IoT BASED SMART CHAIR USING RASPBERRY PI

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Abstract*—The Internet of Things (IoT) is a network of physical objects "things" embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems via the internet. This project enables us to assess a seated person's posture in real time and improve sitting posture. Long-term sitting harms the spine and causes chronic problems that require long-term therapy. People who are sick have a significant impact on office productivity. Long periods of sitting while studying cause major postural and spinal problems in young people. Our motivation is to assist people in paying attention to their health and proper sitting . Maintaining good posture by sitting with a straight back and shoulders not only enhances physical well-being but also enhances confidence and productivity through the development of healthy habits and frequent breaks. To make the chair smart, we use an IoT system with sensors, processing power, and software, with the goal of eventually assisting humans in maintaining good posture and healthy habits. Making a regular chair into a smart chair using Raspberry Pi, which will continuously detect your sitting posture and send a notification if it is incorrect. Two FSR sensors will be fitted onto the backrest of the chair to detect the inclination of the chair. The backrest sensor will detect if the person is sitting straight or not. The humidity and temperature sensor module inside the cushion of the seat will detect the temperature and pressure of the user. The goal of this project is to maintain proper posture for improved health and longevity.

***Keywords*—Posture, Raspberry Pi, Smart Chair, Humidity, Temperature, Flex**

I. INTRODUCTION

High levels of sedentary behavior (SB; sitting or lying down with little energy expended while awake) have been associated with negative health consequences, largely regardless of the amount of physical activity. SB is prevalent all day long. SB is particularly common during workplace. In fact, it was discovered that office workers conduct sedentary activities for up to 71% of their working hours. The majority of modern jobs need extensive desk-based sitting. In light of this, workplace SB may pose a risk to one's occupational health. Adults frequently aren't aware of their extended SB. The usage of monitoring SB devices can help raise awareness of excessive sitting. Adults spend a lot of time at work; thus, the workplace is an excellent arena for providing feedback on their prolonged sitting [1]. We suggest an Internet of Things (IoT) application that combines a chair with sensors and an integrated IoT device to evaluate posture and alert the user of any changes. Through feedback, users will be able to assess their own sitting patterns and improve the effectiveness of posture correction [2]. Modern humans spend the majority of their time sitting, and bad posture can lead to poor head/neck alignment and increased cervico-thoracic muscle activity, which can lead to health issues, especially for people who work long hours. For instance, maintaining a neutral lumbar posture is crucial for wellness. The curved lower lumbar spine that results from poor sitting posture for comfort, however, may increase health risks. People spend an average of 13 hours a day sitting down, according to a survey. But prolonged sitting can raise your risk of obesity and metabolic disorders [3]. Long-term poor posture has an impact on our personal and professional lives. Research from the University of Washington found that 45% of Americans between the ages of 35 and 55 experience acute back pain annually. Back pain is the leading cause of disability in Americans under the age of 45, according to additional Social Security Administration studies. Poor posture strains the neck and spine and increases muscular tension as the body tries to make up for the lack of support [4].

In short, the complications of poor posture include back pain, spinal dysfunction, joint degeneration, rounded shoulders, and a potbelly. Poor posture is dogging people of all ages. It's a common and an important health problem and it can lead to neck pain, back problems, and other aggravating conditions, says Meghan Markowski, a physical therapist at Harvard-affiliated Brigham and Women's Hospital. Turning a normal chair into a smart chair that will continuously detect your sitting posture and sends a notification for wrong postures. We can measure the inclination made by the chair when a person sits on it and our sensor will tell if it is the correct posture and wrong. We can also employ the temperature and humidity module and measure the parameters and send notifications through the app informing the user to take a break. Smart chair can detect our postures and send notifications to the app if our posture is wrong and when to take a break [5].

In the era of ever-advancing technology, the concept of Internet of Things (IoT) has brought a paradigm shift in the way we interact with our surroundings. One of the promising applications of IoT is in the development of smart chair, where sensors and electronics are integrated into everyday items to provide enhanced functionality and convenience [6].

