



# A development of an intelligent bed pad for reducing pressure sores of bed-bound patients using IoT technologies

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## Abstract

Pressure sores are frequently found in bed-bound patients who regularly have to sleep on the same positions for a continuous and long period of time. This symptom can lead to fatality if some serious complications occur. Therefore, to reduce the opportunity of bed sore occurrences, this project presents an intelligent bed pad for monitoring and suggesting the sleeping patterns of bed-bound patients. It is based on machine-learning techniques and IoT technology. The bed pad utilizes a set of force sensors to measure the pressures that the different body parts of the patient have pressed on the pad. Then, a classification algorithm is deployed to detect the current sleeping position of the patient. Finally, the patient's sleeping position, sleeping time duration, temperature and humidity data are used together to determine whether it is time for the patients to change their sleeping position. LINE notifications will be sent to caregivers. Based on the experimental results, the proposed system gives very satisfactory performance. It can detect the patient's sleep position with the accuracy of 90% and above, and all sensors are working accurately.

## Objective

- To study the sleeping positions and bed sore locations for bed-bound patients.
- To apply Internet of Thing (IoT) technology and machine-learning principles to the domain of pressure sores treatment for bed-bound patients.
- To develop a smart bed pad that can be used to reduce the occurrence of pressure sores for bed-bound patients.

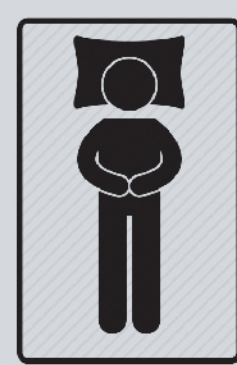
## Project Scope

- Use temperature and relative humidity sensor (DHT22) and force-sensing resistors (FSR) sensor.
- Visualize sensor data on a dashboard.
- Use machine-learning algorithms for determining patient's sleeping positions.
- Send LINE Notifications to caretakers when patients have not changed their sleeping positions for a continuous and long period of time

## Background Knowledge

### The flip position. (Keep moving)

Patients who are unable to move themselves need to change their sleeping positions every 2 hours by using the technique of "lift, arrange, pull, see".



#### • Supine position

Use 30-30-degree setting: set your head no more than 30 degrees (rotate 1 pillow about 3 inches high) and knee 30 degrees.



#### • Side position

Set the hips at an angle of 30 degrees to the bed floor and the head must not exceed 30 degrees. The patient may be tilted, semi-prone, or semi-supine.

### Classification technique

#### • Random forests(RF)

It is a technique that randomly selects multiple sets of attributes (features), and create a model using Decision tree technique.

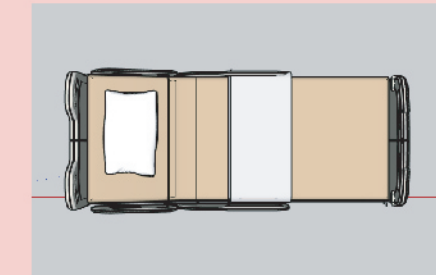
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## Method

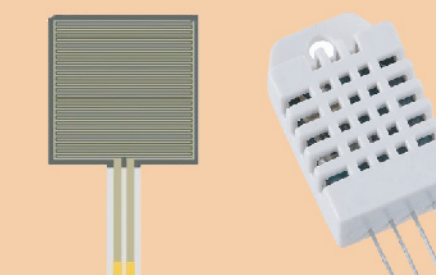
### Step 1

Adjust the sleeping location of the patient such that his/her buttock is placed on the bed pad.



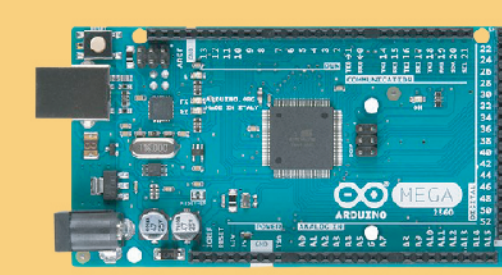
### Step 2

Retrieve force/pressure, temperature, and humidity data from sensors FSR406 and DHT22.



