[0006] A system of one or more computers can be configured to perform particular operations or actions by virtue of having software, firmware, hardware, or a combination of them installed on the system that in operation causes or cause the system to perform the actions. One or more computer programs can be configured to perform particular operations or actions by virtue of including instructions that, when executed by data processing apparatus, cause the apparatus to perform the actions. Disclosed herein is a method including: obtaining, by a data processing system, input data; parsing, by the data processing system, the input data to identify sensor data from a sensor; and comparing, by the data processing system, a first energy level and a second energy level from the sensor data to one or more energy levels associated with a dry or normalized condition for an environment in which the sensor is deployed, where the first energy level is obtained at a first time and the second energy level is obtained at a second time that is after the first time. The method also includes determining, by the data processing system, the first energy level is associated with the dry or normalized condition based on the comparison; determining, by the data processing system, the second energy level is associated with a moisture event based on the comparison; and in response to determining the second energy level is associated with a moisture event, determining, by the data processing system, a subject associated with the sensor has had an incontinence event. The method also includes determining, by the data processing system, the sensor data does not include a third energy level within a predefined period of time after receipt of the second energy level at the second time; in response to determining the sensor data does not include the third energy level, determining, by the data processing system, a undergarment or absorbent pad associated with the subject has become saturated; and providing, by the data processing system, a user interface displaying information concerning the incontinence event and the undergarment or absorbent pad associated with the subject has become saturated. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[0007] Implementations may include one or more of the following features. The method where the parsing includes grouping the sensor data from the sensor over a window of time based on a unique identifier associated with the sensor. The method where the determining the second energy level is associated with the moisture event includes determining a change between the first energy level and the second energy level exceeds a predetermined energy threshold associated with the moisture event or the second energy level exceeds a

predetermined energy threshold associated with the moisture event. The method where the first energy level is a first impedance value and the second energy level is a second impedance value different from the first impedance value. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

[0008] Disclosed herein is a method including: obtaining, by a data processing system, input data; parsing, by the data processing system, the input data to identify sensor data from a sensor; and comparing, by the data processing system, a first energy level and a second energy level from the sensor data to one or more energy levels associated with a dry or normalized condition for an environment in which the sensor is deployed, where the first energy level is obtained at a first time and the second energy level is obtained at a second time that is after the first time. The method also includes determining, by the data processing system, the first energy level is associated with the dry or normalized condition based on the comparison of the first energy level to the second energy level; determining, by the data processing system, the second energy level is associated with a moisture event based on the comparison; and in response to determining the second energy level is associated with a moisture event, determining, by the data processing system, a subject associated with the sensor has had an incontinence event. The method also includes determining, by the data processing system, the sensor data includes a third energy level within a predefined period of time after receipt of the second energy level at the second time; and in response to determining the sensor data does include the third energy level, comparing, by the data processing system, the third energy level to the second energy level. The method also includes determining, by the data processing system, the third energy level is associated with a drying event based on the comparison of the third energy level to the second energy level; in response to determining the third energy level is associated with a drying event, determining, by the data processing system, a undergarment or absorbent pad associated with the subject is unsaturated; and providing, by the data processing system, a user interface displaying information concerning the incontinence event and the undergarment or absorbent pad associated with the subject is unsaturated. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[0009] Implementations may include one or more of the following features. The method where the parsing includes grouping the sensor data from the sensor over a window of time

based on a unique identifier associated with the sensor. The method where the determining the second energy level is associated with the moisture event includes determining a change between the first energy level and the second energy level exceeds a predetermined energy threshold associated with the moisture event or the second energy level exceeds a predetermined energy threshold associated with the moisture event. The method where the determining the third energy level is associated with a drying event includes determining a change between the second energy level and the third energy level exceeds a predetermined drying threshold associated with a drying event or the third energy level exceeds a predetermined drying threshold associated with a drying event. The method where the first energy level is a first impedance value and the second energy level is a second impedance value different from the first impedance value, and the third energy level is a third impedance value different from the first impedance value and the second impedance value. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