This paper explores the development of an IoT-based smart chair using Raspberry Pi, a low-cost and widely popular single-board computer. With the help of smart sensors, actuators, and Raspberry Pi's processing power, this smart chair is capable of collecting and analyzing data related to comfort and health factors, such as sitting posture, temperature, and humidity. The collected data can then be utilized to enhance the chair's functionality, such as adjusting the temperature and backrest to suit individual preferences or alerting users of poor sitting posture to prevent health issues. Overall, this paper not only presents the design and implementation of a prototype smart chair but also highlights the potential of IoT in revolutionizing everyday objects [7]. We need smart chairs because of our poor posture problems and the need for a chair that can actively monitor and adjust to our comfort needs. The development of IoT-based smart chairs has an immense potential to improve the quality of life for people, especially those with mobility or health issues [8]. Poor posture during office work is a common problem that affects many people who spend long hours sitting in front of a computer. According to a study by the Occupational Safety and Health Administration (OSHA), poor posture can lead to musculoskeletal disorders (MSDs), which are a major cause of workplace injuries and illnesses [9]. MSDs are a group of conditions that affect the muscles, tendons, ligaments, nerves, and joints, and they can cause pain, discomfort, and disability. One of the most common MSDs associated with poor posture is lower back pain. A study by the National Institute for Occupational Safety and Health (NIOSH) found that workers who spend long hours sitting in front of a computer are at a higher risk of developing lower back pain [10]. This is because sitting for long periods of time can put pressure on the lower back and cause muscle fatigue, which can lead to pain and discomfort. Poor posture can also cause neck and shoulder pain. According to a study by the American Physical Therapy Association (APTA), sitting with a forward head posture can increase the load on the neck and shoulder muscles, which can cause pain and discomfort [11]. In addition, hunching over a computer can cause the shoulders to round forward, which can lead to tightness and pain in the upper back and neck.

Another adverse effect of poor posture during office work is decreased productivity. A study by the University of California, San Francisco found that workers who sit with poor posture are more likely to experience fatigue, which can lead to decreased productivity [12]. In addition, poor posture can cause discomfort and distraction, which can make it difficult to focus on work tasks. Poor posture during office work can have adverse effects on workers' health and productivity. It is important for workers to maintain good posture and take breaks to stretch and move throughout the day. Employers can also help prevent poor posture by providing ergonomic workstations and promoting workplace wellness programs. By addressing poor posture, employers can improve workers' health and well-being, and increase productivity and job satisfaction [13].

In this project, we develop an IoT-based smart chair using the Raspberry Pi. It will assess the posture of a seated person in real-time and improve sitting posture. If a person is sitting for more than half an hour, it will notify the user to take a stretch or exercise for a healthy lifestyle. Our project targets people who spend almost all of their working time in a sitting position, as it can lead to neck pain, back problems, and other aggravating conditions. Using an IoT system with sensors, processing power, and software to make the chair smart so that it can eventually help humans maintain good posture and healthy habits.

Through the proposed approach, we make the following main implementations.

- On the chair covers, connecting the FSR sensors, DHT11 temperature and humidity module, Raspberry Pi, ADC1115 module and jumper wires.
- Measuring the force readings from FSR sensors and temperature and humidity readings from DHT11 module.
- Implementing a related app to display readings, analyze user posture data, and send notifications.
- We implement the proposed approach on a real office chair for practical evaluation.

II. LITERATURE SURVEY

This paper presents a smart IoT system for sitting posture detection based on force sensors and mobile applications. Six flexible force sensors, two on the backrest and four on the bottom seat, were embedded in the office chair. Node MCU board was used to measure the sensor's resistance and sends the data to the cloud using the MQTT protocol. The data are stored and evaluated on the cloud using Node-RED and MongoDB. The user can see the information about sitting posture correctness and other pieces of detailed information in the mobile application [14]. In this paper, a new system to evaluate the posture of a seated person is presented. The tests demonstrate that this system can be used in situations whenever different level of engagement, that can drive different levels of stress, occur. In fact, the different levels of engagement produce, in general, a different positioning on the chair of the participants, that moved from the required task. The designed system is based on the use of simple textile sensors and of low-cost electronic equipment that can be easily embedded in the chair structure. This, combined with a wireless transmission, can delineate a final product that could be part of a work environment, in which stressing situations can occur for different and not expected reasons, thus increasing the level of safety [15]. An overview of the code that is intended to transfer data from Arduino to the USB port. They have two pins that will receive the data in that situation. Then, they have a number of if conditions. For instance, the timer begins to run when the mass of the person sitting in the chair surpasses 20 kg. The second purpose of them is to signal when a person has been seated on a chair for an extended period. The user should be informed that there is already a time limit in that situation. The timer should not be on when the user is not seated on the chair, which is the final function [16].

