical history/trends to determine the progression of a medical condition or an occurrence of an abnormal event is of utmost importance.

[0005] In order to continuously monitor the medical condition of a patient and gather medical information, different types of monitoring devices are in use. Typically, these monitoring devices include physiological sensors and activity monitors. Further, these monitoring devices can be used as standalone devices and/or in combination as well. The medical information captured from the one or more such monitoring devices is used to gain meaningful insights pertinent to progression of the medical condition or occurrence of an abnormal event.

[0006] Although, there are various products and applications available in the market for remote patient monitoring, these are not designed for continuous, non-invasive monitoring and therefore do not provide longitudinal data necessary for tracking disease progression proactively. Therefore, there is a need for efficient and accurate ways for continuous monitoring of a medical condition in patients. The present invention is directed towards improved method and/or system that can enable effective monitoring of patients.

SUMMARY

[0007] In the light of the above, it is readily apparent that a need exists in the art for an efficient marketplace for a continuous monitoring and real time tracking of patients suffering from chronic conditions. It is therefore a primary object of the invention to provide a marketplace for patients suffering from chronic conditions to improve quality of life of by providing them with continuous monitoring and real time tracking of the progression of the chronic medical condition. The embodiment of the inventions provides answers to key questions such as, an appropriate time to intervene to prevent acute episodes and hospitalizations needed to enhance the quality of life of patients and patient experience as well as track disease progression of a patient.

[0008] An embodiment of the present invention describes a method for continuously monitoring a patient to track the progress of a medical condition. The method includes receiving a first set of parameters by a processing unit. The first set of parameters corresponds to at least one of motion, physical and physiological characteristics of the patient. The method further includes receiving a second set of parameters by the processing unit and the second set of parameters corresponds to information provided by at least one of, but not limited to, a mobile communication device, wearable device, smartphone, tablet, personal digital assistant (PDA) and Internet of Things device. The method further includes correlating the first set of parameters with the second set of parameters by the processing unit. Thereby, at least one of the first set of parameters, the second set of parameters and the correlation between the first set of parameters and the second set of parameters determine the progression of the medical condition.

[0009] In another embodiment of the invention, a patient care-flow system describes, a care-flow controller comprising of, a device interaction policy; a device behavioral model; a body-worn device configured for capturing any one of, a physical and, or physiological characteristic as a first set of parameters; a processor, a non-transitory storage element coupled to the processor, encoded instructions stored in the non-transitory storage element, wherein the encoded instructions when implemented by the processor, configure the system to, capture at least the first set of physiological and, or motion parameters of the patient from the body-worn device, at least a second set of contextual parameters of the patient from at least one other device, aggregate device behavior of at least the captured first and a second set of parameters using the device interaction policy, construct a composite behavioral profile based on the aggregated device behavior and comparing composite behavioral profile with a reference behavioral profile by the device behavioral model, assess and alert a patient threat to any one of the patient and, or provider by detecting a discrepancy between the composite behavioral profile and the reference behavioral profile above a predefined threshold and provide an automated response to the assessed and alerted patient threat.

[0010] The motion characteristics of the patient correspond to at least one of activity related characteristics and sleep related characteristics of the patient. Examples of activity related characteristics of the patient include, but are not limited to, maximum value of acceleration, minimum value of acceleration, time of acceleration, duration of acceleration, frequency of acceleration, gap between two maximum/minimum values of acceleration, rotational velocity, direction of acceleration, orientation, a stride cycle, a left/right step, a stride length, a walking speed, a stride interval, a gait variability, a stride-to-stride interval and a variability of stride length over time.

[0011] Going further, sleep related characteristics of the patient are indicative of at least one of the group comprising sleep time, number of times awake, duration of sound sleep,

duration of light sleep and awake time. The physiological characteristics of the patient are one or more of group comprising heart rate, pulse rate, respiratory rate and body temperature.

[0012] In an embodiment of the present invention, the first set of parameters is captured by a body worn device of the patient and the second set of parameters is provided by at least one of, a mobile communication device, wearable device, smartphone, tablet, personal digital assistant (PDA) and Internet of Things device. The second set of parameters may be indicative of any one of, but not limited to, fatigue, walking/running/movement related behavior, weakness, bladder dysfunction, anxiety/nervousness, severe headache, nausea, gastrointestinal discomfort, vision problems and speech impairment of the patient.

[0013] The method and system further includes generating reports based on at least one of, the first set of parameters, the second set of parameters and the correlation between the first set of parameters and the second set of parameters. The reports are sent to a concerned party such as a healthcare provider, a hospital, a health monitoring service, a doctor, a physician, a clinician, a caregiver and a social service.

[0014] In another embodiment of the present invention, the method also includes receiving a third set of parameters by the processing unit. The third set of parameters corresponds to environmental data, and wherein the environmental data includes at least one of, but not limited to, temperature, humidity, air quality, pollen count, carbon dioxide levels and weather data. The method further includes correlating the third set of parameters with the first set of parameters by the processing unit.

[0015] Another embodiment of the present invention describes a body worn device. The body worn device includes a processor, a non-transitory storage element coupled to the processor and encoded instructions stored in the non-transitory storage element. The body worn device is configured to capture a first set of parameters of a patient, wherein the first set of parameters corresponds to at least one of motion characteristics and physiological characteristics of the patient. The body worn device is further configured to capture a second set of parameters, wherein the second set of parameters corresponds to information provided by the patient in response to a periodic survey. The first set of parameters and the second set of parameters are then sent to a processing unit using a transceiver.

[0016] In an embodiment of the present invention, the body worn device further includes at least one sensor comprising of, a motion sensor, an accelerometer, a 3D accelerometer, a gyroscope, a global positioning system sensor (GPS), a magnetometer, an inclinometer, an impact sensor, a heart rate monitor, a pulse rate monitor, a respiratory rate monitor and body temperature sensor. The body worn device also includes an input unit that enables the patient to provide the information in response to the periodic survey.

BRIEF DESCRIPTION OF DRAWINGS

[0017] FIG. **1** illustrates an exemplary environment in which various embodiments of the disclosure can be practiced.

[0018] FIG. **2** illustrates an exemplary body worn device being used by a patient, according an embodiment of the disclosure.

[0019] FIG. **3** illustrates an exemplary mobile communication device used for presenting a periodic survey to the patient, according an embodiment of the disclosure.

[0020] FIG. **4** illustrates an exemplary processing unit used for monitoring the patient for a medical condition, according an embodiment of the disclosure.

[0021] FIG. **5** illustrates an exemplary display screen used for displaying reports on the patient to a concerned party, according an embodiment of the disclosure.

[0022] FIG. **6** illustrates a method flowchart for continuously monitoring the patient for the medical condition, according an embodiment of the disclosure.

