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"SMART CHAIR FOR BODY POSTURE AND MUSCLE STRAIN DETECTION"

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Abstract : As the world is becoming more technology-based, people often tend to spend a lot of time sitting on their chairs work in their offices for several hours. Our design contributes to society by providing feedback on their poor postures and lowering the risk of back or neck injuries. Our design contributes to society and to human well-being. As it states, our design supports improving people's poor posture as well as muscle strain which is an important problem in society today. Using a prototype chair, Ultrasonic sensors, EMG sensors, DHT11, a buzzer, ESP 32 and a microcontroller we will be designing our system. The system reads and analyses data from a user's sitting posture with the given parts. The data will be fetched from the chair to the microcontroller and passed on to the visual display. The data will be analyzed and the system will determine the posture status if the posture is incorrect, the same will be notified by the feedback system to the user to fix the posture. The chair consists of an additional EMG sensor which will detect muscle strain on the user's arms. This will not just help the users to maintain a proper body posture, but will also reduce back pain issues and arm strain in users.

IndexTerms **- Posture detection, Smart chair, EMG sensor, Muscle strain, Ultrasonic sensor.**

I. INTRODUCTION

Sitting, standing, or lying down in an improper posture continuously for a prolonged period can result in damage and pain in various areas of the body. These areas include the shoulder, body, and neck. While sitting on a chair, the person is not aware of the fact that he/she is sitting in the wrong posture and it can adversely affect the posture and the muscles. Neck pain and disability are major issues related to prolonged use of computers and improper sitting posture [1]. This problem is ignored by most individuals at the start, but over a period, it becomes difficult to rectify it after the damage has already been done. This must be fixed at the initial stage so that the problem does not arise. Sitting time in a chair has been observed to be around four to six hours a day for working adults and thus improper posture can lead to a serious issue [1] [3] [4].

Repetitive Strain Injury (RSI) is the most common occupational injury faced by computer users. Computer users faced a higher possibility of getting RSI due to their prolonged working time and static posture [2]. Maintaining a proper upright sitting posture can help in reducing neck and spinal pain when working on a computer [3].

The aim is to make an automatic alert system that will monitor the user's back posture on a chair as well as strain levels on their arm muscles mostly while working on a computer. This will not just help the users to maintain a proper body posture, but will also reduce back pain issues and arm strain in users. As we can see the difference between the two sitting position the good and bad one. We have designed a chair to detect incorrect sitting posture.

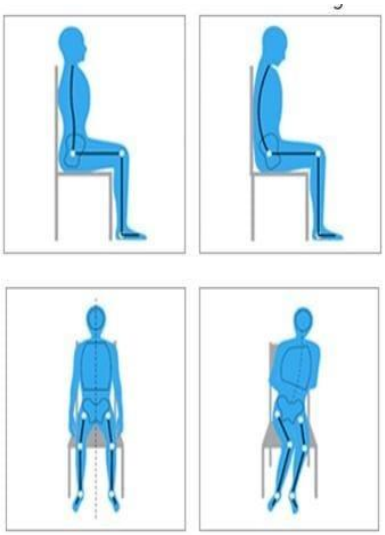

Fig. 1- Sitting Posture

Problem Statement

To design a prototype smart chair that will help in posture correction by alerting the user of bad posture and muscle strain using Ultrasonic sensors and EMG sensors respectively.

Objectives

- Help user maintain proper body posture.
- Help reduce back pain issues in users.
- Reduce chronic problems.
- Increase postural awareness.
- Use emg sensor to monitor strain on arm muscles.
- Provide a smart user experience.

II. LITERATURE REVIEW

George Flutur et al., [1] The objective of the research is a solution for this problem by involving a smart chair based on the IoT paradigm. The chair has sensors embedded that detect the user's position and flag whenever it becomes incorrect. The system allows us to gather real-time data and then determine patterns for each user.

Qisong Hu, Xiaochen Tang and Wei Tang. [2] This paper reports a novel posture recognition system on an office chair that can categorize seven different health-related sitting postures. The system uses six flex sensors, an Analog to Digital Converter (ADC) board and a Machine Learning algorithm of a two-layer Artificial Neural Network (ANN) implemented on a Spartan-6 Field Programmable Gate Array (FPGA).

Krutika Bramhapurikar et al.,[3] The main focus of this paper is on the construction, working, and applications of a posture corrector. The position of flex sensor, which is used to detect back bending, is chosen in such a way that it will detect the back bending properly. For proper back bending detection, we have designed the sensing system. The posture corrector device alerts the user in case of poor posture by sending a message on the smartphone and vibrating vibration motor which is attached to the backside of the user.