[0010] Disclosed herein is a method including: obtaining, by a data processing system, input data; parsing, by the data processing system, the input data to identify sensor data from a sensor; and comparing, by the data processing system, a first energy level and a second energy level from the sensor data to one or more energy levels associated with a stationary position, where the first energy level is obtained at a first time and the second energy level is obtained at a second time that is after the first time. The method also includes determining, by the data processing system, the first energy level is associated with the stationary position based on the comparison. The method also includes determining, by the data processing system, the second energy level is associated with a motion event based on the comparison. The method also includes in response to determining the second energy level is associated with a motion event, determining, by the data processing system, a subject associated with the sensor has moved; and determining, by the data processing system, the sensor data includes a third energy level within a predefined period of time after receipt of the second energy level at the second time. The method also includes in response to determining the sensor data includes the third energy level, determining, by the data processing system, the third energy level is different from the second energy level and the third energy level exceeds a predetermined activity threshold associated with an activity. The method also includes predicting, by a prediction model of the data processing system, the activity is a subject rolling over in bed or getting out of bed based on a pattern of the sensor data, the

determination of the motion event, and the determination that the third energy level is different from the second energy level and the third energy level exceeds the predetermined activity threshold. The method also includes recording, by the data processing system, the prediction that the subject has rolled over in bed or gotten out of bed. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[0011] Implementations may include one or more of the following features. The method where the parsing includes grouping the sensor data from the sensor over a window of time based on a unique identifier associated with the sensor. The method where the determining the second energy level is associated with the motion event includes determining a change between the first energy level and the second energy level exceeds a predetermined energy threshold associated with the motion event or the second energy level exceeds a predetermined energy threshold associated with the motion event. The method where the first energy level is a first impedance value and the second energy level is a second impedance value different from the first impedance value, and the third energy level is a third impedance value different from the first impedance value and the second impedance value. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

[0012] Disclosed herein is an absorbent article including: a liquid permeable top sheet. The absorbent article also includes an absorbent material disposed under the liquid permeable top sheet. The absorbent article also includes a nonabsorbent material disposed adjacent to at least a portion of the liquid permeable top sheet or the absorbent material. The absorbent article also includes a liquid impermeable back sheet disposed over the absorbent material such that the absorbent material is disposed between the liquid permeable top sheet and the liquid impermeable back sheet. The absorbent article also includes one or more attachment structures attached to the liquid impermeable back sheet, where the one or more attachment structures are structured to hold one or more sensors.

[0013] Implementations may include one or more of the following features. The absorbent article where the one or more attachment structures are one or more sleeve structures. The absorbent article where a first attachment structure of the one or more attachment structures is attached to the liquid impermeable back sheet on an anterior side of the liquid impermeable

back sheet over an interface between the underlying absorbent material and the nonabsorbent material. The absorbent article where a second attachment structure of the one or more attachment structures is attached to the liquid impermeable back sheet over an outer margin of the nonabsorbent material. The absorbent article where a fourth attachment structure of the one or more attachment structures is attached to the liquid impermeable back sheet on a posterior side of the liquid impermeable back sheet over an interface between the underlying absorbent material and the nonabsorbent material. The absorbent article where a third attachment structure of the one or more attachment structures is attached to the liquid impermeable back sheet on an anterior side of the liquid impermeable back sheet over the underlying absorbent material. The absorbent article where the one or more attachment structures are a magnetic structure. The absorbent article further including the one or more sensors, where each sensor of the one or more sensors is disposed in a respective attachment structure of the one or more attachment structures. The absorbent article where the one or more sensors are one or more radio frequency identification (RFID) sensors.

[0014] Disclosed herein is an absorbent article including: a liquid permeable top sheet. The absorbent article also includes an absorbent material disposed under the liquid permeable top sheet. The absorbent article also includes a nonabsorbent material disposed adjacent to at least a portion of the liquid permeable top sheet or the absorbent material. The absorbent article also includes a liquid impermeable back sheet disposed over the absorbent material such that the absorbent material is disposed between the liquid permeable top sheet and the liquid impermeable back sheet. The absorbent article also includes one or more sensors attached to the liquid impermeable back sheet.

[0015] Implementations may include one or more of the following features. The absorbent article where the one or more sensors are one or more radio frequency identification (RFID) sensors. The absorbent article where a first sensor of the one or more sensors is attached to the liquid impermeable back sheet on an anterior side of the liquid impermeable back sheet over an interface between the underlying absorbent material and the nonabsorbent material. The absorbent article where a second sensor of the one or more sensors is attached to the liquid impermeable back sheet over an outer margin of the nonabsorbent material. The absorbent article where a third sensor of the one or more sensors is attached to the liquid impermeable back sheet on an anterior side of the liquid impermeable back sheet over the underlying absorbent material. The absorbent article where a fourth sensor of the one or more sensors is attached to the liquid impermeable back sheet on a posterior side of the liquid

impermeable back sheet over an interface between the underlying absorbent material and the nonabsorbent material.