### Step 3

Feed the data values from the sensor into the Arduino Mega.

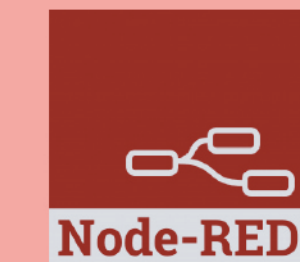


Send LINE notifications to caretakers.



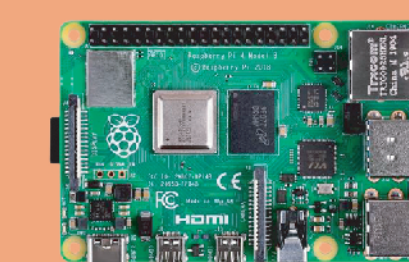
### Step 6

Import data values into models for analysis and display them on the Dashboard.



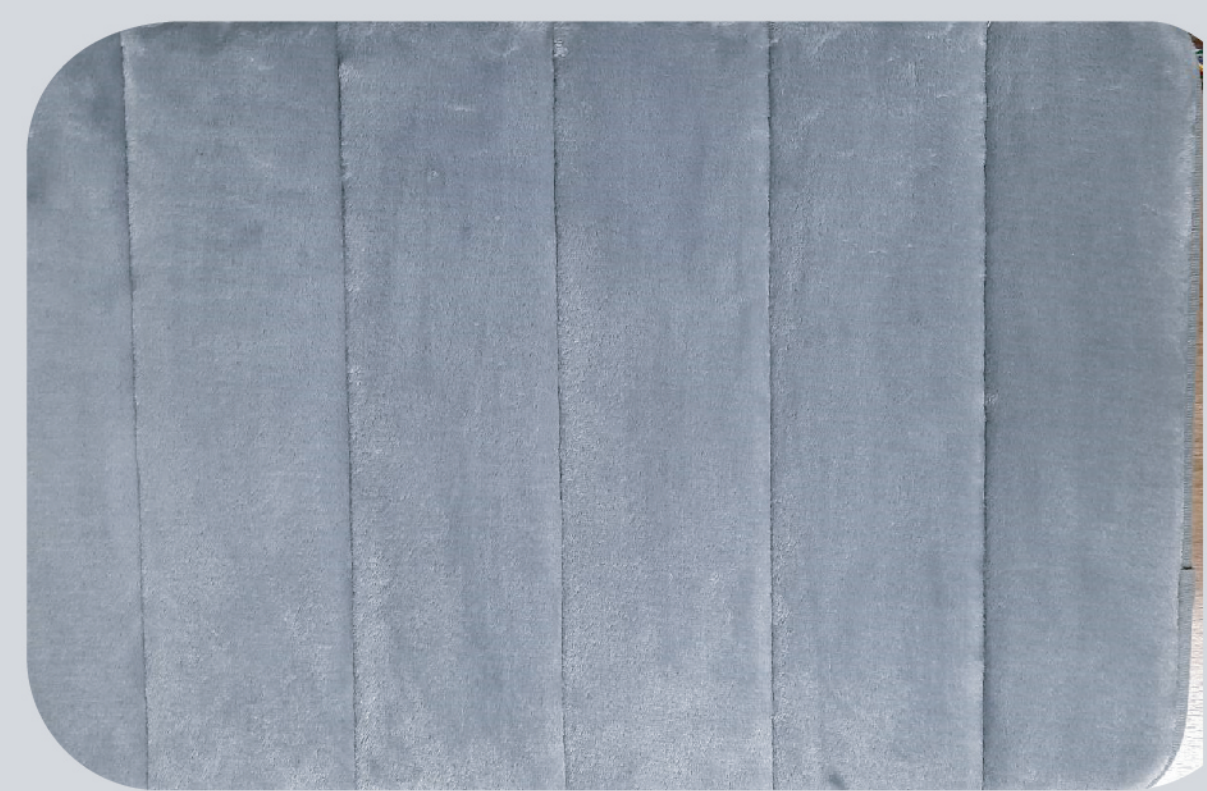
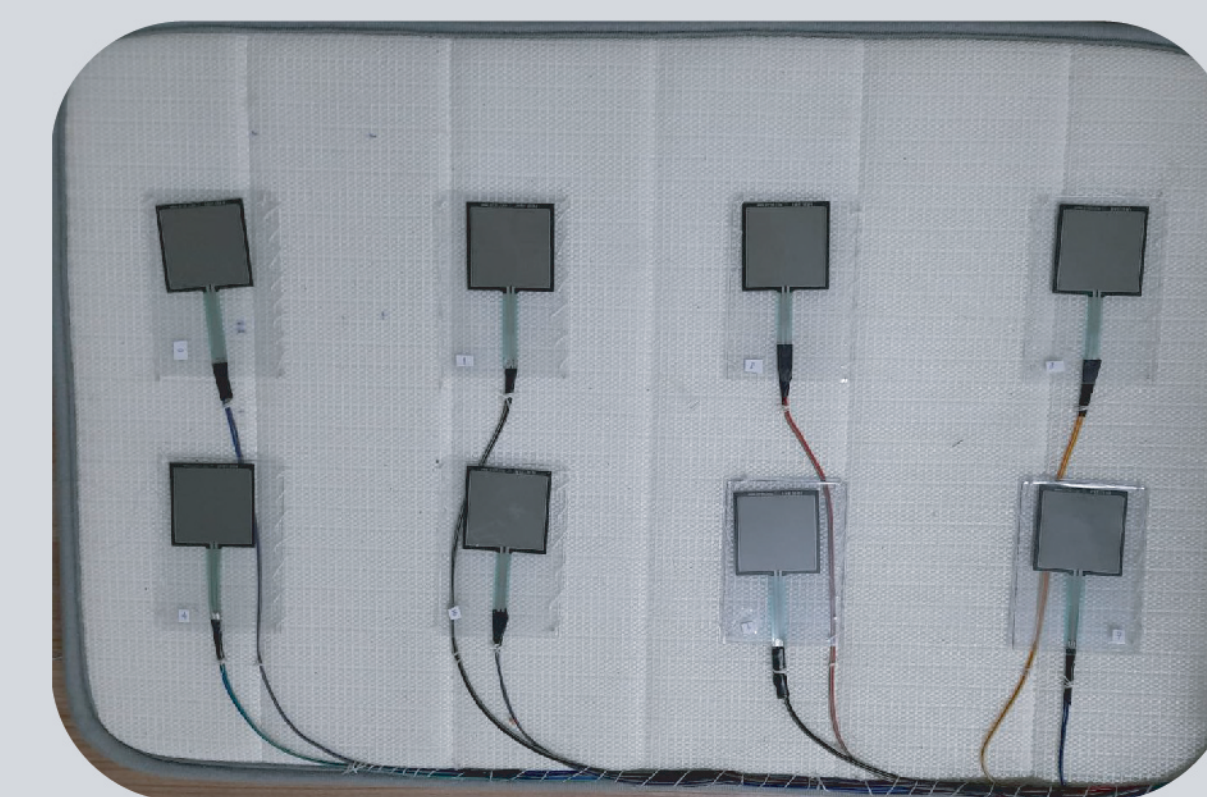