[0023] FIG. **7** is a method flowchart for a method flowchart for continuously monitoring the patient for the medical condition and generating reports, according an embodiment of the disclosure.

[0024] FIG. **8** illustrates a process flow of an embodiment of the invention.

[0025] FIG. **9** illustrates a process flow of the care-flow controller system of the invention.

[0026] FIG. **10** shows an interaction work-flow of the care-flow controller system.

[0027] FIG. **11**A illustrates an exemplary workflow automation tool embodiment of the invention.

[0028] FIG. **11**B shows a workflow automation tool embodiment of the invention.

DETAILED DESCRIPTION OF DRAWINGS

[0029] The present invention will now be described more fully with reference to the accompanying drawings, in which embodiments of the invention are shown. However, this disclosure should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Like numbers refer to like elements throughout.

Overview

[0030] The primary purpose of the disclosure is to enable a concerned party to continuously monitor the progression of a medical condition in one or more patients. Typically, the progression of the medical condition is determined by processing sensor data obtained from one or more physiological and/or motion sensors and survey data obtained from the patients. Further, environmental data such as air quality, temperature and humidity may also be used along with the sensor data and the survey data to monitor/track the progression of the medical condition.

[0031] The present disclosure focuses on continuously monitoring the progression of a medical condition in a patient by processing sensor data, survey data and the environmental data. However, for a person skilled in the art it is understood these examples are just for understanding purposes and the disclosure can be implemented for objects other than medical condition monitoring for example fitness level monitoring.

[0032] Examples of the medical condition include, but are not limited to, Multiple Sclerosis (MS), Primary Progressive Multiple Sclerosis (PPMS), Huntington's disease (Chorea), Epilepsy & Seizures, Parkinson's disease, Post Stroke conditions, Tobacco use related conditions, Asthma, Cancer, Arthritis, Chronic Obstructive Pulmonary Disease (COPD),

Diabetes, heart disease, Obesity, Osteoporosis, Alzheimer's disease, Reflex Sympathetic Dystrophy (RSD) Syndrome, Pruritus and Chronic kidney disease (CKD). Going forward in this disclosure, the present invention will be described taking the example of Multiple Sclerosis. However, for a person skilled in the art it is understood that this example is just for understanding purposes and the disclosure can be implemented for other medical conditions that may result in impairment with respect to motion in the patients.

Exemplary Environment

[0033] FIG. **1** illustrates an exemplary environment **100** in which various embodiments of the present invention can be practiced. The environment **100** includes patient premises **102**, a concerned party **104** and a processing unit **108**. The patient premises **102**, the concerned party **104** and the processing unit **108** are communicatively coupled through a network **106**. Typically, the processing unit **108** enables the concerned party **104** to continuously monitor the symptoms of a medical condition such as Multiple Sclerosis (MS) in the patient, located at the patient premises **102**.

[0034] Examples of the concerned party **104** include, but are not limited to, a healthcare provider, a hospital, a health monitoring service, a doctor, a physician, a clinician, a caregiver and a social service. The processing unit **108** may either be operated by the concerned party **104** or a third-party. Examples of the third party include, but are not limited to, a service provider that specializes in continuously collecting medical data from patients and distributing the medical data to a plurality of concerned parties. Typically, the processing unit **108** includes a processor **114** and a medical information database **116**.

[0035] The patient premises **102** is a place, the patient is located at, other than a hospital or any other similar medical institution/setting. To enable continuous monitoring, the patient uses a body worn device **110** and a mobile communication device **112**. The body worn device **102** is typically embedded/equipped with one or more motion sensors, physiological sensors and environmental sensors. Examples of these sensors include, but are not limited to accelerometers, gyroscopes, inclinometers, geomagnetic sensors, global positioning systems, impact sensors, microphones, cameras, heart rate monitors, pulse oximeters, blood alcohol monitors, respiratory rate sensors, transdermal sensors, galvanic skin response (GSR) sensors and electromyography (EMG) sensors. In an embodiment of the present invention, the data captured by the one or more sensors is sent to the processing unit **108** through the network **106**.

[0036] Typically, the body worn device **102** is worn on one or more body parts of the patient, such as wrist, waist, neck, arm, leg, abdomen, chest, thigh, head, ear and fingers. Further, the body worn device **102** may be a wristband, a watch, an armband, a necklace, a headband, an earring, a waist belt and a ring.

[0037] The mobile communication device **114** is a portable device that has the capability of communicating over the network **106**, presenting periodic surveys to the patient and receiving response from the patient on the periodic surveys. Examples of the mobile communication device **114** include, but are not limited to, a smartphone, a tablet, a personal digital assistant (PDA) and a mobile phone.

[0038] In an embodiment of the present invention, the data captured by the one or more sensors of the body worn device **110** is first sent to the mobile communication device **112** and thereby, sent to the processing unit **108** over the network **106**. The body worn device **110** communicates with the mobile communication device **112** over a short range wireless communication medium. Examples of the short range wireless communication medium include Bluetooth, ZigBee, Infrared, Near Field Communication (NFC) and Radio-frequency identification (RFID).

[0039] The network **106** may be any suitable wired network, wireless network, a combination of these or any other conventional network, without limiting the scope of the present invention. Few examples may include a LAN or wireless LAN connection, an Internet connection, a point-to-point connection, or other network connection and combinations thereof. The network **106** may be any other type of network that is capable of transmitting or receiving data to/from host computers, personal devices, telephones, video/image capturing devices, video/image servers, or any other electronic devices. Further, the network **106** is capable of transmitting/sending data between the mentioned devices. Additionally, the network **106** may be a local, regional, or global communication network, for example, an enterprise telecommunication network, the Internet, a global mobile communication network, or any combination of similar networks. The network **106** may be a combination of an enterprise network (or the Internet) and a cellular network, in which case, suitable systems and methods are employed to seamlessly communicate between the two networks. In such cases, a mobile switching gateway may be utilized to communicate with a computer network gateway to pass data between the two networks. The network **106** may include any software, hardware, or computer applications that can provide a medium to exchange signals or data in any of the formats known in the art, related art, or developed later.

[0040] In an embodiment of the present invention, the processing unit **108** receives the sensor data from the body worn device **110** and response on the periodic surveys from the patient. Thereby, the processing unit **108** correlates the sensor data with the response on periodic surveys, generates reports corresponding to the symptoms of medical condition in the patient and sends the reports and other relevant data to the concerned party **104**. These reports enable the concerned party **104** to track/monitor the progression of the medical condition in the patient.

[0041] In an embodiment of the present invention, the concerned party **104** is enabled to view the reports, as generated by the processing unit **108** using one or more devices selected from the group comprising a smartphone, a computer, a laptop, a tablet, a personal digital assistant (PDA) and a mobile phone.

