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Smart Chair for Posture Detection

Sakshi Deshpande[1] , Siddhesh Dehankar[2] , Viraj Mahajan[3] and Shreyash Shiledar[4]
[1-4]Department of Electronics Engineering, Shri Ramdeobaba College of Engineering and Management, Nagpur
Email: sakshimd333@gmail.com, siddheshdehankar@gmail.com, virajmahajan10@gmail.com, shreyashshiledar10@gmail.com

***Abstract*—This paper presents an electronic system for determining the posture of the person sitting on the smart chair using collaboration of different components and technologies. We include force sensitive resistor (FSR) and a micro-controller to build this system for posture detection. FSR's are mounted on seat and back rest. The circuit is designed using micro- controller and data is obtained from FSR's for different sitting postures. This data is analyzed for detecting correct and incorrect posture. The main purpose of this system is to detect posture for health monitoring.**

I. INTRODUCTION

In recent years, people try and improve their standard of living by utilizing advancement in current technologies. This technology has been a boon for health monitoring infrastructure. Various sensors are used for capturing the information and utilizing it for health monitoring. Force Sensitive Resistor is one such sensor which can be used in posture detection. Force is sensed using FSR which can be further utilized for determining posture.

A secondary sensor such as heartbeat sensor is also used for measuring heartbeat of a person. The additional sensor makes the whole system a complete health monitoring package. Posture detection and correction is very important as incorrect posture may cause various physical and mental health issues. Employees working for 8-10 hours tend to forget that they are sitting in an incorrect posture. For such employees a chair detecting sitting postures help them to adapt healthy sitting postures.

We have referred various papers describing the posture detection. The idea behind design and development of this chair is to help users especially employees by notifying their incorrect sitting postures.

FSR and micro-controller is used for building the system. Various types of postures, correct as well as incorrect are predefined. FSR's are mounted on the seat of the chair as well as the back rest. This system can be used for health monitoring of elderly patients as well. A great impact can be created by this chair in rural areas where there is a scarcity of health monitoring resources. The following sections introduce and demonstrate our idea effectively using diagrams and graphs.

II. MOTIVATION

Due to radical change in the job sector in past decade the average working hours of an employee has increased. Also, with increase in working hours responsibilities have also increased which in turn has

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increased stress. This makes development of a health monitoring a necessity in today's world.
Scientists and researchers first noticed something was up in a study that compared two similar groups: who sit most of the day, and those who don't. Though their diets and lifestyles were a lot alike, those that sat were about twice as likely to get heart disease as those that stood.
Proper sitting posture ensures proper blood circulation. Sitting in incorrect posture for long hours can influence blood circulation badly. The disadvantages of bad sitting posture are mostly not known to people. Some of the most commonly experienced health issues because of incorrect sitting postures are cardiovascular complications, increasing risk of diabetes, risk of muscle degeneration, leg disorders, increasing stress level, imbalance of spinal structure.