A smart chair equipped with embedded IoT and cloud technology is developed for detecting and notification of wrong sitting posture. It is identified that only a force sensor is not enough to get the perfect idea of the wrong sitting posture. During backward inclination, the force sensor produced different outputs for the different people having different weights for the same column. To avoid this, the combination of the force sensor and flex sensor is used to detect the wrong sitting posture. The proposed work provides seamless connectivity and a notification mechanism. Not only does it notify the person about the wrong sitting posture but also it maintains the database on the cloud using the Blynk 2.0 platform. The database can be used for medical diagnosis purposes [17]. This project mainly aims at creating an awareness about the importance of maintaining a good posture to avoid the problems that would take place if it's not been given proper care. The project focus on detecting the user's posture and telling the position of it as ok or worse. Along with the detection on a chair, we have made it wearable by which the kit can be carried anywhere and be detected where it's not necessary that the user should be in a seating position. The chair system is made for the old, aged people by taking their comfort into mind. Also, the data saved in the app by IOT serves as a record for the observations that helps in the cope of improvement for people undergoing physiotherapy or exercises [18]. In this research study, a smart chair sensors system was designed, realized, and tested with an experiment involving 40 subjects. A large dataset was created with the acquired data. The performance of the designed sensors system was evaluated with seven deep learning models for eight sitting postures classification and secured by k- fold cross validation. Results of all DL models were compared, and the best average accuracy of 91.68% was achieved by an EMN model, obtained in 5-fold, each fold lasting 27 min for computations and to train the 162,248 trainable parameters. The MLP model, instead, achieved the average accuracy of 90.83%, obtained in 5-fold, each fold lasted 3 min for computations and to train 480 trainable parameters. This second one can be considered an appropriate trade-off model for our application in terms of computational cost vs. accuracy [19]. Smart chair system was built in this paper to detect sitting posture of human body. The experimental result showed that the overall classification rate of eight sitting postures is high using ANN classifier. The developed smart chair system can monitor the sitting behavior of human body and help in advocating better sitting habits of users. the ANN classifier was trained with the pressure data of known postures. 40 sets of collected pressure data of each position were used as the training sets of ANN classifier. In order to acquire the best overall classification accuracy, various parameters were tested in the first place to find out the optimal settings of the ANN, including the number of neurons in the hidden layer, the transfer function and the network training function. Based on the test results, 20 neurons in the hidden layer, logarithmic sigmoid transfer function and scaled conjugate gradient (SCG) backpropagation network training function were adopted for the ANN classifier in this study. The training performance of the ANN classifier is shown in Figure 5, with mean square error (0.00989) less than the goal (0.01) after 166 epochs. With the properly trained ANN classifier, another 40 sets of pressure data of each position were used for verification of the classifier [19]. This article presents a prototype, mainly oriented to wheelchair use, that allows the assessment of people's behavior. To achieve the objectives, a DSR methodology has been followed, creating a prototype that evolves over time. As a result, the proposed prototype is able to adapt its behavior to monitor not only the sitting time without movements, but also to detect the correctness of the user's position. Through the development, different tests were carried out to train the algorithms, as well as to validate the results of the postural evaluation. However, to carry out a complete validation, it was necessary to have users who fit with the target audience of the project, and also to have the feedback of expert people. Therefore, once the development of the system was completed, a new validation stage was started in a health center that works with people in wheelchairs, which fits with the target audience of the project, thus increasing the value of the tests carried out. Analysis of the sitting behavior of the users, the test has been done in a short time period. The main goal of this study is to provide a system that is capable of analyzing user habits and helping to improve it, being able to detect behaviors that may be harmful to health [20].

A prototype for a potentially viable posture monitoring system was developed. The device has the capability to gather data pertaining to the sitting posture of the user at periodic intervals. The prototype also employs sensors that can be used to measure body vitals effectively. The time-series data obtained can further be leveraged to produce data-driven insights that can help the user with corrective measures. A smart posture monitoring system with multiple functions was designed. The system was built in consideration of a research survey initially conducted to identify the issues and expectations of people with regard to an ergonomic environment. The system is a cost-effective low-power consuming device that can help with the monitoring the posture of people, and also serve as a health monitoring system effectively. The designed chair is targeted at employees at their office, students, and home makers. The technology can also be exploited by gamers who use chairs for long periods of time [21]. This paper singles out 15 current studies whose methods and results are briefly explained. The selected papers describe various sensors, such as: force-sensitive resistor, heartrate sensor, respiratory monitoring sensor, voice control sensor and acceleration sensor. The system for observing the way of sitting, collecting and processing data and displaying them in real time brings the best results, because in this way it directly influences the user to change the position or keep it. The presented solutions include various applied technologies, ways of functioning and outcomes. Diversity is good and acceptable, but it can cause certain problems, especially if it is not standardized. That has been the case in many of the presented sensor technology solutions that are not always compatible with each other. One of the solutions for wider application and faster implementation of sensor technologies in everyday use in work or home chairs would be the introduction of certain standards that would overcome the obstacles of matching different user needs into a single monitoring system [22]. The subject is to be seated in a relaxed posture during the acquisition of physiological signals from various sensors attached to his/her body. The raw signals from the sensors are processed digitally by an onboard microcontroller and analyzed for any common abnormalities in the health parameters of the subject [23]. The project identifies four different incorrect sitting postures such as of a person and detects who works for a long duration and alerts them by sending message through mobile phones connected via GSM module. If the person continues to sit for a long time in the wrong position, the position motor which is connected using motor driver in the system will adjust the chair to the original position [24].