Body Worn Device

[0042] FIG. **2** illustrates the exemplary body worn device **110** being used by the patient, according an embodiment of the disclosure. The body worn device **110** includes a processor **202**, a memory **204**, a transceiver **206**, a display **208** and an input unit **210**. The processor **202** executes a set of computer executable instructions stored in the memory **204** for providing the overall functionality of the body worn device **110**. The processor **202** is further communicatively coupled to motion sensors **212**, physiological sensors **214** and environmental sensors **216**.

[0043] Continuing with the example of Multiple Sclerosis (MS), it has been observed that walking impairment, fatigue and weakness are the most visible symptoms of MS and

affect more than 80% of MS patients. Therefore, these motion related characteristics of the patient are markers of both disability and the progression of MS. In an embodiment of the present invention, the motion sensors **212** and the physiological sensors **212** continuously capture a first set of parameters that reflect motion characteristics and physiological characteristics of the patient respectively.

[0044] The motion characteristics of the patient include both activity related characteristics and sleep related characteristics of the patient. Examples of parameters of the first set of parameters, captured by the motion sensors **212**, corresponding to activity related characteristics of the patient include, but are not limited to, maximum value of acceleration, minimum value of acceleration, time of acceleration, duration of acceleration, frequency of acceleration, gap between two maximum/minimum values of acceleration, rotational velocity, direction of acceleration, orientation, a stride cycle, a left/right step, a stride length, a walking speed, a stride interval, a gait variability, a stride-to-stride interval and a variability of stride length over time.

[0045] In an embodiment of the present invention, parameters of the first set of parameters, captured by the motion sensors **212**, corresponding to the sleep related characteristics of the patient are indicative of at least one of the group comprising sleep time/duration, number of times awake, duration of sound sleep, duration of light sleep and awake time.

[0046] Examples of the motion sensors **212** include, but are not limited to, accelerometers, 3D accelerometers, gyroscopes, global positioning system (GPS), magnetometers, inclinometers and impact sensors.

[0047] Further, examples of parameters of the first set of parameters, captured by the physiological sensors **214** include, but are not limited to, heart rate, pulse rate, respiratory rate and body temperature of the patient.

[0048] The environmental sensors **216** of the body worn device **110** capture a third set of parameters corresponding to the environmental data for the current location of the patient. Examples of a parameter of the third set of parameters include, but are not limited to, temperature, humidity, air quality, pollen count, carbon dioxide levels and weather data.

[0049] In an embodiment of the present invention, the first set of parameters, as captured by the motion sensors **212** and the physiological sensors **214**, are sent to the processing unit **108** over the network **106** by the transceiver **206**. In another embodiment of the present invention, the third set of parameters, along with the first set of parameters, are sent to the processing unit **108** by the transceiver **206** over the network **106**.

[0050] Going further, the display **208** is configured to display reminders and periodic surveys/questionnaires to the patient. The reminders may be medication reminders or reminders for completing a pending periodic survey. In an embodiment of the present invention, the patient is enabled to report his/her symptoms and also, respond to the reminders and the periodic surveys using the input unit **210**. In an example, the input unit **210** is a set of one or more push buttons.

Mobile Communication Device

[0051] FIG. **3** illustrates the exemplary mobile communication device **112** used for presenting the periodic surveys to the patient, according an embodiment of the disclosure.

[0052] The mobile communication device **112** is configured to present periodic surveys to the patient. The response of the patient to questions of a periodic survey determines a second set of parameters. In an embodiment of the present invention, the second set of parameters enable the concerned party **104** to understand patient's perception of changes in his/her motion characteristics such as fatigue, walking/running/movement impairment and weakness. In another embodiment of the present invention, along with the motion characteristics, the second set of parameters are also indicative of at least one of the group comprising bladder dysfunction, vision problems and speech impairment of the patient.

[0053] In an example, the periodic survey is a 12 Steps MS Walking Scale (MSWS-12) test. The response of the patient to the test is captured as ordinal measures and thus, generates the second set of parameters.

[0054] In an embodiment of the present invention, the mobile communication device **112** is configured to send the second set of parameters to the processing unit **104** using the network **106**. As described above, the second set of parameters is determined by the response of the patient to the questions of the periodic survey.

[0055] In an embodiment of the present invention, the mobile communication device **112** is also configured to provide the third set of parameters to the processing unit **104**.

Processing Unit

[0056] FIG. **4** illustrates the exemplary processing unit **108** used for monitoring the patient for the medical condition, according an embodiment of the disclosure. As shown, the processing unit **108** includes the processor **114** and the medical information database **116**. The processor **114** is communicatively coupled to a transceiver **402**, an analytics unit **404** and a correlation unit **406**. The processor **114** is also communicatively coupled to the medical information database **116** and a memory **414**.

[0057] The transceiver **402** is configured to receive the first set of parameters from the body worn device **110**. Also, the transceiver is further configured to receive the second set of parameters from at least one of the mobile communication device **112** and the body worn device **110**. In an embodiment, the transceiver **402** is also configured to receive the third set of parameters from at least one of the body worn device **110** and the mobile communication device **112**.

[0058] Going further, the analytics unit **404** is configured to analyze the first set of parameters to compute and derive one or more metrics. The one or more metrics are computed using one or more analytical algorithms that are applied on first set of parameters, received continuously from the body worn device **110**. In an example, the analytics unit **404** computes metrics corresponding to sustained activity (such as maximum/minimum number of steps in a continuous interval of time), peak activity (such as maximum mean step rate in a 30 minutes' time interval) and walking bouts (such as number of walking bouts, mean duration of walking bouts, mean number of steps in walking bouts and mean cadence of walking bouts) for the patient. However, for a person skilled in the art it is understood that these examples are just for understanding purposes and the disclosure can be implemented for other metrics that may be computed based on the first set of parameters.

[0059] In an embodiment of the present invention, the analytics unit **404** is also configured to establish a personal motion signature of the patient based on the first set of parameters. The personal motion signature reflects the normal activity and sleep related characteristics of the patient.

[0060] The correlation unit **406** is configured to correlate the second of parameters, as received from the patient in response to the periodic surveys, with at least one of the first set of parameters and the metrics, as computed by the analytics unit **404**. In an example, the correlation unit **406** compares the second set of parameters corresponding to the 12 Steps MS Walking Scale (MSWS-12) test with the first set of parameters corresponding to the motion characteristics and physiological characteristics of the patient over a period of 12 months. This enables the concerned party **104** to monitor the activity related characteristics and sleep related characteristics of the patient and compare them with patient's perception of changes in his/her motion characteristics such as fatigue, walking/running/movement impairment and weakness.

[0061] In an embodiment of the present invention, the correlation unit **406** is also configured to correlate the first set of parameters with the third set of parameters. This enables the concerned party **104** to monitor the activity related characteristics and sleep related characteristics of the patient and track how these characteristics change with changes in the environmental data.