III. Literature Review

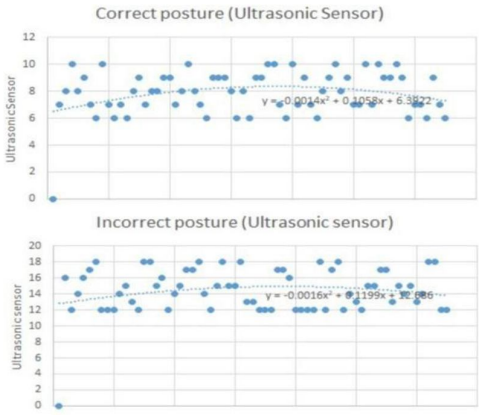
- Prior work regarding posture detection has shown it is possible to detect posture with the help of certain sensors and IoT technology. The authors: Dr. Baswaraj Gadgay, Veeresh Pujari PG Student Dept. Of VLSI Design & Embedded Systems VTU PG Centre Kalaburagi, Karnataka, India [1] have explained that the implementation combines two different technologies together which are Embedded systems and IOT (Internet Of Things) server. The posture of the person sitting on the chair is recognized through various applications. Also, a server motor helps to improve current posture.
- The paper by Steven Haveman, Gijs Kant [2] shows that computer use, in particular with inappropriate postures, increases the risk of musculoskeletal disorders. From this research it is clear that preventing or improving incorrect postures will lead to less musculoskeletal disorder and better ergonomics. In this paper a system is proposed, Context Aware Posture Recognition In Offices (CAPRIO), that continuously monitors the posture of an office worker, so that such dynamic interventions can be done. The monitoring of the posture should be done in a smart way, which means that the monitoring does not need any effort from the worker. For this smart monitoring the worker posture must be measured accurately.
- Paper by Mengjie Huang, Ian Gibson, and Rui Yang [3] presents that the data obtained from different postures was treated as the input and the output was the classification of the varied positions. These positions were obtained from the ANN classifier. The sitting postures were evaluated earlier before testing so that the output should be standardized.
- Research done by Wonjoon Kim, Byungki Jim, Sanghyoon Choo, Myung Hwan Yun from Institute of Industrial system and Innovation, Seoul National University, Seoul, North Korea [4] says that sitting in a chair is a typical act of modern people. Prolonged sitting and sitting with improper postures can lead to musculoskeletal disorders. Thus, there is a need for a sitting posture classification monitoring system that can predict a sitting posture. The purpose of this paper is to develop a system for classifying children's sitting postures for the formation of correct postural habits. For the data analysis, a pressure sensor of film type was installed on the seat of the chair, and image data of the postu.re were collected. A total of 26 children participated in the experiment and collected image data for a total of seven postures. The authors used convolutional neural networks (CNN) algorithm consisting of seven layers. In addition, to compare the accuracy of classification, artificial neural networks (ANN) technique, one of the machine learning techniques, was used. This study successfully performed the posture classification of children.

IV. The System for Posture Detection

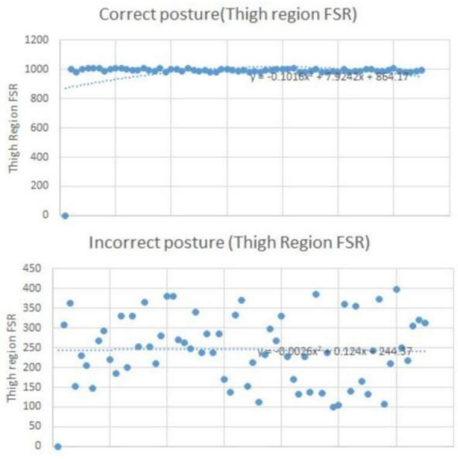
The definition of a Sitting Posture:
The five types of sitting postures which can be detected with the help of our system:
Type 1 (correct posture): sitting on chair with back properly rested on back rest.
Type 2 (incorrect posture): sitting on chair with back not touching the back rest.
Type 3 (incorrect posture): Crossing legs.
Type 4 (incorrect posture): Lazy posture.
Type 5 (incorrect posture): Back touching the back rest but lower body sliding forward.

Fig 1. Different sitting postures. (1) Correct and (2), (3), (4), (5) Incorrect.

Best fit curve is shown in Fig 2. Fig 2a represents that the distance between lumbar back and chair should be less than 10 cm to sit correctly. The points are scattered in the graph around a line representing quadratic equation. Fig 2b represents that if force sensed by FSR on the seat is less than 800 then the posture is incorrect. Also, the points lie nearly on the best fit line for correct posture whereas the points are scattered in the plot for incorrect posture. The scattered behaviour of plot clearly imply that for an ultrasonic sensor or a FSR to detect any posture, the value has to be in a certain predefined range.