III. SYSTEM ANALYSIS

A. Proposed System

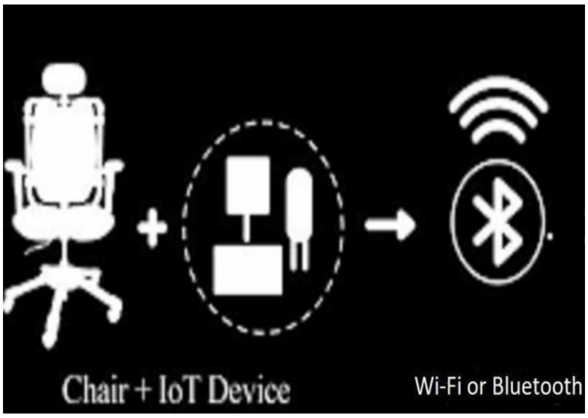

Figure 1. System Architecture of Smart Chair

Figure 1 represents that to use Raspberry Pi on a wired network, rather than a wireless (Wi-Fi) network, you'll also need a network cable. IoT devices such as raspberry pi, FSR, DHT11 Temperature and Humidity sensor are used in the smart chair. With Raspberry Pi OS the components are connected via Bluetooth or Wi-Fi then the readings of each component can be observed in the terminal. By creating a smart chair project, we have tried to comprehend solutions for problems such as poor posture and prolonged sitting. To make our project more helpful, we decided to include two main functions, monitoring posture and sending notifications.

B. Monitoring Posture

Our proposed system will continuously measure the posture as soon as the user sits on the smart chair. If the user's posture is improper, a notification will be sent to the app associated.

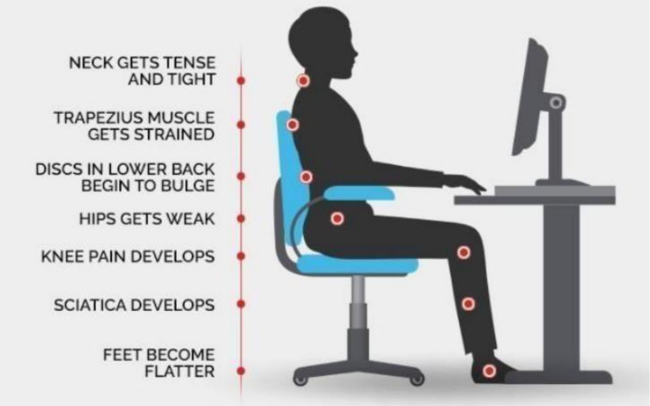

Figure 2. The sitting posture

Figure 2 depicts the problems caused by poor posture, such as muscle tension, sciatica, knee pain, swayback posture, and so on.

Figure 3. Improper Sitting Positions

Figure 3 depicts the improper sitting positions. A person can minimize the risk of bad posture and back health by avoiding: sitting slumped to one side with the spine bent. keeping the knees, ankles, or arms crossed. dangling or not properly supporting the feet.

Figure 4. Proper Sitting Positions

Fig 4 depicts the proper sitting posture. Sitting with a straight back and shoulders can help prevent common complaints, such as lower back pain and a stiff neck.

C. Sending notifications

If the user's posture is improper, if the chair isn't in its position and if the user is sitting for more than 30 minutes; a notification concerning action will be sent to the users app.

D. Control

We also want to provide the user control over the application so that the user can make the chair normal anytime he wants it to be without sensing.

IV. HARDWARE DETAILS

A. Raspberry Pi

Raspberry Pi is a series of small single-board computer (SBC) developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. The Raspberry Pi project originally leaned towards the promotion of teaching basic computer science in schools and in developing countries. The original model became more popular than anticipated, selling outside its target market for uses such as robotics. It is widely used in many areas, such as for weather monitoring, because of its low cost modularity, and open design. It is typically used by computer and electronic hobbyists, due to its adoption of HDMI and USB devices.

B. DHT11 Humidity and Temperature Module

DHT11 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin no analog pins needed. It's fairly simple to use but requires careful timing to grab data. Also, the DHT11 sensor has better humidity measuring range, from 0 to 100% with 2-5% accuracy, while the DHT11 humidity range is from 20 to 80% with 5% accuracy.