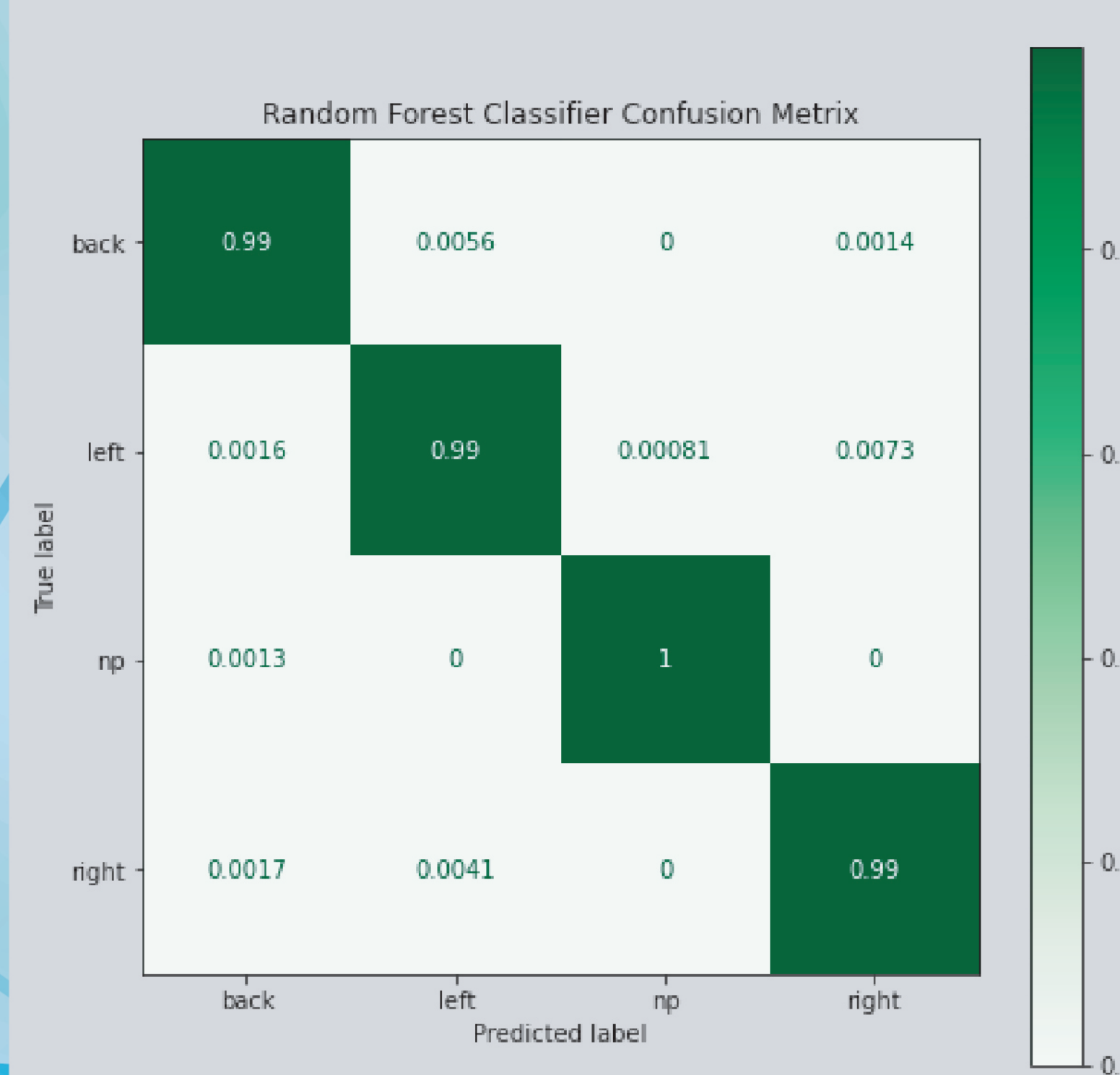
### Step 5

Perform data processing on the Raspberry Pi



### Step 4

## Experimental Result



The experimental setup: 13,061 sleep-posture data were collected, which can be divided into the following categories: (i) lying supine (2394 records), (ii) lying right (4062 records), and (iii) lying left (4072 records). The best algorithm is random forest which gives 99.3% accuracy.

## Conclusion

In this work, A smart bedsheet based on machine-learning techniques and IoT technology is developed. It could be used to reduce the opportunity of bed sore occurrences for bed-bound patients. Based on the experiment results, random forest algorithm achieved the highest performance.