(a)-Graph plot of Ultrasonic sensor with respect to weight



(b)-Graph plot of Thigh region FSR with respect to weight

Fig 2. Results on the basis of the survey done among people of different Weight groups

FSR's (Force Sensitive Resistors) are used for sensing the force exerted onto the seat and back rest. Two FSR's are mounted on the seat while the other two are mounted on back rest of the chair.
The force exerted is analog in nature. ADC in FSR converts this analog input to digital data output. Also, an ultrasonic sensor is mounted on the lower region of chair to calibrate the distance between lumber back and lower end of the seat. Two FSR's on back rest are helpful in detecting Type 1 and Type 2 postures whereas the other two FSR's are helpful in detecting Type 3 and Type 4 posture. Ultrasonic is used for detecting the Type 5 posture.
Data collected from all these sensors is fed to a micro-controller for further processing. ESP8266 is used for establishing wireless communication between system and user device. The data is transmitted to an IoT server using ESP8266.
Now that the data is available on the IoT cloud server, this data is used for processing. After processing, sever sends the notification on user devices such as phones, laptops, PC's. IoT server can store the data in cloud which can be viewed at any time. It can also show the trend of a user's data over a certain period of time graphically.
Thus, a user can rectify his incorrect posture and correct it accordingly. Apart from visual notification, a small vibrating motor is connected below the seat which vibrates if the user is sitting in an incorrect posture.

Fig 3. Block Diagram for implementation of Smart Chair

V. CONCLUSIONS

This paper presents a system to analyze information of sitting posture by force sensitive resistor (FSR). We use FSR's and micro-controller to build a system for posture detection. Positions of the correct posture are predefined in the first place, and those who deviate from this would be notified. We analyze and try to classify the information for recognizing the sitting postures through the data which is obtained by the FSR's. This system helps in determining the postures which may create present and future health problems for all ages. One of the most efficient uses of this smart chair would be for Health Monitoring.

- Literature shows that wrong sitting postures increase musculoskeletal disorders which are harmful for people working for long hours.
- Research revealed that this Smart Chair leads to healthy work environment and helps improve performance. This makes the workers more organized.
- Postures that are problematic for today's work environment should be targeted for improving efficiency of eachemployee.

Thus, after working on this project, a smart chair will be designed and developed which will detect the posture of the person accurately and will monitor the health.

REFERENCES

[1] Dr. Baswaraj Gadgay, Veeresh Pujari, "Implementation of an IOT Based Smart Chair", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume: 5 Issue 6, Pg.no:1314-1317, (2017).
[2] "Smart monitoring of worker posture in an office Environment" by Steven Haveman, Gijs Kant.
[3] "Smart Chair for Monitoring of Sitting Behavior" by Mengjie Huang, Ian Gibson, and Rui Yang.
[4] Wonjoon Kim, Byungki Jim, Sanghyoon Choo, Myung Hwan Yun, "Designing of smart chair for monitoring a sitting posture using convolutional neural networks" Institute of Industrial system and Innovation, Seoul National University, Seoul, North Korea. ISSN: 2514-9288. Publication date: 1 April 2019.

[5] A. M. Lis, K. M. Black, H. Korn, and M. Nordin, “Association between sitting and occupational LBP”, European Spine Journal, Volume: 16, Pg.no:283–298, (2007).
[6] J. Van Dieen, M. De Looze, and V. Hermans, “Effects of dynamic office chairs on trunk kinematics, trunk extensor EMG and spinal shrinkage”, Ergonomics, Volume:44, Pg.no:739–750, (2001).
[7] M. Huang, K. Hajizadeh, I. Gibson, and T. Lee, “Analysis of compressive load on intervertebral joint in standing and sitting postures”, Technology and Health Care, Volume 24, Pg.no:215–223, (2016).
[8] H. Z. Tan, L. Slivovsky, and A. Pentland, “A sensing chair using pressure distribution sensors”, IEEE/ASME Transactions on Mechatronics, Volume:6, Issue:3, Pg.no:261– 268, (2001).
[9] “Sitting Posture Detection and Recognition Using Force Sensor” by Yong-Ren Huang and Xu- Feng Ouyang.