A Smart Sitting Chair for Office Employees

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Abstract : Sitting is the most common status of human beings. Some sitting postures may bring health issues. To overcome, the harm from bad sitting postures, a local sitting posture recognition system is desired with low power consumption and low computing overhead. A smart sitting chair model was proposed especially who are all working for long time in IT sector and in other fields. Our project can categorize four different wrong sitting postures of a person who sits and works for a long duration and alerts them the correct posture to reduce their health issues. This project gives the solution to avoid health related issues such as, increase in low back pain, cardiovascular disease, obesity, and diabetes. In this project, sensor modules are used to sense the sitting postures of the employees. When the person or employee sitting for long time or sitting in incorrect position, he/she will be given an alert message by our system and our system take place the person to the correct sitting posture and that should be considered by the employee. First, the user will be given intimation to their mobile phone 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 our system will adjust the movement of chair according to the user's comfortableness. Thus, our proposed system will bring a beneficial for both office and office employee.

IndexTerms - **Employee, GSM module, Postures, Recognition**

I. INTRODUCTION

Due to changes in workplace, transportation, entertainment or communication, sitting has now become one of the most commonly adapted postures of human beings in daily life, leading to a more sedentary lifestyle. Long periods of sitting might result in health issues and musculoskeletal discomfort. This prolonged sitting causes damage to the spinal cord. Spinal cord discomfort is an issue that affects people all over the world. Regardless, it has always been overlooked until it becomes a significant deformity. It's always inconvenient and exhausting. Back discomfort is exacerbated by variables such as prior employment, a lack of strength, a slowed metabolism, and degenerative disc disease. Lower back pain can be caused by the bony lumbar spine, discs between the vertebrae, ligaments around the spine and discs, spinal cord and nerves, lower back muscles, Internal organs of the abdomen and pelvis, as well as the skin around the lumbar region, Scoliosis, or upper back pain, is caused mostly by rolled shoulders or a hunchback. Scoliosis is more common in people who spend lengthy periods of time in front of a computer or monitor. Upper back pain might be caused by Upper back pain might be caused by aortic issues, chest cancer, or spine inflammation. In today's fast-paced world, employee health and well-being is a hot topic. When employees suffer from various health issues, employers lose money. Sitting behaviour analysis has lately become a significant study topic in a range of domains, including biomedical engineering, public healthcare, and facility design. An average adult watches television or relaxes for two hours a day. Working hours which are mostly eight in an average case, start standing at least two hours of those eight hours. However, every person tries to push those two hours to four hours for relaxation and decreases stress level. This means that at work the person should spend as much time standing as the person sit.

Until now, people are absolutely failing to understand or even acknowledge the need to stand more. With respect to avoid the adverse effects of poor sitting behaviour, the real-time monitoring of sitting posture has received particular attention.
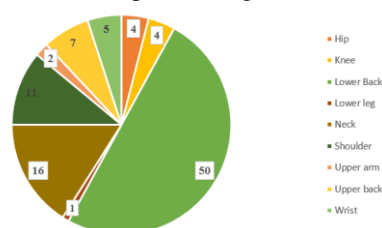

Figure 1: Percentage of employees suffer from body pains

II. PROBLEM STATEMENT

In existing method the sitting positions are monitored, and the mechanism involved was moving and bending approach installed in chair. Most of the chair are like wheel chair which are all designed for physically challenged people. For office employees the chairs are cost is more to get the soft sitting chair. Due to this, companies face productivity loss as well as the employees stress level gets increased.

III. OBJECTIVES

The companies face productivity loss due to the health issues of the employees. To overcome the problem faced in existing method our project comes up with the idea of developing a smart sitting chair with low power consumption and low computing overhead. Four different wrong positions such as right, left, backward and forward. If the person is sitting in that wrong position message alert will be given to the user using GSM module. The person bends the chair to the backward then the DC motor will re-position the chair to the original position.

IV. RELATED WORK.

"Sitting Posture Detection using Adaptively fused 3D features-2021". This paper deals with the bad postures of the person sitting for a long time which is afflict harm on people's physical and mental health, which seriously causes myopia, waist cervical disease and other ailments. Recent sitting posture detection approaches can be divided into two categories: 1) traditional sensor-based method, and 2) image processing-based method. Traditional sensor-based approaches require the subjects wearing a specific sensor. A camera is used to locate the human body and conduct picture feature detection in the image processing-based method. Compared with traditional sensor-based methods, the image processing-based approaches are more suitable for practical applications. This paper adopts the Astra 3D sensor for data collection, which supports the Windows, Linux and Android. Based on this, this paper designs a real-time sitting posture detection method using an embedded 3D sensor, and works will focus on making a more robust foreground segmentation in real applications and building a larger dataset for depth analysis and analysing the relationship between sitting postures and learning efficiency. The outcome of this project involves a lengthy procedure, but in our project uses a basic controllers and sensors to achieve great precision.

