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SMART WAIST BELT FOR HEALTH MONITORING

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Abstract - *Although fitness bands are the most efficient way to manage a detailed and ongoing log of a user's health parameters in the modern world, serious flaws in current fitness bands, such as inaccurate step counting due to frequent hand movements, discourage users from using them. Additionally, people's lives are being swiftly transformed by the advances in wearable technology in recent years. Employees in corporate environment nowadays are compelled to spend long periods of time in front of workstations where their posture, whether knowingly or unknowingly, is affected. Back pain is reportedly one of the most common reasons for people to visit the orthopedic, so maintaining good posture is crucial for living a healthy lifestyle. The purpose of this project is to resolve this by designing a Smart Waist Belt that actively tracks the number of steps taken, keeps track of the wearer's posture, and measures heart rate. All of the data is transmitted in real time to the mobile application and is also stored in the cloud for subsequent access. The smartphone application also categorizes the type of activities undergone, such as walking, running, or standing, and provides information on the number of calories burned, heart rate, and duration of exercises. In this paper we have implemented Random Forest Algorithm as our classifier to classify different activities. Support Vector Classifier accuracy is 94.02%, Logistic Regression accuracy is 95.19%, KNN accuracy is 90.02% and finally, Random Forest gives an accuracy of 95.51%.*

Key Words: **Smart Waist Belt, Posture, Step Count, Pulse Rate, Heartbeat, Random Forest, Machine Learning and IoT.**

1. INTRODUCTION

The World Health Organization defines health [6] as a condition of overall well-being, not just physical well-being, but also mental, bodily, and social well-being. People who are mentally healthy are immediately physically healthy. Man's greatest possession is good health. A healthy individual is one who can perform at their highest level without any hindrance. Numerous other bodily processes are made easier by good health. We can cope with stress and fight off mounting demands better when we are in good health.

Our wellbeing of spine depends on having good posture, which has many advantages like fewer back pains, more energy, and more self-assurance. Having proper posture can help us avoid muscle strain, soreness, exhaustion, and many other common illnesses and medical disorders, which are crucial for our general health. It's never too late to adjust our posture or make improvements, especially if it's causing one or more health issues.

Walking is a painless way to burn calories. These days, experts advise taking a daily, 30-minute walk. Fast walking is required, not sluggish ambling. Additionally, walking delivers a fantastic total-body workout. It improves metabolism and combats fat. Diabetes patients are recommended to exercise every day since it can drastically lower their blood glucose levels.

Although wearable technology is the most efficient way to keep track of a detailed and ongoing log of a user's health behaviors, critical flaws in current fitness trackers, such as inaccurate step calculations caused by frequent hand movements, make it difficult to offer personalized treatment. As a result, users avoid using these devices, which eventually lowers the rate of activity tracker use over time. Working from home means that no one is watching our posture during this time, and long periods of sitting have been shown to be fatal for many of us. According to research, smoking is not as harmful as prolonged sitting. Due to their busy job schedules, most people in today's world forgo fitness and exercise. To overcome this problem, Smart Waist Belt integrates well with our daily routine and reminds us to be physically active.

The Smart Waist Belt's objectives are to: Track the user's step count in real time and show the number of calories burned using a mobile application. To keep track of the user's upper body posture and warn them if the right posture isn't being kept. To keep track of the user's pulse rate. To categorise actions (such sitting, standing upright, running, and walking) using the Random Forest approach.

2. RELATED WORK

This chapter has the available literature that we have referred to. We have referred many research papers, some of the relevant research papers are listed below:

"IoT based Smart Posture Detector" - Greeshma Karanth, Niharika Pentapati, Shivangi Gupta and Roopa Ravish [1]. In this paper, a feasible solution to the bad posture problem is presented using a wearable device that recognizes the posture of the person and sends live data on the phone through an app.

"Microcontroller based fitness analysis using IoT"– M Gunasekaran and Dr. G Nallavan [2]. This paper, aims to measure the number of steps and the distance walked by the person using a small mechanical pedometer of size 50×50×25 mm. The device counts the number of steps taken by the person and multiplies it by the average step length fed to give the distance walked by the person.