C. Flex Sensors

Flex sensors, which are highly versatile sensors that are used to detect bending or flexing movements in various applications. Flex sensors are made of a conductive material, such as carbon or copper, which is coated with a polymer layer. The resistance of a flex sensor varies with the degree of flexing or bending, and the resistance range of a typical flex sensor is between 10KΩ and 50KΩ. Flex sensors are highly sensitive to small changes in bending or flexing movements, making them ideal for detecting subtle movements in robotics or posture correction systems.

D. ADS1115 module

ADS1115 is an analog-to-digital converter module with a 16-bit resolution. It is a low-power device and operates at a voltage range of 2.0-5.5V. The ADS1115 IC oscillator and communicated to a microcontroller using the I2C communication protocol. It also includes a programmable gain amplifier up to x16, which helps to scale up small/differential signals to the full range.

D. Smart Chair Implementation

All Raspberry Pi models from the Raspberry Pi 3 Model B (2016) and later ship with on-board Wi-Fi. We can configure Wi-Fi on our Raspberry Pi with both Raspberry Pi OS desktop and server. Power source will provide power supply to our Raspberry Pi module. The FSR is connected to the Raspberry Pi via the 40 GPIO pins on the backrest of the chair. A DHT11 Humidity and Temperature Sensor Module is placed on the cushion with a FSR sensor.

Figure 5. Design of Smart Chair

Figure 5 represents a prototype of the placement of sensors and other components on the smart chair. We will implement this on a cushion office chair.

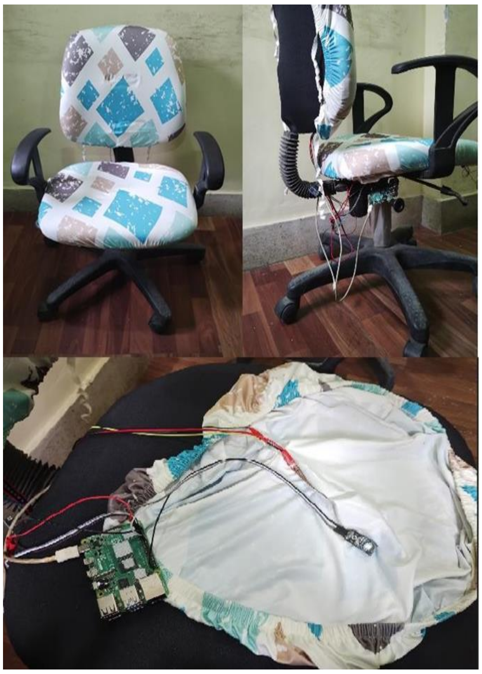

Figure 6. Hardware Implementation

Figure 6 shows the hardware implementation of the smart chair and its setup. The hardware part of our smart chair project involves the use of a Raspberry Pi to collect data from the sensors, including the flex sensor and DHT11 sensor, and send it to a MySQL server. The Raspberry Pi is connected to the sensors via jumper wires, and the data is collected using the ADS1115 module to convert analog signals to digital signals with high resolution. The Raspberry Pi is powered by a DC power supply and connected to the internet using Wi-Fi. Once the data is sent to the MySQL server, the Android application can access it and use it to determine the posture of the user. If the posture is incorrect, the alert system is triggered and a notification is sent to the user's mobile phone via the Android application. Overall, the hardware implementation of our project is designed to be easy to assemble and maintain, while providing accurate and reliable data collection and analysis for posture correction.

Figure 7 explains how the proposed system works is it detects the FSR sensor readings, this indicates the user sitting on chair. The Raspberry Pi processes this data and sends it to the mobile application through Wi-Fi or Bluetooth. The application provides feedback to the user, alerting them when they need to adjust their posture and displaying real-time data on their seating position and environmentOnce the user sits, one more FSR sensor readings are obtained to check if the person sitting in proper position for posture detection and start counting for 30 minutes. If the counting exceeds more than specified time, it will give appropriate message to the user. Meanwhile temperature and humidity reading are collected from DHT11 sensor constantly. If the values exceeds notification will be issued to user. This system has the potential to improve user health by promoting correct posture, reducing the risk of musculoskeletal disorders.

