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; 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, wherein the first antenna is positioned orthogonal to the second antenna.

2. The system of claim 1, wherein the one or more sensors are one or more radio frequency identification (RFID) sensors, and wherein each RFID sensor comprises a temperature sensing circuit.

3. The system of claim 1 or 2, wherein the first antenna, the second antenna, or both the first and second antenna comprise a quadrifilar helix antenna.

4. The system of claim 1, 2, or 3, 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.

5. The system of any of claims 1 to 4, 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.

6. The system of any of claims 1 to 5, 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.

7. The system of any of claims 1 to 6, 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.

8. The system of any of claims 1 to 7, 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.

9. The system of claim 8, 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.

10. The system of any of claims 1 to 9, 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.

11. The system of claim 10, 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.

12. The system of claim 10 or 11, wherein the predetermined distance is 1 meter.

13. A method comprising:

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, wherein 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, wherein the first and second antenna are in wireless communication with the sensor, wherein the first antenna is positioned orthogonal to the second antenna, and wherein 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.

14. The method of claim 13, wherein the parsing includes grouping the sensor data from the sensor over a window of time based on a unique identifier associated with the sensor and a unique identifier associated with each of the first antenna and the second antenna.

15. The method of claim 13 or 14, further comprising:

comparing, by the data processing system, a third energy level obtain by the first antenna at a third period of time to a fourth energy level obtained by the second antenna at a fourth period of time;

determining, by the data processing system, based on the comparison of the third energy level and the fourth energy level, whether the third energy level is greater than or less than the fourth energy level;

when the third energy level is greater than the fourth energy level, determining, by the data processing system, that a second position of the subject through the third period of time and the fourth period of time is the subject lying on their side in the bed; and

when the third energy level is less than the fourth energy level, determining, by the data processing system, that the second position of the subject through the third period of time and the fourth period of time is the subject lying on their back in the bed;

comparing, by the data processing system, the first position of the subject to the second position of the subject;

determining, by the data processing system, based on the comparison of the first position of the subject to the second position of the subject, whether the first position of the subject is the same or different from the second position of the subject;

when the first position of the subject is the same as the second position of the subject, determining, by the data processing system, that the subject has not changed positions and is static; and

when the first position of the subject is different from the second position of the subject, determining, by the data processing system, that the subject has changed positions and is dynamic.

16. The method of claim 15, further comprising recording, by the data processing system, the subject has not changed positions and is static or has changed positions and is dynamic between the first time and the second time.

17. A system comprising:

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 actions including:

obtaining input data;

parsing the input data to identify sensor data from a sensor associated with an undergarment or absorbent pad used with a subject, wherein 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, wherein the first and second antenna are in wireless communication with the sensors, wherein the first antenna is positioned orthogonal to the second antenna, and wherein 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 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 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 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 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.

18. 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 actions including:

obtaining input data;

parsing the input data to identify sensor data from a sensor associated with an undergarment or absorbent pad used with a subject, wherein 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, wherein the first and second antenna are in wireless communication with the sensors, wherein the first antenna is positioned orthogonal to the second antenna, and wherein 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 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 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 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 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.

19. A method comprising:

obtaining, by a data processing system, input data;

parsing, by the data processing system, the input data to identify sensor data from a sensor, wherein 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, wherein 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, wherein 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.

20. The method of claim 19, wherein the parsing includes grouping the sensor data from the sensor over the window of time based on a unique identifier associated with the sensor.