"Posture Detection and Correction System using IoT": A Survey-Nitesh Sahani, Prafull Patil and Siddhesh Chikane [3]. This paper provides a survey on detecting posture of a person and suitable means to correct it with the aid of IoT.

A very compact device where user can attach it easily on the back side of their body. The device alerts the user through buzzer alarm in case of a bad posture and sends data to android application via Bluetooth.

"Health Monitoring Systems using IoT and Raspberry Pi"-Vivek Pardeshi, Saurabh Sagar, Swapnil Murmurwar and Pankaj Hage [4]. In this paper, an analysis on Raspberry-Pi based health monitoring system using IoT has been made. Any abnormalities in the health conditions can be known directly and are informed to the particular person through GSM technology or via internet. An accessible database is created about patient's health history which can be further monitored & analysed by the doctor if necessary.

"An Activity Recognition Framework Deploying the Random Forest Classifier and A Single Optical Heart Rate Monitoring and Triaxial Accelerometer Wrist-Band"- Saeed Mehrang, Julia Pietila and Ilkka Korhonen [5]. In this paper, wrist-worn sensors have better compliance for activity monitoring compared to hip, waist, ankle or chest positions. A random forest (RF) classifier was exploited to detect these activities based on the wrist motions and optical HR.

3. METHODOLOGY

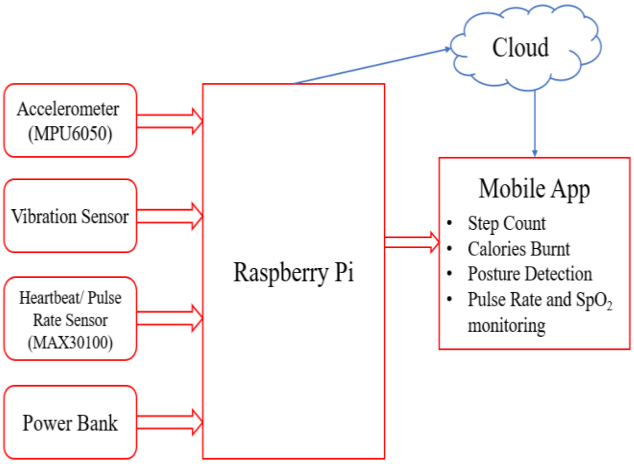

Fig -1: Block Diagram

MPU6050 (accelerometer) is integrated with the Raspberry Pi which is used to monitor the posture. MAX30100 Heartbeat sensor keeps track of Heart Rate and Oxygen Saturation level of the user. Vibration sensor is used to sense the vibrations while walking. Hence counting the number of steps taken by the user. Data from sensors is sent to the cloud over the Wi-Fi. The Smart Waist Belt is powered by a battery or power bank. The data stored in the cloud is displayed through the mobile application. Data analytics is done using the data collected from cloud.

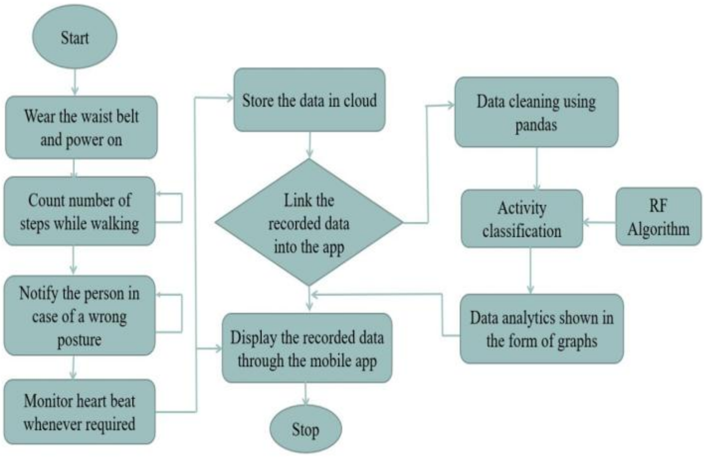

Fig -2: Flow Chart of Smart Waist Belt

The Flow Chart of Smart Waist Belt is as shown in Fig -2. Using Raspberry Pi, the accelerometer and heart rate sensors are integrated and calibrated. The number of steps taken are counted using a vibration sensor, which is mounted on the back of the body on the Smart Waist Belt. We can assess our body's posture using an accelerometer. We can record the user's heartbeat whenever necessary by employing a heartbeat sensor. We make use of Blynk to create an app with data from hardware sensors (i.e., stored in cloud).