M. Udin Harun Al Rasyidet al. [4] The signal generated by the EMG sensor can be sent to the device or network that can extend the signal from the EMG sensor area. That is what underlies the author making a research on the implementation and monitoring of EMG sensors in a Wireless Body Area Network (WBAN). In the present study, the use of EMG can be expanded by utilizing WBAN which can transmit information through the network, so that the results of the EMG sensor can be determined and analyzed by us.

Andreas Wege and Armin Zimmermann, [5] This paper presents an electromyography (EMG) control for a hand exoskeleton. The device was developed with a focus on support of the rehabilitation process after hand injuries or strokes. As the device is designed for later use on patients, which have limited hand mobility, fast undesired movements have to be averted.

Research Summary

Researchers have proposed solutions to the posture problem, such as a smart chair that uses IoT technology. One system uses flex sensors and an artificial neural network to recognize different postures. Another system is a posture corrector that alerts the user via smartphone

message and vibration motor. EMG sensors have been used in wireless body area networks for monitoring posture, while an EMG control was designed for a hand exoskeleton to aid in rehabilitation.

Machine learning models were also built to classify sitting posture using pressure sensors, and a smart IoT system for posture detection uses force sensors and mobile applications. Finally, EMG signal processing has been studied for identifying human muscle strength in
rehabilitation. Overall, these research efforts demonstrate a growing interest in developing technology-based solutions to address the problem of poor posture.

The use of sensors, machine learning algorithms, and wireless networks shows promise in detecting and correcting incorrect posture in real time. These solutions could potentially improve posture-related health issues, such as back pain, and help individuals maintain better health and well-being in the long term. However, further research and development are needed to refine these technologies and make them more accessible and user-friendly for wider adoption.

III. METHODOLOGY

A. Ultrasonic sensor array:

- Three ultrasonic sensors are used to develop this system. These sensors are placed at the middle back region and both sides shoulders. The neck and back should maintain a ninety-degree angle with respect to the hips for a proper posture to be maintained. Hence, once the hip region of the person is connected to the back of the chair the upper part of the back should maintain distance from the chair and ideally not stick to the chair.
- So, the first ultrasonic sensor will detect the distance of the back from the chair.
- Similarly, if the distance of the sensor at the back level decreases below the threshold it means the person is slouching and hence, the posture is incorrect.
- The two sensors by the side measure the distance of the shoulders from the chair. Both shoulders should maintain a uniform distance from the chair as well as have a uniform distance with respect to the back to have a normal posture. If one of the shoulders is having more distance it would mean the user is leaning from a side, while if both shoulders are far away with respect to the back it would mean the user is leaning forward. Such seating postures are not ideal.
- In any of the above-mentioned case the buzzer will ring and the LCD screen will highlight the part where the error is present.

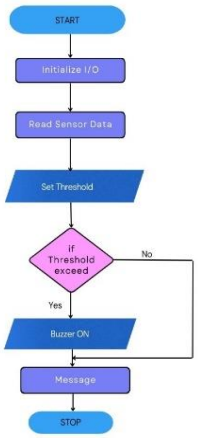

Fig. 2- Flow diagram of ultrasonic sensor

B. EMG sensor:

The EMG sensor is attached to the handle of the chair. The primary purpose of the EMG sensor is to measure the strain on the hands in these cases to monitor for symptoms of Repetitive strain
injury. When the user feels that they have been working for too long or feels any discomfort in their hand they can check the strain level of their hand by connecting the EMG sensor pads at appropriate positions as directed. The EMG sensor will check the strain level of the dedicated muscle and give output regarding the strain level on the LCD display. The EMG sensor can be used for other muscles as well but here it is set for arm muscle and hence the strain condition displayed on the LCD will display the level accordingly and thus can be misleading if connected to other muscles.