"Design and Architecture of smart belt for real time posture monitoring-2021". This paper presents the architecture and design of the posture monitoring system. The back posture is completely tracking. To get the complete information about the back posture the shoulder bent monitoring in introduced. The monitoring is a smart belt equipped by inertial sensors to detect the trunk flexion and a shoulder bent to monitor the posture over time. The smart belt gathers bending trunk and shoulder variations and sends them to a cloud server for data storage. A smartphone application is developed to notify the person in case of bad posture detection. Therefore, the results give the complete information about the posture monitoring for seating person. Only tracking and monitoring back postures of the person are included in this study. Re-positioning for back posture is included in our method.

"A smart system for sitting posture detection based on force sensors and mobile application-2021". This paper reveals about the development of information currently brings new health risks. Nowadays people don't move much time, but work stress is much more front of computer. So, it may affect spine and causes chronic problems that need long-time therapy. Adopting the correct sitting position is essential for maintaining good posture and a healthy back and spine. It describes about the several ways to monitor people's postures. According to the principle of how to obtain this information, the systems can be dividing into three main categories based on the following are Computer image processing Wearable clothing with sensors measuring the load distribution on some form of substrate. This paper reports as 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. This paper brings out the solution as solution on the network-attached storage from QNAP. However, due to the simplicity of the evaluation process, our smart system may be run on low-cost hardware like the Raspberry Pi with only minor modifications. QIoT specific gateway must replace it with a regular MQTT gateway. It is also necessary to install services like Mosquito broker, standalone Node-RED application, and optional Mongo DB manually on Raspberry Pi.

"**A Smart Chair Sitting Posture Recognition System Using Flex Sensors and FPGA Implemented Artificial Neural Network-2020".** This paper reports a novel posture recognition system on an office chair that can categorize seven different health-related sitting postures. Six flex sensors, an ADC board, and a Machine Learning algorithm comprising a two-layer Artificial Neural Network (ANN) developed on a Spartan-6 are used in the system. Field Programmable Gate Array (FPGA). The system achieves accuracy with a floating-point evaluation and with the 9-bit fixed-point implementation. The ADC control logic and the ANN are constructed with a maximum propagation delay of 8.714 ns. The dynamic power consumption is 7.35mW when the sampling rate is 5 Sample/second with the clock frequency of 5MHz.

"Monitoring of Prolonged and Asymmetrical Posture to improve sitting behavior-2020". In this paper research, design, develop and implement a low-cost automatic sitting posture monitoring system. A pressure sensing system embedded in complex interfaces on a seat cover is constructed taking into consideration human biomechanics. A multi-layer architecture is used to build the pressure sensor which is a full solution for manufacturing and real world use. The sensors' flexible and fabric-based nature allows them to be designed for anthropomorphic factors such as various human back sizes and chair forms. IoT communication layer is used to transfer sensor data to the cloud server. This offers an easy and user's friendly way to visualize and monitor sitting posture which can be used for monitoring and rehabilitation purpose, to work with diseases associated with sitting in a clinical setting, work place, school and patient's home.

"Smart Chair Posture Classification using Sensors mounted under Chairs Legs - 2020". This paper reveals about a smart chair system for human posture classification was developed, gathering information from 4 sensors placed under the legs of a chair. Multiple classification networks were tested using the data gathered from 8 different subjects sitting in 8 commonly used sitting postures, with the best results being achieved through an Artificial Neural Network.

"Flexible force sensors Embedded in office chair for monitoring of sitting posture-2019" As a result of this paper, Six flexible force sensors were implanted in the upholstery of an off-the-shelf office chair, two on the backrest and four on the seat, to enable non-intrusive monitoring of sitting positions. In this project the apparatus used are monitoring platform comprises an Arduino Nano microcontroller with Wi-Fi transmitter, embedded on the chair, a Wi-Fi receiver communicating with a remote server and a Graphical User Interface (GUI) showing real-time readings. The results showed that sensor S2 had the greatest significance, closely followed by S1, then S3, S4, S5, and S6. Three combinations of sensors were used to measure the effect of the decreasing number of sensors on the accuracy 65% when only S1 and S2 were used.