The data delivered to the mobile app (application) has to be cleansed because it contains erroneous calculations and sensor-generated mistakes. Pandas (Panel Data) is a Python module that is used for data cleansing. Data is read, written, cleaned, and modified using Pandas. The mobile app displays the number of steps taken and calories burned, and informs the user anytime poor posture is detected. To create an activity classifier for activities like sitting, walking, jogging, etc., we employ a Machine Learning algorithm (i.e., the Random Forest classifier). Both Classification and Regression models use the Random Forest classifier. The collective data is used for data analytics which is stored in the form of graphs. These graphs can be obtained on daily, weekly and monthly basis. If there are any irregularities in the user, this can be helpful for the doctor for analyzing the problem.

A well-known Machine Learning Algorithm that uses Supervised Learning is called Random Forest . The Flow Diagram of the Random Forest Algorithm is shown in Fig -3. Random Forest Algorithm can be applied to Machine Learning issues involving both Classification and Regression. It is built on the idea of ensemble learning, which is a method of integrating various classifiers to address difficult issues and enhance model performance.

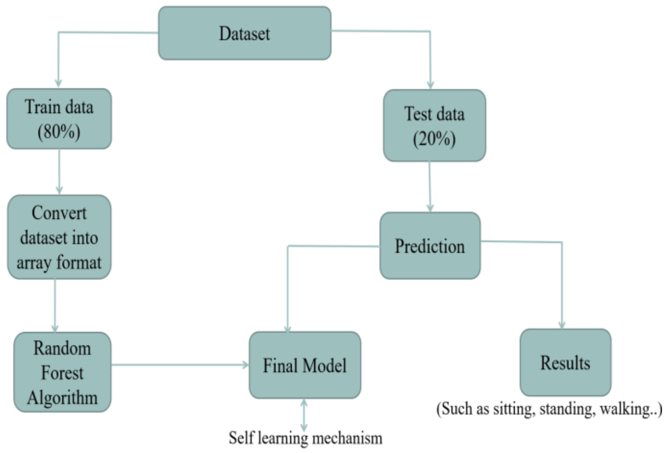

Fig -3: Flow Diagram of Random Forest Algorithm

Random Forest is a classifier that uses many decision trees on different subsets of the input dataset and averages the results to increase the dataset's predicted accuracy. Instead of depending on a single decision tree, the Random Forest uses forecasts from each tree and predicts the result based on the votes of the majority of predictions. Higher accuracy and overfitting are prevented by the larger number of trees in the forest.

4. RESULTS AND DISCUSSION

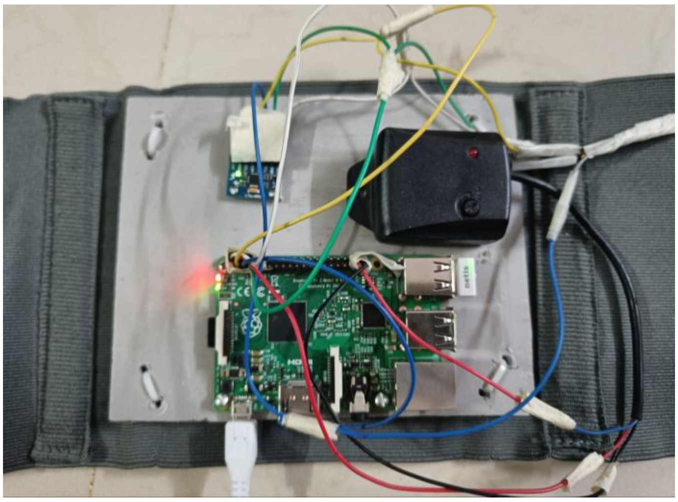

Fig -4: Prototype of Smart Waist Belt for Health Monitoring

Fig -4 shows the prototype of Smart Waist Belt which has been implemented by interfacing Raspberry Pi with different sensors like the Accelerometer [IMU MPU6050], the Heartbeat sensor [MAX30100] and the Vibration sensor. The Blynk Platform is used to build the mobile application as shown in Fig -5, which displays the Heart Rate (in BPM) and SpO_2 readings (in %), steps taken, calories burned, number of unfavorable postures, as well as graphs of both current and historical data.