[0062] In an embodiment of the present invention, the processor **114** also includes a reporting unit **408**, a notification/alerting unit **410** and a survey unit **412**. The reporting unit **408** is configured to generate reports for the patient and provide these reports to the concerned party **104** through the transceiver **402**. The reports may be provided to the concerned party at regular intervals (such as daily at 12:00 PM, weekly and monthly), on-demand (when the concerned party **104** requests for a report corresponding to the patient), or when triggered by a condition. Typically, the condition may be defined by the concerned party **104**. An example of the condition is when the first set of parameters indicates that the patient has not been active for a predefined interval of time.

[0063] In an embodiment of the present invention, a report, as generated by the reporting unit **408**, includes data corresponding to at least one of the group comprising the first set of parameters, the second set of parameters, the third set of parameters and the correlation between the first set of parameters and at least one of the second set of parameters and the third set of parameters. The data shown in the report may be dynamically defined/selected by the concerned party **104**. An example of the report, as generated by the reporting unit **408** is shown in FIG. **5**. This report is displayed at a computer terminal being used by the concerned party **104** and includes two graphs **501** and **502** for the patient. The graph **501** represents the activity related characteristics i.e. step count of the patient as detected in the last 24 hours. The graph **502** reflects the correlation between the 12-point MSWS test scores over a 12-month period with an activity related characteristic i.e. percentage of walking time for the patient. An increase in MSWS scores indicates a decrease in activity as reported by the patient. This correlates with the decrease in time spent walking over the same 12-month period. The report also includes the profile of the patient including information such as patient identification number, age, gender, address, consulting doctor and hospital. In an embodiment of the present invention, the report also enables the concerned party **104** to view the medical history of the patient, the one or more metrics as computed by the analytics unit **404** for the patient, the current status (real-time) of the patient in terms of the first set of parameters and the second set of parameters, the medication the patient is taking, medical history of the patient, alerts/notifications corresponding to the patient and generate more reports for the patient. Further, the concerned party **104** is also enabled to search for other patients using the patient monitoring tool.

[0064] The Notification/Alerting unit **410** is configured to generate reminders for the patient. The reminders may be medication reminders or reminders for completing a pending periodic survey. In an embodiment of the present invention, the reminders are displayed to the patient using the body worn device **110**.

[0065] In an embodiment of the present invention, the Notification/Alerting unit **410** is also configured to send a notification to the patient and/or the concerned party **104** on detecting a deviation in the first set of parameters with respect to the personal motion signature of the patient using machine learning algorithms. The notification may be a message, a phone call or any other communication means to instantly make the patient and/or the concerned party **104** aware of the deviation.

[0066] The survey unit **412** is configured to generate the periodic surveys for the patient and send them to the patient using the transceiver **402**. The survey unit **412** may also be configured to determine the questions to be included in the periodic surveys and the frequency at which the periodic surveys are presented to the patient. In an embodiment, the concerned party **104** may configure the survey unit **412** by defining the questions to be included in the periodic surveys and the frequency of presenting these periodic surveys to the patient.

[0067] In an embodiment of the present invention, the processor **114** stores the first set of parameters, the second set of parameters and the third set of parameters, as received by the transceiver **402**, in the medical information database **116**. The medical information database **116** is also used to store the profile of the patient including information such as patient ID number, age, gender, address, medical condition, medical history, medication, reports, the one or more metrics (as computed by the analytics unit **404**), questions corresponding to the periodic surveys, frequency of presenting the periodic surveys to the patient, reports (as generated by the reporting unit **408**) and the reminders/alerts.

[0068] FIG. **6** illustrates a method flowchart for continuously monitoring the patient for the medical condition, according an embodiment of the disclosure. The method **600** starts at step **602**.

[0069] At step **602**, the processing unit **108** receives the first set of parameters from the body worn device **110**. The motion sensors **212** and the physiological sensors **212** continuously capture the first set of parameters that reflect motion characteristics and physiological characteristics of the patient respectively. The motion characteristics of the patient include both activity related characteristics and sleep related characteristics of the patient.

[0070] At step **604**, the processing unit **104** receives the second set of parameters from the mobile communication device **112**. The response of the patient to the questions of a periodic survey, as presented by the mobile communication device, determines the second set of parameters. In an

embodiment of the present invention, the second set of parameters enable the concerned party **104** to understand the patient's perception of changes in his/her motion characteristics such as fatigue, walking/running/movement impairment and weakness. In another embodiment of the present invention, along with the motion characteristics, the second set of parameters are also indicative of at least one of the group comprising bladder dysfunction, vision problems and speech impairment of the patient.

[0071] At step **606**, the processing unit **108** correlates the first set of parameters with at least one of the first set of parameters and the one or more metrics, as computed by the analytics unit **404**. In an example, the processing unit **108** compares the second set of parameters corresponding to the 12 Steps MS Walking Scale (MSWS-12) test with the first set of parameters corresponding to the motion characteristics and physiological characteristics of the patient over a period of 12 months. This enables the concerned party **104** to monitor the activity related characteristics and sleep related characteristics of the patient and compare them with the patient's perception of changes in his/her motion characteristics such as fatigue, walking/running/movement impairment and weakness.

[0072] The method **600** stops at step **608**.

[0073] FIG. **7** is a method flowchart for a method flowchart for continuously monitoring the patient for the medical condition and generating reports, according an embodiment of the disclosure. The method **700** starts at step **702**.

[0074] At step **704**, the transceiver **402** of the processor **114** receives the first set of parameters from the body worn device **110**. The motion sensors **212** and the physiological sensors **212** of the body worn device **110** continuously capture the first set of parameters that reflect motion characteristics and physiological characteristics of the patient respectively. The motion characteristics of the patient include both activity related characteristics and sleep related characteristics of the patient.

[0075] At step **706**, the transceiver **402** receives the second set of parameters from the mobile communication device **112**. The response of the patient to the questions of a periodic survey, as presented by the mobile communication device, determines the second set of parameters. In an embodiment of the present invention, the second set of parameters enable the concerned party **104** to understand the patient's perception of changes in his/her motion characteristics such as fatigue, walking/running/movement impairment and weakness. In another embodiment of the present invention, along with the motion characteristics, the second set of parameters are also indicative of at least one of the group comprising bladder dysfunction, vision problems and speech impairment of the patient.

[0076] At step **708**, the transceiver **402** receives the third set of parameters from at least one of the mobile communication device **112**. In an embodiment of the present invention, the transceiver **402** receives the third set of parameters from the body worn device **110**. The third set of parameters corresponds to the environmental data for the current location of the patient. Examples of a parameter of the third set of parameters include, but are not limited to, temperature, humidity, air quality, pollen count, carbon dioxide levels and weather data.