[0016] According to an aspect, there is provided a system including: an absorbent article including: a liquid permeable top sheet, an absorbent material disposed under the liquid permeable top sheet, a nonabsorbent material disposed adjacent to at least a portion of the liquid permeable top sheet or the absorbent material, a liquid impermeable back sheet disposed over the absorbent material such that the absorbent material is disposed between the liquid permeable top sheet and the liquid impermeable back sheet, and one or more sensors attached to the liquid impermeable back sheet. The system also includes an internet of things (IoT) device in wireless communication with the one or more sensors.

[0017] Implementations may include one or more of the following features. The system where the one or more sensors are one or more radio frequency identification (RFID) sensors. The system where the IoT device includes a RFID reader and a controller. The system where a first sensor of the one or more sensors is attached to the liquid impermeable back sheet on an anterior side of the liquid impermeable back sheet over an interface between the underlying absorbent material and the nonabsorbent material. The system where a second sensor of the one or more sensors is attached to the liquid impermeable back sheet over an outer margin of the nonabsorbent material. The system where a third sensor of the one or more sensors is attached to the liquid impermeable back sheet on an anterior side of the liquid impermeable back sheet over the underlying absorbent material. The system where a fourth sensor of the one or more sensors is attached to the liquid impermeable back sheet on a posterior side of the liquid impermeable back sheet over an interface between the underlying absorbent material and the nonabsorbent material. The system further including an angled bracket including a first end attached to the IoT device and a second end attached to an external antenna connected to the IoT device.

[0018] Disclosed herein is a measurement system including: a container. The measurement system also includes a linear array of sensors attached to the container, where each sensor of the array of sensors is positioned on the container relative to a respective liquid volume indictor. The measurement system also includes a computing device including a processor and a memory storage device, where a data table is stored in the memory storage device and the table includes a unique identifier for each sensor of the array of sensors and a respective liquid volume indexed with the unique identifier.

[0019] Disclosed herein is a method including: (i) obtaining, by a data processing system, input data. The method also includes (ii) parsing, by the data processing system, the input data to identify all sensor data collected by an internet of things (IoT) device from a plurality of sensors disposed on a collection device, where the parsing includes grouping the sensor data into subsets of sensor data received from each sensor of the plurality of sensors over the window of time based on a unique identifier associated with each of the sensors, and where at least one subset of sensor data received from a sensor of the plurality of sensors includes a first energy level obtained at a first time and a second energy level obtained at a second time that is after or later than the first time. The method also includes (iii) comparing, by the data processing system, a first energy level and a second energy level from the sensor data to one or more energy levels associated with a dry or normalized condition for an environment in which the plurality of sensors are deployed. The method also includes (iv) determining, by the data processing system, the first energy level is associated with the dry or normalized condition based on the comparison. The method also includes (v) determining, by the data processing system, the second energy level is associated with a moisture event based on the comparison. The method also includes (vi) in response to determining the second energy level is associated with a moisture event, identifying, by the data processing system, a liquid volume associated with the sensor that is associated with the at least one subset of sensor data. The method also includes repeating, by the data processing system, steps (iii)-(vi) for all other subsets of sensor data associated with other sensors of the plurality of sensors to identify additional liquid volumes associated with the other sensors. The method also includes analyzing, by the data processing system, the liquid volume associated with the sensor and the additional liquid volumes associated with the other sensors to determine a total liquid volume of the collection device. The method also includes providing, by the data processing system, a user interface displaying the total liquid volume of the collection device. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[0020] Disclosed herein is a method including: obtaining, by a data processing system, sensor data from a plurality of radio frequency identification (RFID) sensors associated with a subject. The method also includes determining, by the data processing system using the sensor data, a plurality of incontinent events over a period of time. The method also includes determining, by the data processing system using the determined plurality of incontinent

events, a mean intervoiding interval for the subject. The method also includes determining, by the data processing system, a statistical aberration in the determined plurality of incontinent events based on the mean intervoiding interval. The method also includes predicting, by a prediction model, a risk of a subject having or developing a urinary tract infection based on the sensor data and the statistical aberration. The method also includes providing, by the data processing system, a user interface displaying information concerning the predicted risk of the subject having or developing the urinary tract infection. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[0021] Implementations may include one or more of the following features. The method further including: in response to determining the statistical aberration, triggering, by the data processing system, a request for a urinalysis and urine culture to be performed for the subject. The method further including obtaining, by the data processing system, results of the urinalysis and urine culture, where the predicting the risk of the subject having or developing the urinary tract infection is based on the sensor data, the statistical aberration, and the results of the urinalysis and urine culture. The method further including obtaining, by the data processing system, additional data including time interval of meals, iv rates, g tube feed rates, or a combination thereof, where the predicting the risk of the subject having or developing the urinary tract infection is based on the sensor data, the statistical aberration, the results of the urinalysis and urine culture, and the additional data. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