"Design and modelling of a textile pressure sensor for sitting posture classification-2019". This paper reports that a textile pressure sensor has been designed for measuring pressure distribution on the human body. Electrodes built with conductive textiles are arranged on both sides of a compressible spacer, forming a variable capacitor. The use of textiles makes unobtrusive, comfortable, lightweight, and washable sensors possible. This simplifies the goal to integrate such sensors into clothing in the future, to be simple, and fast to mount just as getting dressed. Hysteresis induced by the spacer of the sensor has been modelled

with the Preisach model to reduce the measurement error from 24% to 5% on average and the maximal error from above 50% to below 10%.The data of nine subjects have been classified with Naive Bayes classifier, achieving an average recognition rate of 82%.

"Continuous posture sensing chair for office workers-2018". This study discuss workers sitting postures and offers tips on how to modify it in order to avoid health-related problems or take a break from sitting. This project recognized 18 sitting postures using accelerometer sensor with an accuracy of 80.1%. Here they identifies only the sitting postures of the person in the chair but in our project identifies and notifies the incorrect postures of the users using GSM module.

V. PROPOSED WORK

In this project, a smart sitting chair is designed for the office employees who are all working in the IT sector for a long time. A Smart chair with low cost to avoid some health-related issues is proposed in our project. Our project identifiesfour 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 our system will adjust the chair to the original position.
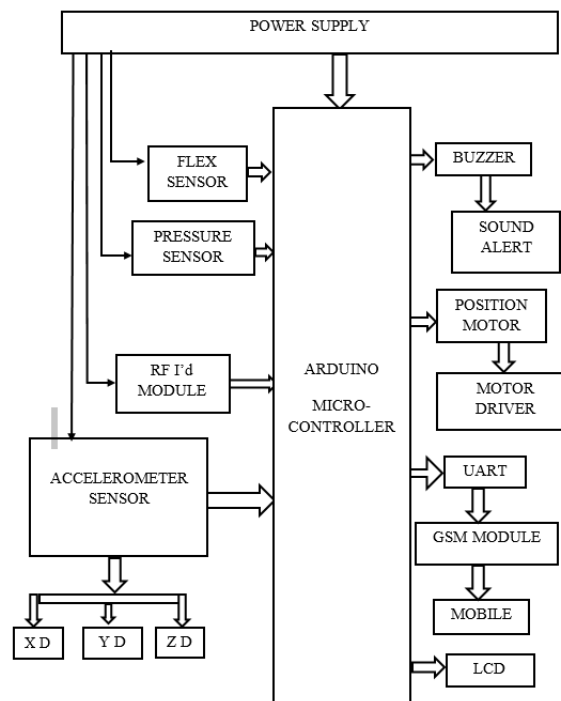

Figure 2: Block diagram of Smart Sitting Chair

A power supply circuit is used, it consists of step-down transformer, bridge rectifier, and filter circuit and voltage regulator. A 230V AC supply is given to the step-down transformer. The step-down transformer will step down the 220V to 12V. 12 v is given to the bridge rectifier. A filter section is used to convert pulsating dc to a purer, more desirable form of dc voltage and Regulator, It maintains the output of the power supply at a constant level despite large changes in load current or input line voltages.

All the components including power supply are connected to the Arduino UNO microcontroller. The components are operated by programming the microcontroller using Embedded C. To outline a smart sitting chair capable of measuring the pressure of the sitting person using pressure sensor.

The chair flex value detector is a kind of sensor which is used to measure the amount of defection or bending of the chair while the person sitting in the chair, Accelerometer sensor which has three axis dimensions called X,Y and Z dimensions, which monitors the dimensions of the sitting person in the chair. The monitoring unit comprises of communication UART and GSM module.