[0077] At step **710**, the correlation unit **406** of the processing unit **108** correlates the first set of parameters with at least one of the first set of parameters and the metrics, as computed by the analytics unit **404**. In an example, the correlation unit **406** compares the second set of parameters corresponding to the 12 Steps MS Walking Scale (MSWS-12) test with the first set of parameters corresponding to the motion characteristics and physiological characteristics of the patient over a period of 12 months. This enables the concerned party **104** to monitor the activity related characteristics and sleep related characteristics of the patient and compare them with the patient's perception of changes in his/her motion characteristics such as fatigue, walking/running/movement impairment and weakness. In an embodiment of the present invention, the correlation unit **402** correlates the first set of parameters with the third set of parameters. This enables the concerned party **104** to monitor the activity related characteristics and sleep related characteristics of the patient and track how these characteristics change with changes in the environmental data.

[0078] At step **712**, the reporting unit **408** generates a report for the patient. Typically, the report includes data corresponding to at least one of the group comprising the first set of parameters, the second set of parameters, the third set of parameters and the correlation between the first set of parameters and at least one of the second set of parameters and the third set of parameters. The data shown in the report may be dynamically defined/selected by the concerned party **104**.

[0079] At step **714**, the transceiver **402** sends the report to the concerned party **104** through the network **106**. The report may be sent to the concerned party **104** at regular intervals (such as daily at 12:00 PM, weekly and monthly), on-demand (when the concerned party **104** requests for a report corresponding to the patient), or when triggered by a condition. Typically, the condition may be defined by the concerned party **104**. An example of the condition is when the first set of parameters indicates that the patient has not been active for a predefined interval of time.

[0080] The method **700** stops at step **716**.

[0081] Now in reference to FIGS. **8** and **9**—an exemplary process/interaction flow for an integrated patient care-flow system and, or platform for receiving, recognizing, analyzing, and alerting a patient threat based on multiple device inputs is disclosed. The disclosed patient care-flow system and, or platform **10**, **20** comprises: a care-flow controller further comprising: a device interaction policy **12***b*, **22**; and a device behavioral model **13***b*, **23***b*. The care-flow system and, or platform **10** further comprises a body-worn device configured for capturing any one of a motion characteristic and, or physiological characteristic as a first set of parameters; a processor: a non-transitory storage element coupled to the processor; encoded instructions stored in the non-transitory storage element.

[0082] The encoded instructions when implemented by the processor, configure the care-flow system and, or platform **10**, **20** to: capture at least the first set of physiological and, or motion parameters of the patient from the body-worn device **11**, **21**; at least a second set of contextual parameters of the patient from at least one other device **11**, **21**. The care-flow system and, or platform **10**, **20** is further configured to aggregate device behavior of at least the captured first and a second set of parameters **12***a*, using the device interaction policy **12***b*, **22**.

[0083] Once the device input **11**, **21**—however disparate—is aggregated, the patient care-flow system and, or platform **10**, **20** constructs the composite behavior profile

13*a*, **23***a* by a behavioral model **13***b*, **23***b* and compares said composite behavior profile based on the aggregated device behavior with a reference behavioral profile. If a discrepancy between the composite behavioral profile and the reference behavioral profile is above a pre-defined threshold **14***a*, then the care-flow system and, or platform **10**, **20** assesses the potential threat and alerts the patient of said threat **15***a*, **25**. In addition to alerting the patient, the care-flow system and, or platform **10**, **20** may be configured to provide at least one automated response to the assessed and alerted patient threat **16**, **26**.

[0084] In a preferred embodiment, device data input **11**, **21** may encompass the sensor-captured raw data input or transduced and processed data input from the body worn device that is the subject of the supra device and method claims. Device input **11**, **21** may also encompass the sensor-captured raw data input or transduced and processed data input from any other device associated with the patient/user. Examples may be devices worn, mobile devices, and, or fixed-access devices, such as Internet-of-Things devices (e.g. smart thermostat, home automation consoles, etc.). The plurality of device inputs provides additional input for aggregation and behavior profiling, thus layering the behavior profile with additional context for generating a higher fidelity of predictive analytics. Alternatively, the data input **11**, **21** may be from at least two disparate devices—capturing and processing non-overlapping motion or behavior parameters. In yet other embodiments, the data input **11**, **21** may be from at least two disparate devices—capturing and processing overlapping motion or behavior parameters. For instance, the system **10**, **20** may employ a 6-axis accelerometer data input **11**, **21** of the body worn device and the 3-axis accelerometer data input **11**, **21** of an additionally worn fitness tracker and stack these motion metrics to generate a composite gait profile. Conversely, the data input **11**, **21** may be from at least two disparate devices capturing non-overlapping metrics, such as accelerometer data from the body worn device and gyroscopic data from a fitness tracker to inform the composite gait profile. Even further, these non-overlapping metrics may inform distinct sub-profiles of the composite behavioral profile (gait/posture).

[0085] In continuing reference to FIGS. **8** and **9**, these multiple and heterogenous data inputs may converge in an integration layer **21**—within or external to the care-flow controller. The integration layer may further manage the data packets—of varying format—and collate into discrete bundles of packets/formats. In other embodiments, the integration layer **21** may serve as a data format converter, converting the plurality of data formats—from disparate devices—into a universally recognized format. In yet other embodiments, the plurality of data inputs and formats converge into the interaction policy layer **22** for any one of collating the disparate data formats from a multitude of devices; and, or, converting the disparate data formats into a universally recognized data format; and aggregating the bundled and, or converted data inputs for configuring a composite behavioral profile **13***a*, **23***a*.

[0086] Devices—however disparate—including the body worn device, can communicate with either integration layer **21** and, or the interaction policy layer **12***b*, **22** wirelessly via Bluetooth—or any other short-range communication protocol—interfacing with any one of a mobile phone, Wi-Fi router and Wide Area Network access. The care-flow controller aggregates a first set of parameters from the body worn device and a second set of parameters from at least one of, a mobile communication device, wearable device, smartphone, tablet, personal digital assistant (PDA) and Internet of Things device.

[0087] The behavioral profiles, both composite and reference, take into account complete device behavior. Device behavior includes not only data output informed by patient/user behavior, but also data output informed by network and device technical characteristics. Such technical characteristics may take into account network traffic, bandwidth, network bottlenecks, network malfunctioning, device malfunctioning, sensor data acquisition fidelity, signal transduction, latency, patient feedback, etc. By taking in such device and network technical characteristics, the system or controller may be able to make a secondary assessment **15***b* of a discrepancy threshold and rule out device or network malfunctioning—verifying that the threshold discrepancy is due to a patient threat. In some embodiments, the alert of a patient threat and, or automated response is triggered only after the device and, or network anomaly is ruled out after the discrepancy threshold is reached.