[0022] Disclosed herein is a method including: obtaining, by a data processing system, sensor data from a plurality of radio frequency identification (RFID) sensors associated with a subject. The method also includes determining, by the data processing system using the sensor data, a plurality of motion events over a period of time. The method also includes determining, by a first prediction model, using the determined plurality of motion events, a pattern of motion activity. The method also includes predicting, by a second prediction model, a risk of a subject having or developing a decubitus based on the sensor data and the pattern of motion activity. The method also includes providing, by the data processing system, a user interface displaying information concerning the predicted risk of the subject having or developing the decubitus. Other embodiments of this aspect include corresponding

computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[0023] Implementations may include one or more of the following features. The method further including obtaining, by the data processing system, additional data including frequency of staff engagement with the subject, where the predicting the risk of the subject having or developing the decubitus is based on the sensor data, the pattern of motion activity, and the additional data. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

[0024] Disclosed herein is a system including: an absorbent article comprising: a liquid permeable top sheet; an absorbent material disposed under the liquid permeable top sheet; a nonabsorbent material disposed adjacent to at least a portion of the liquid permeable top sheet or the absorbent material; a liquid impermeable back sheet disposed over the absorbent material such that the absorbent material is disposed between the liquid permeable top sheet and the liquid impermeable back sheet; and one or more sensors attached to the liquid impermeable back sheet; and an internet of things (IoT) device connected to a first and second antenna in wireless communication with the one or more sensors, where the first antenna is positioned orthogonal to the second antenna.

[0025] Implementations may include one or more of the following features. The system where the first antenna, the second antenna, or both the first and second antenna comprise a quadrifilar helix antenna. The system further including a bed, where the first antenna is disposed at a foot of the bed and the second antenna is located under a mattress of the bed or under the bed. The system further including an angled bracket comprising a first end attached to the IoT device and a second end attached to the first antenna, where the angled bracket is attached to a foot board of the bed. The system where the first antenna is disposed within a predetermined distance of the one or more sensors and arranged at any angle within a transmitted plane perpendicular to a first axis (x-axis) of radio signal propagation from the one or more sensors. The system where the second antenna is disposed within the predetermined distance of the one or more sensors and arranged at any angle within a transmitted plane perpendicular to a second axis (y-axis) of radio signal propagation from the one or more sensors.

[0026] Disclosed herein is a method including: obtaining, by a data processing system, input data; parsing, by the data processing system, the input data to identify sensor data from a

sensor associated with an undergarment or absorbent pad used with a subject, where the sensor data includes multiple energy levels obtained within a window of time from a first and second antenna connected to an internet of things (IoT) device, where the first and second antenna are in wireless communication with the sensor, where the first antenna is positioned orthogonal to the second antenna, and where the first antenna is disposed at a foot of a bed and the second antenna is located under a mattress of the bed or under the bed; comparing, by the data processing system, a first energy level obtained by the first antenna at a first period of time to a second energy level obtained by the second antenna at a second period of time; determining, by the data processing system, based on the comparison of the first energy level and the second energy level, whether the first energy level is greater than or less than the second energy level; when the first energy level is greater than the second energy level, determining, by the data processing system, that a first position of the subject through the first period of time and the second period of time is the subject lying on their side in the bed; and when the first energy level is less than the second energy level, determining, by the data processing system, that the first position of the subject through the first period of time and the second period of time is the subject lying on their back in the bed.

[0027] Disclosed herein is a method including: obtaining, by a data processing system, input data; parsing, by the data processing system, the input data to identify sensor data from a sensor, where the sensor data comprises multiple signal responses within a window of time; determining, by the data processing system, a first energy level for a first period of time within the window of time, where the first energy level is determined as (i) an average signal response, or (ii) a signal response at a virtual frequency determined using linear regression, of multiple signal responses over the first period of time; comparing, by the data processing system, the first energy level to a moisture threshold for the sensor, where the moisture threshold is determined by adding a predetermined error value to a baseline average signal response or a signal response of the sensor at the virtual frequency determined using linear regression of multiple energy states over a period of time for dry or normalized conditions for an environment in which the sensor is deployed; determining, by the data processing system, based on the comparison, whether the first energy level is greater than, equal to, or less than the moisture threshold; when the first energy level is less than the moisture threshold, determining, by the data processing system, the first energy level is associate with dry or normalized conditions for the environment; and when the first energy level is greater than or

equal to the moisture threshold, determining, by the data processing system, the first energy level is associate with wet conditions.