Fig -5: Smart Waist Belt Mobile App

Fig -6 illustrates how the mobile application counts steps. It is noted that 42 steps were taken and 1.6 kilocalories were burned. Additionally, the graph has been set up to display the total amount of steps taken over the previous hour. The graph can also be shown for various time periods, such as one hour, six hours, one day, one week, one month, and three months.

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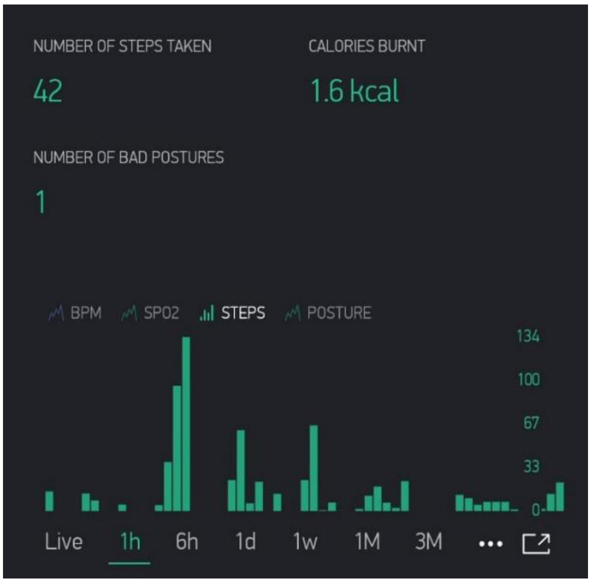

Fig -6: Counting steps in real time

The user's pulse rate (in BPM) and saturation level (in percent) are displayed in Fig -7. It has been noted that the user's BPM, or beats per minute, is 96. Additionally, the user's SpO_2, or oxygen saturation, is observed to be 100%.

Fig -7: Display of Pulse Rate (in BPM) and SpO_2 (in %)

The line graph of pulse rate v/s time is displayed in Fig -8. It can be seen that the graph is drawn using BPM data from the previous hour. The graph can also be shown for various time periods, such as one hour, six hours, one day, one week, one month, and three months. Similar graphs can also be observed for SpO_2 (in %), steps taken and the number of bad postures.

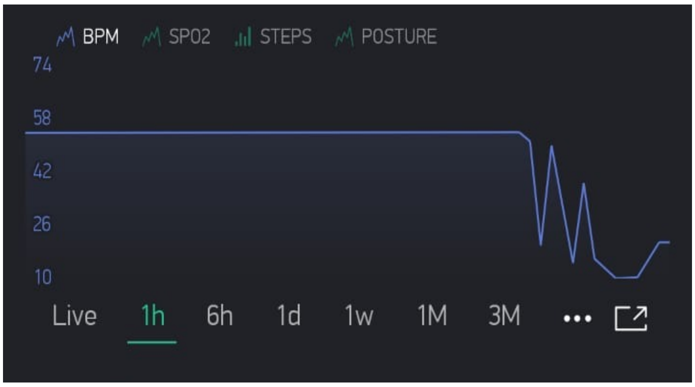

Fig -8: Line graph of Pulse Rate (in BPM) v/s time

The notification when an improper posture is found is shown in Fig -9. A notification is displayed in the mobile application as shown in Fig -9 when the user maintains the improper posture for more than 5 seconds thereby warning the user of his bad posture.

Fig -10 shows the demonstration of correct posture using the Smart Waist Belt and Fig -11 shows the demonstration of incorrect posture wherein the posture of the person is not right, leading to an incorrect posture notification as shown in Fig -9.