If the person sitting in the wrong position. Firstly, the notification message is sent to the respective person via GSM module through mobile phones. The buzzer will also indicate the employee by giving alert sound and if the person ignores the notification message and buzzer sound after that the Position motor is driven by the motor driver which is connected to the Arduino microcontroller. The position motor automatically takes the chair to its original position which means sits up straight and keep hips far back in the chair.
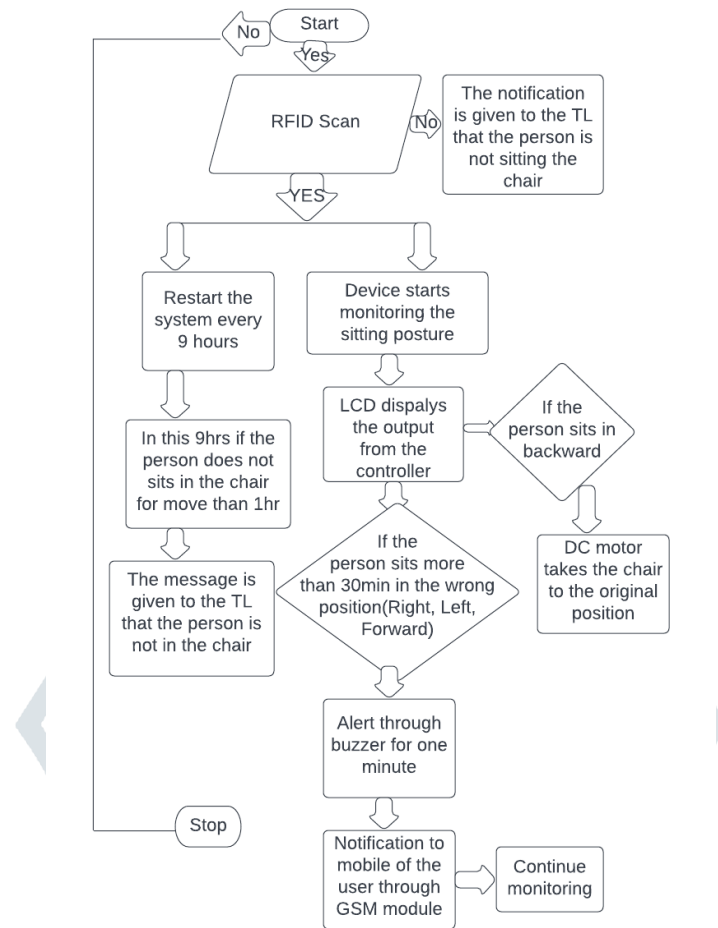
Figure 3: Flow Chart of Smart Sitting Chair

The above figure is the flowchart for monitoring the sitting position of the person.

The system is starts by the power supply. Once the system is started the person should give their details through RFID tag which is read by EM18 RFID reader. Now the sensors are waiting for the person to sit.

There are three sensors connected to microcontroller such as Pressure sensor, Flex sensor and Accelerometer mems. Working of these sensors is:

- Pressure sensor: Starts detect when the person is detected

- Flex sensor: Detect the bending approach of the chair in the back side

- Accelerometer sensor: It has three dimension which is given to detect the Right side, Left side and Backward direction.

If the person is not sitting the chair after scanning the RF I'd then it will be display as there is no person is sitting in the chair. And message also given to the persons mobile using GSM module.

After Detecting Person then there are three cases:

Case 1: If the person sits more than 30 minutes the alert is displayed in the LCD and alert sound is from buzzer for one minute. And then the gets a message to their mobile phone.

Case 2: When the person returns right side or left side along with chair it is detected by accelerometer sensor therefore, the information given to the microcontroller and buzzer will give an alert sound, LCD will be display as "Turn left side" and "Turn right side" respectively. This message also given to the user's mobile phone.

Case 3: When the person bends the chair to backward the buzzer gives the alert sound and immediately the chair comes to the original position using DC position motor which is connected to the chair's backside.

Person Not Detecting:

Once if the person is detected then the sensor starts detecting the person's position and also if the person is not sitting for more than one hour then the message will be given to the TL of the person with his/her RF I'd details.

The system will stop:

If the person didn't give their RF I'd then the system stops.

And the system works continuously for 9 hours so after that system automatically stops.

VI. RESULTS AND DISCUSSION

After execution of the modules in our proposed framework, the results have been taken. Then results display the values of the pressure sensor, flex sensor and accelerometer sensor in the LCD display and in mobile phone.

The simulation implantation of smart chair using Arduino UNO microcontroller in proteous software which is detecting using the given sensors and motors and display the values
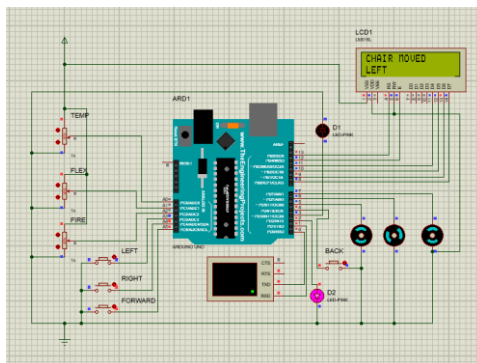