[0028] In some embodiments, a system is provided that includes one or more data processors and a non-transitory computer readable storage medium containing instructions which, when executed on the one or more data processors, cause the one or more data processors to perform part or all of one or more methods disclosed herein.

[0029] In some embodiments, a computer-program product is provided that is tangibly embodied in a non-transitory machine-readable storage medium and that includes instructions configured to cause one or more data processors to perform part or all of one or more methods disclosed herein.

[0030] Disclosed herein is a system including one or more data processors. In some embodiments, the system includes a non-transitory computer readable storage medium containing instructions which, when executed on the one or more data processors, cause the one or more data processors to perform part or all of one or more methods and/or part or all of one or more processes disclosed herein. Some embodiments of the present disclosure include a computer-program product tangibly embodied in a non-transitory machine-readable storage medium, including instructions configured to cause one or more data processors to perform part or all of one or more methods and/or part or all of one or more processes disclosed herein.

[0031] The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed. Thus, it should be understood that although the present invention as claimed has been specifically disclosed by embodiments and optional features, modification and variation of the concepts herein disclosed may be resorted to by those skilled in the art, and that such modifications and variations are considered to be within the scope of this invention as defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] FIG. 1 shows a management platform in accordance with various embodiments.

CLAIMS

1. A system comprising:

an absorbent article comprising:

a liquid permeable top sheet;

an absorbent material disposed under the liquid permeable top sheet;

a nonabsorbent material disposed adjacent to at least a portion of the liquid permeable top sheet or the absorbent material;

a liquid impermeable back sheet disposed over the absorbent material such that the absorbent material is disposed between the liquid permeable top sheet and the liquid impermeable back sheet;

one or more sensors attached to the liquid impermeable back sheet; and

an internet of things (IoT) device connected to at least one antenna in wireless communication with the one or more sensors.

2. The system of claim 1, wherein the IoT device is connected to first and second antennas.

3. The system of claim 2, wherein the first antenna is orthogonal to the second antenna.

4. The system of any one of the preceding claims, wherein the one or more sensors comprise at least one radio frequency identification (RFID) sensor integrated to the liquid-impermeable backsheet and configured to sense moisture and/or temperature without reliance on conductive trace grids bridging electrodes on the absorbent article.

5. The system of claim 4, wherein the system comprises a single RFID sensor.

6. The system of any one of the preceding claims, wherein the absorbent article is worn by the subject such that the sensor(s) are above any bed linens.

7. The system of claim 4, wherein the IoT device is configured to interrogate a plurality of RFID sensors within a scan window using an RFID anti-collision protocol.

8. The system of claim 2, wherein the first antenna, the second antenna, or both the first and second antenna comprise a quadrifilar helix antenna.

9. The system of any one of the preceding claims, wherein a first sensor of the one or more sensors is attached to the liquid impermeable back sheet on an anterior side of the liquid impermeable back sheet over an interface between the underlying absorbent material and the nonabsorbent material.

10. The system of claim 9, wherein a second sensor of the one or more sensors is attached to the liquid impermeable back sheet over an outer margin of the nonabsorbent material.

11. The system of claims 10, wherein a third sensor of the one or more sensors is attached to the liquid impermeable back sheet on an anterior side of the liquid impermeable back sheet over the underlying absorbent material.

12. The system of claim 11, wherein a fourth sensor of the one or more sensors is attached to the liquid impermeable back sheet on a posterior side of the liquid impermeable back sheet over an interface between the underlying absorbent material and the nonabsorbent material.

13. The system of claim 2, further comprising a bed, wherein the first antenna is disposed at a foot of the bed and the second antenna is located under a mattress of the bed or under the bed.

14. The system of claim 13, further comprising an angled bracket comprising a first end attached to the IoT device and a second end attached to the first antenna, wherein the angled bracket is attached to a foot board of the bed.

15. The system of claim 2, wherein the first antenna is disposed within a predetermined distance of the one or more sensors and arranged at any angle within a transmitted plane perpendicular to a first axis (x-axis) of radio signal propagation from the one or more sensors.

16. The system of claim 15, wherein the second antenna is disposed within the predetermined distance of the one or more sensors and arranged at any angle within a transmitted plane perpendicular to a second axis (y-axis) of radio signal propagation from the one or more sensors.

17. The system of claim 15 or 16, wherein the predetermined distance is 1 meter.