Block Diagram

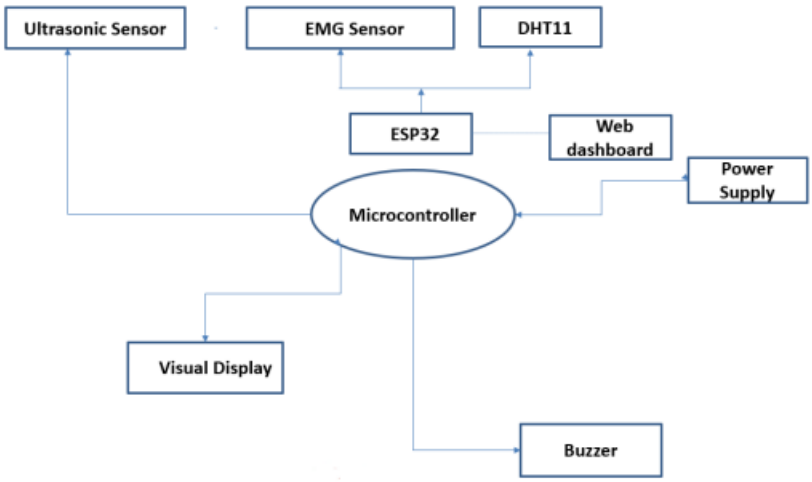

Fig. 3- System Block Diagram

As you can see in the block diagram, we have used an Ultrasonic sensor to measure the particular distance at which the person is sitting according to that we have to give an alert. The EMG sensor is used to detect the muscle strain of a person. Then we used an Arduino Uno to collect the data from the respective sensors and then display that data on a Visual display and accordingly if the posture is incorrect the buzzer will give an alert to correct the posture. By doing this the person who is sitting on the chair will correct his sitting posture. A secondary controller is used which is ESP32 which controls other sensors and also sends data to the browser using Wi-Fi.

IV. METHODOLOGY RESULTS AND DISCUSSION

The EMG sensor output can be seen in the graph as shown below. When there is no strain on the arm muscles, the graph is a straight-line graph. This tells us that there is no muscle strain.
In case there is a muscle strain, the output of the graph contains spikes that indicate how intense the strain is. In order to visualize the strain graph, we have put some strain on the muscles and there is a spike that shows a high strain level.

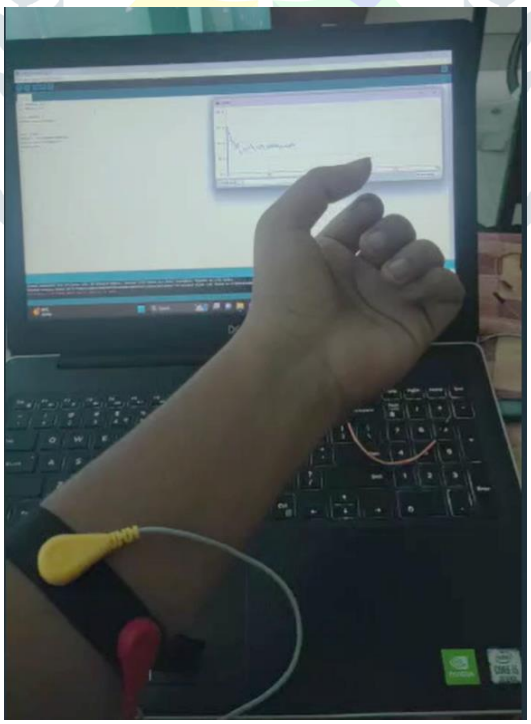

Fig. 4- EMG Output-1

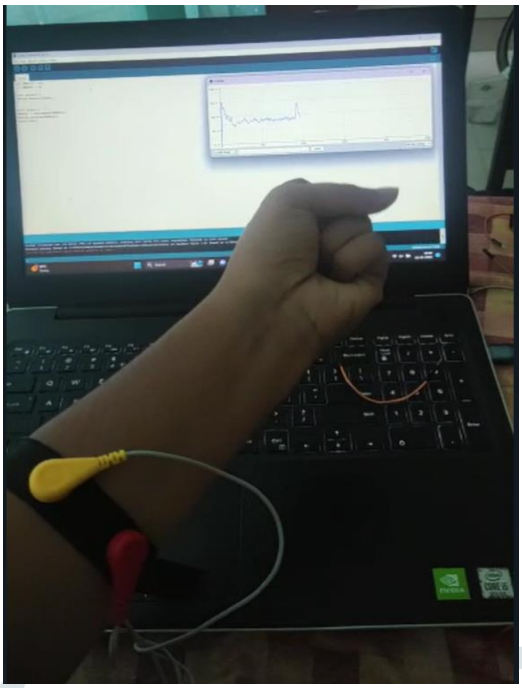

Fig. 5- EMG Output-2

Fig. 6- Chair Display

The alerts will be displayed on the LCD screen to the user. When the user is not sitting, the chair will alert the user to sit properly. When no user is sitting, the LCD displays to sit properly. After every 1 hour, an alert will be displayed which asks the user to take a walk which is advisable. The ultrasonic sensors will monitor the distance of the back from the chair at focal points and if one of the points shows variation with respect to others, it means the posture of that part is not maintained which will activate the alert system. This is when the shoulders are not properly aligned. The system checks for the same focal point repeatedly after 100 seconds for five times, if the error is present then the user is alerted.

V. CONCLUSION

The system will help people maintain posture while working long hours. It will help by alerting faulty posture and suggesting correction wherever required in the back. It will help in reducing chronic diseases related to the back such as spondylitis, herniated disc, spinal stenosis, etc. EMG sensor will help detect strain levels in limbs thus suggesting rest whenever strain level is high.

VI. ACKNOWLEDGMENT

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