Figure 4. Chair Moved Left

The Mems sensors sense the sitting posture of the person and it indicates that the person is sitting towards the left side direction of the chair. The Arduino microcontroller unit which receives the sensed value will act upon the correct posture to be altered. So, in the above figure, it is assumed that the person is sitting towards rightside direction, our system will directs the person to sit along right side direction which is shown in LCD display as output.
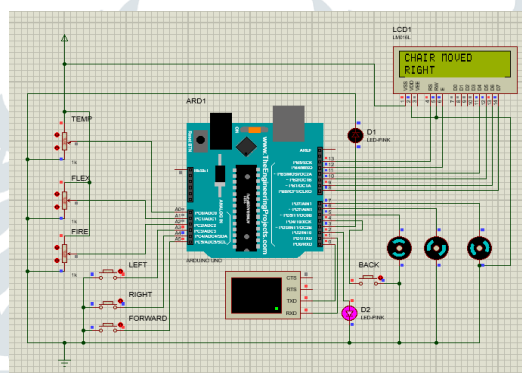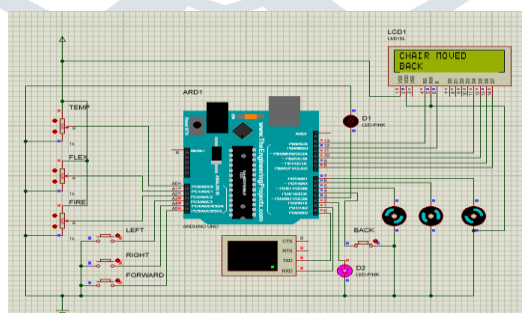

Figure 5 Chair Moved to the Right

Figure 6. Chair moved Backward

The Mems sensors sense the sitting posture of the person and it indicates that the person is sitting towards the backward direction of the chair. The Arduino microcontroller unit which receives the sensed value will act upon the correct posture to be altered. So, in the above figure, it is assumed that the person is sitting towards forward direction, our system will directs the person to sit along right side direction which is shown in LCD display as output.
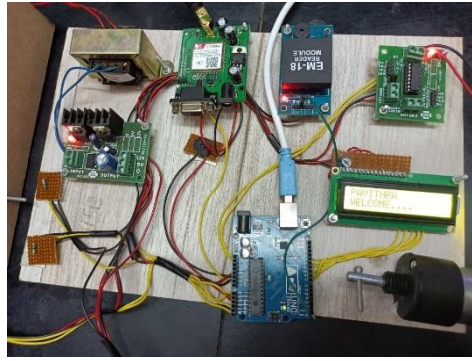
HARDWARE RESULTS;

Figure 7. System start monitoring

The figure 7 shows that after giving power supply and RF I'd tag is scanned in the EM18 reader module that is displayed in the LCD.

Figure 8. Chair moved left

Now the chair turns left side it is detected by accelerometer sensor. The buzzer gives alert sound for 4secs then the LCD display as the person wants to "turn right side" as shown in the figure 8
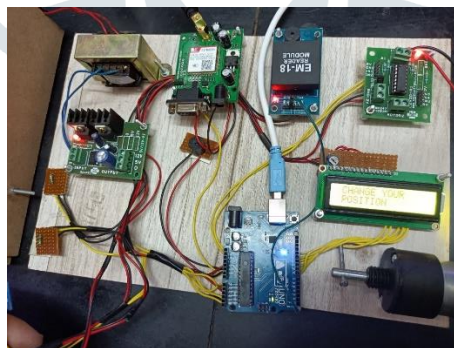

Figure 9. Change the position

That is displayed in the LCD that the chair turns to the original position as "Change your Position".
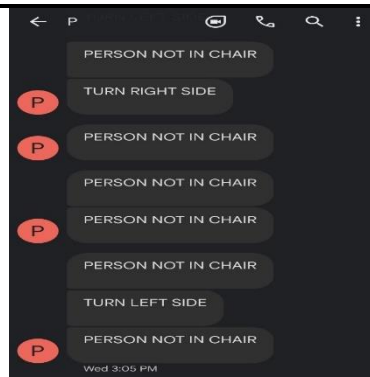
Figure 10. Mobile notification

VII. CONCLUSION

Thus, the four sitting postures Right side, Left side, Forward and Backward direction. Indications are monitored with the help of sensor module. Based on the received values, our system will automatically adjust the movement of the chair with the help of position motor which is attached to the control unit. Using IR sensor there are two kinds of time is calculating one is if the person sits more than 30 minutes then the message is sent to the user's mobile to know their time of sitting, second is if the user is not sitting more than the message will sent to the TL of the user with the user's details which is getting from RF I'd.

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