[0088] Still in reference to FIGS. **8** and **9**, the care-flow controller may flag or tag a threshold discrepancy of an event between the composite behavioral profile and the reference behavioral profile **14***a*, **24** to detect a threat, whereby the threshold discrepancy is determined by machine learning algorithms **14***b*. Machine learning algorithms **14***b* may be employed to inform a threshold discrepancy rater **24** to determine whether a discrepancy threshold has been reached. Further yet, a machine learning algorithm may be employed to inform upstream processes: generating a composite behavioral profile and, or the reference behavioral profile **13***a*, **23***a* by a behavioral model/er **13***b*, **23***b*.

[0089] As shown in FIG. **9**, embodiments may include the addition of a remote server or cloud server to further provide for back-end functionality and support. The server may be situated adjacent or remotely from the system and connected to each system via a communication network. In one embodiment, the server may be used to support disparate device interaction; user/device behavior history function; disease state assessment; predictive analytics; network sharing function; patient and, or care provider alert function; disease management and, or symptom mitigation tools; and care-flow automation tools. The remote server may be further configured to provide a user-control system, which authenticates the user and retrieves behavioral data of the user, device, and, or network and applies the data against a specific group of users/patients/devices/networks for more accurate predictive modelling and disease state/patient threat assessment.

[0090] The network may be any type of network that is capable of transmitting or receiving data to/from/between user devices: computers, personal devices, telephones or any other electronic devices. Moreover, the network may be any suitable wired network, wireless network, a combination of these or any other conventional network, including any one of, or combination of a LAN or wireless LAN connection, an Internet connection, a point-to-point connection, or other network connection—either local, regional, or global. As such, the network may be further configured with a hub, router, node, and, or gateway to serve as a transit point or bridge to pass data between any of the at least networks. The network may include any software, hardware, or computer applications that implement a communication protocol

(wide or short) or facilitate the exchange of data in any of the formats known in any art, at any time. In some embodiments, any one of a hub, router, node, and, or gateway may additionally be configured for the body worn device, receiving wearable and, or IoT data, and such data may be integrated, collated, formatted for behavioral profiling, assessment/alerting a patient threat, and, or any other downstream autonomic response. Such contextualized data may further inform the suggestion tool layer or automation tool layer on suggesting reactive or proactive routines within the care-flow.

[0091] FIG. **10**, illustrates an exemplary interaction flow in which various embodiments of the disclosure can be practiced. In a preferred embodiment of the invention, the inputs **50** recognizes a command and processes input from anyone of, multiple sensors on the body worn device, a plurality of devices, patients, caregivers, doctors or concerned party and further, provides the recognized command to the care-flow controller **51**. The care-flow controller **51** receives the input **50**, recognizes the device behavior via the device interaction policy **51** and is converted and processed for a subsequent assessment of the threat alert **52** for generating a real time automatic response **53** informing the patient, caregiver, doctor or a concerned party of an imminent threat.

[0092] Further yet, in an embodiment of the invention, the inputs **50** may be motion characteristics corresponding to at least one of, physical activity, physiological and sleep related characteristics of the patient. Additionally, the physical and physiological activities may have a set of parameters corresponding to activity related characteristics of the patient to be at least one of, but not limited to, maximum/minimum value of acceleration, time of acceleration, duration of acceleration, frequency of acceleration, gap between two maximum/minimum values of acceleration, rotational velocity, direction of acceleration, orientation, a stride cycle, a left/right step, a stride length, a walking speed, a stride interval, a gait variability, a stride-to-stride interval and a variability of stride length over time. Moreover, the sleep related characteristics of the patient may be indicative of at least one of, duration of sleep time, number of times awake, sound sleep, light sleep and awake time. Additionally, environmental conditions may affect patient activity. The environmental conditions can be at least one of, but not limited to, wind velocity, temperature, humidity, aridness, light, darkness, noise pollution, exposure to UV, airborne pollution and radioactivity. Further yet, data generated from a set of parameters corresponding to at least one of, but not limited to, patient reported symptoms and side effects, periodic surveys may be used to generate a behavioral profile of a patient. The data generated may in any one of, but not limited to, audio, video or an image input and further, implemented on at least one of, but not limited to a mobile communication device, body worn device, wearable device, tablet and or IoT.

[0093] Additionally, in another embodiment of the invention, the care-flow controller **51**, aggregates the data obtained from the body worn device and generates a composite behavioral profile of a patient. Further yet, in another preferred embodiment of the invention, the device behavioral model aggregates a different set of parameters from at least one of, but not limited to, a mobile communication device (e.g. pager), wearable device, smartphone, tablet, personal digital assistant (PDA). Subsequently, after assessing the composite behavioral profile and the reference behavioral profile **52**, the care-flow controller may flag a threshold discrepancy of an event between the composite behavioral profile and the reference behavioral profile to detect a threat, whereby the threshold discrepancy is determined by machine learning algorithms.

[0094] In another embodiment of the invention, the care-flow controller **51** rules out device and, or network anomaly once a threshold discrepancy is reached by any one of a network traffic analysis, application API interactions, adaptive learning of network/device malfunctioning, and manual feedback of a certain behavior from the patient. Further yet, the alert of a patient threat **52** and, or automated response **53** is triggered only after the device and, or network anomaly is ruled out after the discrepancy threshold is reached. Further yet, in another embodiment of the invention, an automated response **53** in real-time is alerted to at least one of, patient, family member, caregiver or doctors.

[0095] Further yet, in another embodiment, the patient care-flow system may further comprise integration with any one of a third-party application via an Application Program Interface (API) **54**. This allows for 3rd party database integration, such as Electronic Medical Records (EMR), health monitoring, proxy health provisioning, remote server and, or a cloud based server for other 54 downstream analytics and provisioning. Additionally, the completed automated responses may be saved onto a remote cloud based server for easy access for data acquisition and archival analytics for future use.

[0096] In another embodiment of the invention, the care-flow controller **51** may allow for easy saving, searching, printing, and sharing of completed automated response information with authorized participants. Additionally, the care-flow controller may allow for non-API applications, for example, building reports and updates, create dashboard alerts as well as sign in/verifications **54**. Alternatively, sharing may be possible with less discrimination based on select privacy filters.

[0097] FIG. **11**A-B, illustrates a workflow automation tool diagram for prompting the system to perform a task command, provided a trigger is activated based on the threshold discrepancy. In an embodiment of the invention, at least one conditional event triggers at least one action controlled by a "if this, then that" script manager. Further yet, the "if this, then that" script manager is embedded with an "and, or" trigger or action operators, allowing increased triggers or actions in a command set.