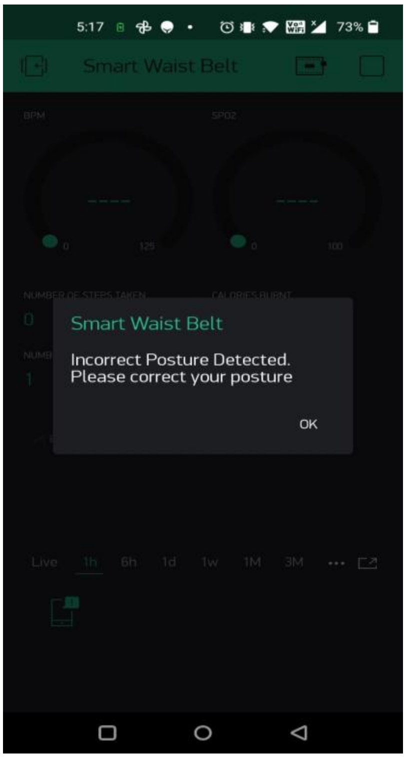

Fig -9: Notification when incorrect posture is detected

Fig -10: Demonstration of correct posture

Fig -11: Demonstration of incorrect posture

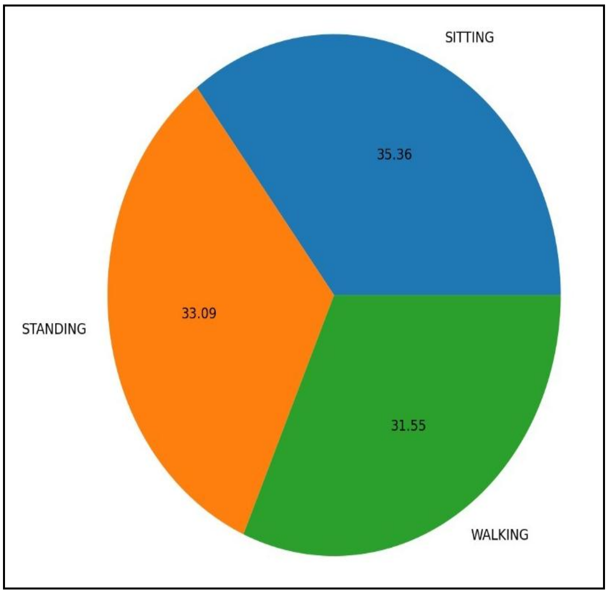

Fig -12: Activity classification

Fig -12 classifies the data into different activities like sitting, walking and standing. The values in pie chart indicate the percentage of the activities performed.

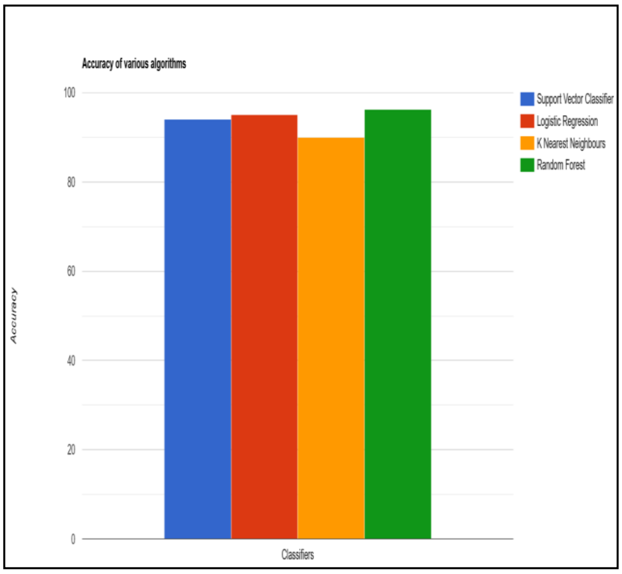

Fig -13: Accuracy of different classifiers

Fig -13 shows the accuracy of the Machine Learning models of Support vector, Logistic Regression, K Nearest and Random Forest using the dataset.

The Random Forest gives the best accuracy for the dataset used. Support Vector Classifier accuracy is 94.02%, Logistic Regression accuracy is 95.19%, KNN accuracy is 90.02% and finally, Random Forest gives an accuracy of 95.51%. In this project we have implemented Random Forest as our classifier to classify different activities.

5. CONCLUSION

In this paper, a prototype of Smart Waist Belt for Health Monitoring has been implemented to monitor the health of a person and classify the activities performed accordingly using Random Forest Algorithm which gives greater accuracy as compared to other algorithms. This Smart Waist Belt tracks the number of steps taken by the user in real time and displays the calories burnt through the mobile application. This Smart Waist Belt can be used to cater wide range of users which help them in monitoring the step count, calories burnt, posture detection and Heart Rate.

6. REFERENCES

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