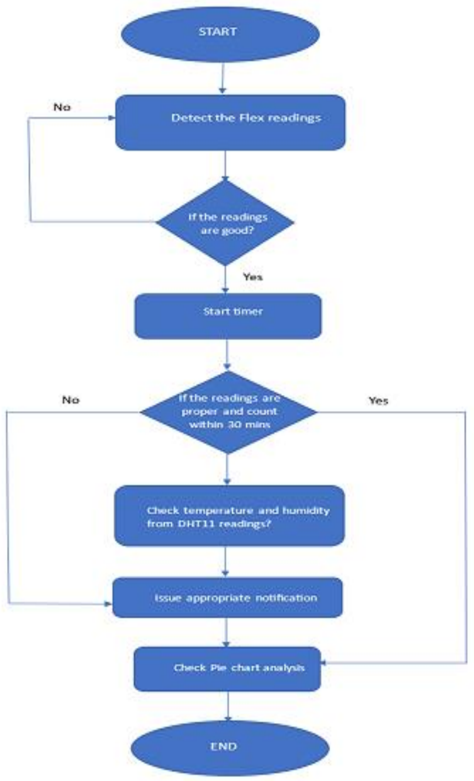

Figure 7. Data flow diagram

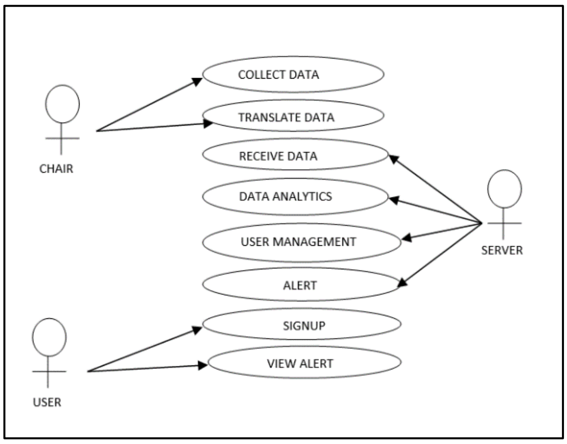

Figure 8. Use Case Diagram

Figure 8. depicts the use case diagram. The chair collects the data, which is the three flex sensor readings which is attached to the backrest of the chair and on the seat. It also collects the temperature and humidity of the user. It translates or interprets the data. Server receives the data and stores it. Data analysis is performed on the data, which is mostly visualization of the user's sitting habits. User data management is done and send an alert to the user, if the user is sitting for more than 30 minutes. The user gets the alert on the smart chair application. User needs to sign up and view the alert and related information.

Figure 9 depicts the sequence diagram. User and smart chair system interaction can be seen. The smart chair project involves several components working together to provide posture correction. The process starts with the user sitting on the chair, and the flex sensor detecting their posture. The flex sensor then sends the posture data to the Raspberry Pi for processing. If the user is sitting in an incorrect posture, the Raspberry Pi sends a notification to the mobile application, which displays it to the user. The user can then adjust their position accordingly. The DHT11 sensor detects the temperature and humidity in the environment and sends the data to the Raspberry Pi. The Raspberry Pi processes the data and sends a notification to the mobile application if the user is sitting in an improper posture and for a long time. The user can then adjust the temperature, humidity, flex sensors as needed.

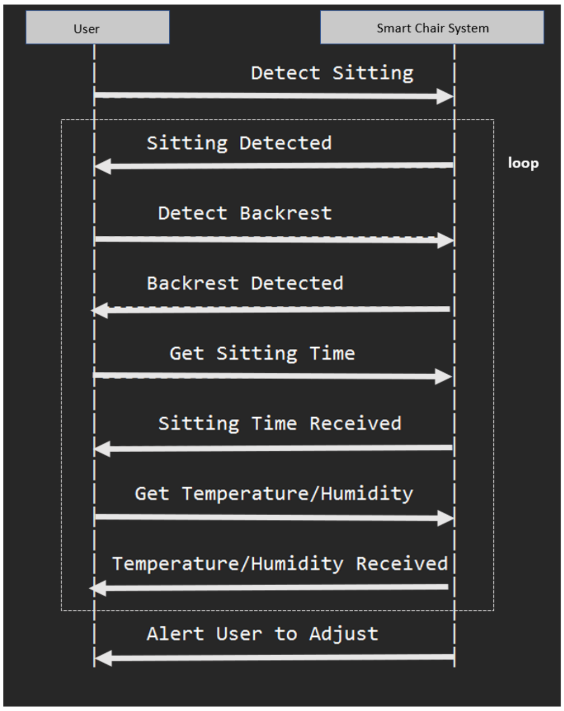

Figure 9. Sequence Diagram

V. SOFTWARE DETAILS

A. Python

Python is a high-level, interpreted programming language that was first released in 1991 by Guido van Rossum. Since then, it has become one of the most popular programming languages in the world, used by developers for a wide range of applications. Some of the key features of Python include its simplicity, readability, and ease of use. Python has a simple syntax that is easy to learn, making it a great language for beginners. It also has a large standard library, which provides developers with a wide range of tools and functionality that they can use in their applications. It can be used for a variety of applications, including web development, data analysis, machine learning, scientific computing, and more.