[0098] In a preferred embodiment of the invention, for instance, for a patient suffering from epileptic seizure, as shown in FIG. **11**A, "IF" a threat is alerted to a patient "THEN" the ambulance will be on the way. In another instance, the script manager may be embedded with a "if, this, then that" as well as a "and, or" trigger or action operator for increased triggers either downstream or upstream of a command set. As shown in FIG. **11**B, "IF" a threat is alerted to a patient, "THEN", the ambulance will be alerted "AND" the nearest hospital will be notified about the incoming patient for a transfer of EMR records based on geolocation. All of the commands are automatically triggered once a discrepancy threshold is reached.

[0099] In yet another embodiment of the invention, "OR" operators may be used instead of the "AND" operator. Further, any number of "AND" and, or "OR" operator may be used in a command function. Such an automation layer

may add further efficiencies to the patient care-flow. This ecosystem of apps may provide for a link to the care-flow controller for enhanced co-interactivity among patient and care providers, diagnostics, and other measurables.

[0100] In yet another embodiment of the invention, the body worn device and alert notification mechanism generated by the care-flow system is further configured to, either receive or transmit an automated response of at least one of, notification reminders, notifications, medication reminders, activity confirmations, health analysis, health checks, from at least one of, device, mobile phone, tablet, email, text or internet server. Additionally, the automated response may be anyone of, or a combination of, duration, frequency and severity analytics of threat episodes suffered by a patient. Further yet, in another embodiment, the alert notification is at least one of, text, email, vibration with or without audible notification, visual display, and, or a color-coded or blinking notification.

[0101] Although the present disclosure describes the invention with respect to only one patient and concerned party, for a person skilled in the art it is understood that this example is just for understanding purposes and the disclosure can be implemented for monitoring a plurality of patients and a plurality of concerned parties.

[0102] In some embodiments, the method flowchart of FIG. **6** and FIG. **7** may be implemented in any suitable hardware, software, firmware, or combination thereof, that exists in the related art or that is later developed.

[0103] In the drawings and specification, there have been disclosed exemplary embodiments of the disclosure. Although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined by the following claims. Those skilled in the art will recognize that the present invention admits of a number of modifications, within the spirit and scope of the inventive concepts, and that it may be applied in numerous applications, only some of which have been described herein. It is intended by the following claims to claim all such modifications and variations which fall within the true scope of the invention.

[0104] Embodiments described in the present disclosure can be implemented by any system having a processor and a non-transitory storage element coupled to the processor, with encoded instructions stored in the non-transitory storage element. The encoded instructions when implemented by the processor configure the system to continuously monitor the plurality of patients as discussed above in FIGS. **1-11**. The systems shown in FIGS. **1-5** and **8-11** can practice all or part of the recited methods (FIGS. **6** and **7**), can be a part of the recited systems, and/or can operate according to instructions in the non-transitory storage element. The non-transitory storage element can be accessed by a general purpose or special purpose computer, including the functional design of any special purpose processor. Few examples of such non-transitory storage element can include RAM, ROM, EEPROM, CD-ROM or other optical disk storage or other magnetic. The processor and non-transitory storage element (or memory) are known in the art, thus, any additional functional or structural details are not required for the purpose of the current disclosure.

[0105] Embodiments are described at least in part herein with reference to flowchart illustrations and/or block diagrams of methods, systems, and computer program products and data structures according to embodiments of the disclosure. It will be understood that each block of the illustrations, and combinations of blocks, can be implemented by computer program instructions. These computer program instructions may be provided to a processor of a general-purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the block or blocks.

What is claimed is:

1. A method for continuously monitoring a patient to track the progress of a medical condition, the method comprising:

receiving a first set of parameters by a processing unit, wherein the first set of parameters corresponds to at least one of motion characteristics and physiological characteristics of the patient;

receiving a second set of parameters by the processing unit, wherein the second set of parameters corresponds to information provided by the patient in response to a periodic survey; and

correlating the first set of parameters with the second set of parameters by the processing unit;

whereby, at least one of the first set of parameters, the second set of parameters and the correlation between the first set of parameters and the second set of parameters determine the progress of the medical condition.

2. The method of claim **1**, further comprising receiving a third set of parameters by the processing unit, wherein the third set of parameters corresponds to environmental data, and wherein the environmental data includes at least one of the group comprising temperature, humidity, air quality, pollen count, carbon dioxide levels and weather data.

3. The method of claim **1**, further comprising correlating the third set of parameters with the first set of parameters by the processing unit.

4. The method of claim **1**, wherein the medical condition is selected from the group comprising Multiple Sclerosis (MS), Primary Progressive Multiple Sclerosis (PPMS), Huntington's disease, Chorea, Epilepsy, Parkinson's disease, Seizures Post Stroke conditions, Tobacco use related conditions, Asthma, Cancer, Arthritis, Chronic Obstructive Pulmonary Disease (COPD), Diabetes, heart disease, Obesity, Osteoporosis, Alzheimer's disease, Reflex Sympathetic Dystrophy (RSD) Syndrome, Pruritus and Chronic kidney disease (CKD).

5. The method of claim **1**, wherein the motion characteristics of the patient correspond to at least one of activity related characteristics and sleep related characteristics of the patient.

6. The method of claim **5**, wherein a parameter of the first set of parameters corresponding to the activity related characteristics of the patient is at least one of the group comprising maximum value of acceleration, minimum value of acceleration, time of acceleration, duration of acceleration, frequency of acceleration, gap between two maximum/minimum values of acceleration, rotational velocity, direction of acceleration, orientation, a stride cycle, a left/right step, a stride length, a walking speed, a stride interval, a gait variability, a stride-to-stride interval and a variability of stride length over time.

7. The method of claim **5**, wherein a parameter of the first set of parameters corresponding to the sleep related characteristics of the patient is indicative of at least one of the

group comprising sleep time, number of times awake, duration of sound sleep, duration of light sleep and awake time.

8. The method of claim **5**, wherein the first set of parameters corresponding to the motion characteristics of the patient are captured by one or more sensors selected from the group comprising a motion sensor, an accelerometer, a 3D accelerometer, a gyroscope, a global positioning system sensor (GPS), a magnetometer, an inclinometer and an impact sensor.

9. The method of claim **1**, wherein a parameter of the first set of parameters corresponding to physiological characteristics of the patient is one of group comprising heart rate, pulse rate, respiratory rate and body temperature.

10. The method of claim **1**, wherein the first set of parameters is captured by a body worn device of the patient.

11. The method of claim **10**, wherein the second set of parameters is provided by the patient using at least one of a mobile communication device and the body worn device of the patient.

12. The method of claim **1**, wherein a parameter of the second set of parameters is indicative of at least one of the group comprising fatigue, walking/running/movement related impairment, weakness, bladder dysfunction, vision problems and speech impairment of the patient.

13. The method of claim **1**, further comprising generating reports based on at least one of the first set of parameters, the second set of parameters and the correlation between the first set of parameters and the second set of parameters.

14. The method of claim **13**, further comprising sending the reports to a concerned party, wherein the concerned party is at least one of the group comprising a healthcare provider, a hospital, a health monitoring service, a doctor, a physician, a clinician, a caregiver and a social service.

15. The method of claim **1**, further comprising establishing a personal motion signature of the patient based on the first set of parameters.

16. The method of claim **15**, further comprising detecting a deviation from the personal motion signature of the patient using machine learning algorithms.

17. The method of claim **16**, further comprising sending a notification to at least one of the patient and a concerned party when the deviation from the personal motion signature of the patient is detected.

18. A body worn device comprising:

a processor, a non-transitory storage element coupled to the processor, encoded instructions stored in the non-transitory storage element, wherein the encoded instructions when implemented by the processor, configure the body worn device to:

capture a first set of parameters of a patient, wherein the first set of parameters corresponds to at least one of motion characteristics and physiological characteristics of the patient;

capture a second set of parameters, wherein the second set of parameters corresponds to information provided by the patient in response to a periodic survey; and

sending the first set of parameters and the second set of parameters to a processing unit using a transceiver;

whereby, at least one of the first set of parameters, the second set of parameters and a correlation between the first set of parameters and the second set of parameters determine the progress of a medical condition in the patient.

19. The body worn device of claim **18** further comprising one or more sensors selected from the group comprising a motion sensor, an accelerometer, a 3D accelerometer, a gyroscope, a global positioning system sensor (GPS), a magnetometer, an inclinometer, an impact sensor, a heart rate monitor, a pulse rate monitor, a respiratory rate monitor and body temperature sensor.

20. The body worn device of claim **18** further comprising an input unit, wherein the patient provides the information in response to the periodic survey using the input unit.

21. A patient care-flow system, said system comprising:

a care-flow controller comprising:

a device interaction policy;

a device behavioral model;

a body-worn device configured for capturing any one of a physical and, or physiological characteristic as a first set of parameters;

a processor:

a non-transitory storage element coupled to the processor;

encoded instructions stored in the non-transitory storage element, wherein the encoded instructions when implemented by the processor, configure the system to:

capture at least the first set of physiological and, or motion parameters of the patient from the body-worn device; at least a second set of contextual parameters of the patient from at least one other device;

aggregate device behavior of at least the captured first and a second set of parameters using the device interaction policy;

construct a composite behavioral profile based on the aggregated device behavior and comparing said composite behavioral profile with a reference behavioral profile by the device behavioral model;

assess and alert a patient threat to any one of the patient and, or provider by detecting a discrepancy between the composite behavioral profile and the reference behavioral profile above a predefined threshold; and

provide an automated response to the assessed and alerted patient threat.

22. The patient care-flow system of claim **21**, wherein the first set of parameters corresponding to motion and, or physiological characteristics of the patient from the body worn device is at least one of, maximum and minimum value of acceleration, time of acceleration, duration of acceleration, frequency of acceleration, gap between two maximum/minimum values of acceleration, rotational velocity, direction of acceleration, orientation, a stride cycle, a left/right step, a stride length, a walking speed, a stride interval, a gait variability, a stride-to-stride interval and a variability of stride length over time.

23. The patient care-flow system of claim **21**, wherein a set of parameters corresponding to an environmental condition surrounding the patient is at least one of, wind velocity, temperature, humidity, aridness, light, darkness, noise pollution, exposure to UV, airborne pollution and radioactivity.

24. The patient care-flow system of claim **21**, wherein the care-flow controller aggregates a second set of parameters from at least one of, a mobile communication device, wearable device, smartphone, tablet, personal digital assistant (PDA) and Internet of Things device.

25. The patient care-flow system of claim **21**, wherein the care-flow controller may flag a threshold discrepancy of an event between the composite behavioral profile and the

reference behavioral profile to detect a threat, whereby the threshold discrepancy is determined by machine learning algorithms.

26. The patient care-flow system of claim **21**, wherein the care-flow controller rules out device and, or network anomaly once a threshold discrepancy is reached by any one of a network traffic analysis; application API interactions; adaptive learning of network/device malfunctioning; and manual feedback of a certain behavior from the patient.

27. The patient care-flow system of claim **26**, wherein the alert of a patient threat and, or automated response is triggered only after the device and, or network anomaly is ruled out after the discrepancy threshold is reached.

28. The patient care-flow system of claim **21**, further comprising integration with any one of a third-party application via an Application Program Interface (API).

29. The patient care-flow system of claim **21**, further comprising integration with any one of, electronic medical records (EMR), remote server, and, or a cloud-based server for down-stream analytics and, or provisioning.

30. The patient care-flow system of claim **21**, wherein at least one conditional event triggers at least one action controlled by a "if this, then that" script manager.

31. The system of claim **21**, wherein a "if this, then that" script manager is further embedded with an "and, or" trigger or action operators, allowing increased triggers or actions in a command set.

32. The patient care-flow system of claim **21**, wherein the patient threat alert is at least one of, text, email, vibration with or without audible notification, visual display, and, or a color-coded or blinking notification.

33. The patient care-flow system of claim **21**, wherein the automated response is anyone of, or a combination of, duration, frequency and severity analytics of threat episodes.

34. The patient care-flow system of claim **21**, wherein the assessed and alerted patient threat is related to any of, or combination of, Multiple Sclerosis (M.S.), Primary Progressive Multiple Sclerosis (PPMS), Huntington's Disease, Epilepsy, Chorea, Parkinson's Disease, Seizures, and, or any post-stroke conditions.

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专利名称(译)	用于连续监测患者的医疗状况的方法和系统		
公开(公告)号	US20170231528A1	公开(公告)日	2017-08-17
申请号	US15/431538	申请日	2017-02-13
[标]申请(专利权)人(译)	SMART MONITOR		
[标]发明人	NATHAN ANOO		
发明人	NATHAN, ANOO		
IPC分类号	A61B5/11 A61B5/01 A61B5/0205 G06N99/00 A61B5/00		
CPC分类号	A61B5/112 A61B5/0816 A61B5/1118 A61B5/4806 A61B5/1112 A61B5/4082 A61B5/4088 A61B5/4094 A61B5/4504 A61B5/6801 A61B5/0205 A61B5/01 A61B5/7264 A61B5/74 G06F19/363 A61B2562/0219 A61B2562/0223 A61B5/024 G06N99/005 A61B5/0002 A61B5/1122 A61B5/4842 A61B5/6802 A61B5/6898 G06N20/00 G16H10/20		
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摘要(译)

本发明描述了使相关方能够连续监测一个或多个患者的医疗状况的进展的方法和系统。通过处理从一个或多个生理和/或运动传感器获得的传感器数据和从患者获得的调查数据来确定医学状况的进展。此外，诸如空气质量，温度和湿度的环境数据也可以与传感器数据和调查数据一起使用，以监视/跟踪医疗状况的进展。