B. MySQL

MySQL is a widely-used open-source relational database management system that provides a powerful set of features for managing databases. It supports a variety of data types and can handle large volumes of data efficiently, making it a popular choice for high-traffic web applications. MySQL is scalable and can handle multiple users and concurrent connections. It can be used with a variety of programming languages and provides a range of tools and utilities for managing and administering databases, including graphical its versatility, performance, and ease of use, making it a valuable tool for developers and businesses alike.

C. Raspberry Pi Imager

Raspberry Pi Imager is a software tool used to install operating systems onto an SD card for use with a Raspberry Pi. The tool is free and available for download on the Raspberry Pi website. Raspberry Pi Imager simplifies the process of installing an operating system onto a Raspberry Pi by providing a user-friendly interface and automatically formatting and writing the image to the SD card. The tool also supports a range of operating systems, including the Raspberry Pi OS, Ubuntu, and various third-party distributions. Overall, Raspberry Pi Imager is a useful tool for anyone looking to set up a Raspberry Pi with an operating system, providing a streamlined and hassle-free installation process.

D. VNC Viewer

VNC Viewer is a widely used remote desktop client that allows users to access and control remote desktops over a network connection. It is particularly popular in IT support and remote working scenarios, as it allows users to access remote systems and provide technical support without needing to be physically present. VNC Viewer provides a range of features, including support for multiple operating systems, encryption and authentication for secure connections, and the ability to transfer files between remote and local systems. It also provides a range of customization options, allowing users to adjust display settings, keyboard and mouse configurations, and other preferences to suit their needs. Overall, VNC Viewer is a powerful and versatile remote desktop client that is used by individuals and businesses around the world to access and control remote systems with units. In the example, write "Magnetization (A/m)" or "Magnetization {A[m(1)]}", not just "A/m". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K".

E. Android Studio

Android Studio is an integrated development environment (IDE) for developing Android applications. It is developed by Google and is the official IDE for Android app development. Android Studio provides a comprehensive set of tools and features that enable developers to create high-quality Android applications. Android Studio is built on the IntelliJ IDEA platform and supports a wide range of programming languages, including Java, Kotlin, and C++. It includes an emulator that allows developers to test their applications on different Android devices and versions.

VI. MOBILE APPLICATION

The Mobile application is developed using Android Studio. The Application receives data from the server and displays it to the user. It provides real-time information about the user's posture, temperature, and humidity levels. Notifications via mobile applications are a common way for smart chairs to alert users about incorrect posture. When a flex sensor attached to the chair detects that the user's posture is incorrect, it sends the data to a microcontroller, which sends a notification to the user's mobile device. If the user has been sitting for more than 30 minutes, a notification is sent to them. The user can then adjust their posture and receive real-time feedback on how well they are doing. Integrating a mobile app with a smart chair improves functionality and usability. Users can change their notification preferences and track their progress over time. This feature is especially beneficial for people who spend long periods of time sitting in chairs, such as office workers or students, and can help prevent or alleviate health problems associated with poor posture, such as back pain or muscle strain. Notifications sent via mobile app in smart chairs are an effective way to alert users to incorrect posture and promote healthy sitting habits. Smart chairs can help improve the user's overall well-being and comfort by providing real-time feedback and customizable settings. Posture, such as back pain or muscle strain. Notifications sent via mobile app in smart chairs are an effective way to alert users to incorrect posture and promote healthy sitting habits. Smart chairs can help improve the user's overall well-being and comfort by providing real-time feedback and customizable settings.

Figure 10. Signup Page

Figure 10. shows the signup page of the mobile application where user can complete the registration by providing basic details.

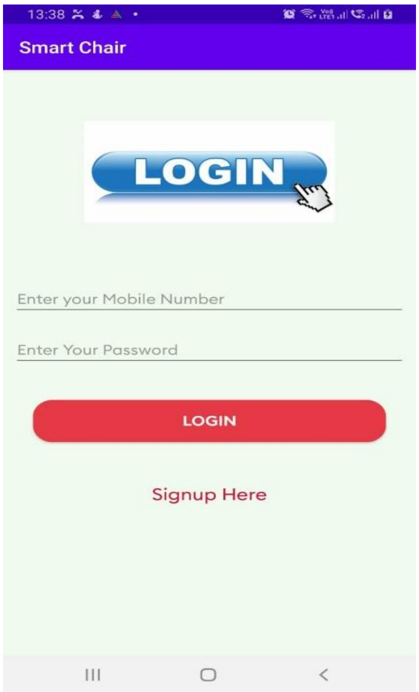

Figure 11. Login Page

Figure 11. shows the login page where user can login into smart chair application.

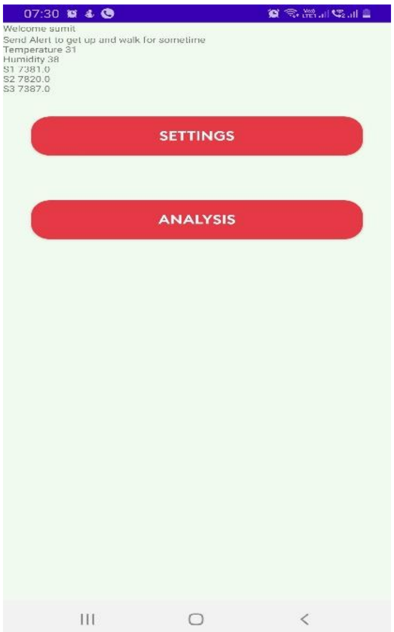

Figure 12. Home page

Figure 12 shows the home page where user can see readings of humidity, temperature and flex sensors. Users can see the notifications alert messages according to their posture whether they are sitting in proper or improper posture. When humidity and temperature is increasing above the threshold value, it will show the alert message like humidity is increasing. User data management is done and send an alert to the user, if the user is sitting for more than 30 minutes. User settings page where the user can change the default settings to its own customizable sensor values. Notifications sent via mobile app in smart chairs are an effective way to alert users to incorrect posture and promote healthy sitting habits.

Figure 13. Analysis Page

Figure 13 shows the visualization of the incorrect and correct posture via pie chart.

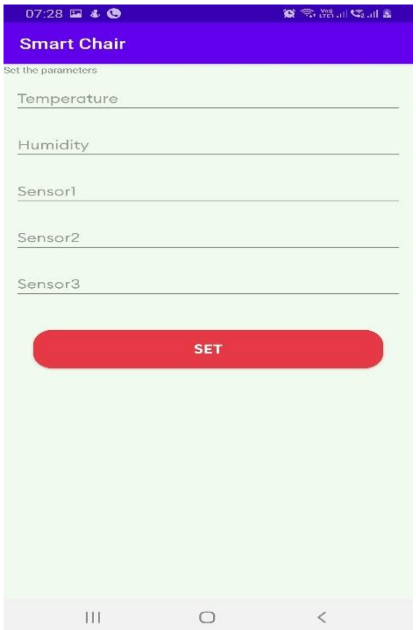

Figure 14. Settings Page

Figure 12 shows that the user can customize the readings of sensors based on his/her preferences.

VII RESULT

The smart chair with IoT technology monitors the user's posture and environment using sensors connected to a Raspberry Pi microcontroller. This system provides personalized feedback to promote healthy habits and reduce the risk of musculoskeletal disorders. The sensors play a crucial role in collecting accurate data, allowing for comprehensive insights and recommendations.

CONCLUSION

Maintaining a correct seating position is crucial for preventing long-term health problems and promoting comfort and productivity in daily life. By monitoring the user's posture and environment through various sensors connected to a Raspberry Pi microcontroller, this system can provide personalized feedback to the user and promote healthy habits. The sensors, such as the flex sensor and DHT11 sensor, play a crucial role in collecting accurate data on the user's seating position and environment, allowing for comprehensive insights and recommendations. With the potential to reduce the risk of musculoskeletal disorders and improve overall health and wellbeing, this technology has significant implications for workplace ergonomics and daily life. Ultimately, the smart chair with IoT technology represents a powerful tool for promoting good posture, preventing long-term health problems, and enhancing comfort and productivity.

FUTURE ENHANCEMNET

Future improvements to an IoT-based smart chair project that uses a Raspberry Pi, flex sensor, DHT11 temperature and humidity module, and an app to measure posture are possible. Among these improvements are:

a) *Adding machine learning*: By incorporating machine learning algorithms into the project, the smart chair can learn the user's sitting habits and provide more accurate feedback on their posture. This can assist users in improving their posture over time.

b) *Integrating Additional Sensors*: To provide a more comprehensive posture analysis, additional sensors such as an accelerometer or a gyroscope can be added to the smart chair. These sensors can aid in movement detection and provide more detailed information about the user's posture.

c) *Providing Customized Feedback*: The smart chair can be programmed to provide the user with customized feedback based on their posture. For example, if the user is slouching, the chair can vibrate to remind them to sit up straight.

d) *Voice Recognition*: By incorporating voice recognition technology, users will be able to interact with the smart chair via voice commands, making it easier to use.

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