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INTELLIGENT SITTING POSTURE CLASSIFIER SMART CHAIR

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Abstract: In recent years, there has been growing interest in postural monitoring while seated. Nowadays in modern societies, a sedentary lifestyle is almost inevitable for a majority of the population. Long hours of sitting especially in wrong postures, may result in health complications. Our aim is to provide rapid entire body assessment for computer operators, this review is convenience for assessment of jobs in various professions like construction health care jobs, workshop etc. Negative effects of bad posture on the body are depression, stress poor breathing, nerve damages etc. Experts estimates that up to 80% of the population will experience back pain at some time in their lives. Computer is operated by user for a longer time so sitting posture should be taken care by the operator if not it may lead to harmful effect for the body such as neck pain, pain in the spinal cord, various disorders relating to change in eye pressure and also may occur vision related problem caused by continuous use of computer for longer duration and also work stress will cause incardiovascular diseases. The computer operator can protect themselves from the health issues by implementing good body posture by the use of sensors and communication devices we can continuously monitor the computer operator for the betterment of sitting posture of human body.

Keywords: Posture, Smart Chair, Health monitoring.

I. INTRODUCTION

At present, given the difficulty of continuous monitoring by health specialists, postural monitoring and diagnosis is carried out by means of specific questionnaires. The interest in the development of postural monitoring devices that allow objective quantification of a patient's postural status has grown in recent years.

The aim of this project is to present a robust sitting posture classification model, focused on smart chair users, able to distinguish between the common improper sitting postures adopted by disabled users regardless their physical complexion.

II. LITERARTURE SURVEY

1. "**To develop an automated sitting posture recognition system utilizing pressure sensors**"
Authors:

Lan Mu et al. [17] used a Webcam to recognize sitting postures. The Hausdorff distance was adopted to recognize face and body postures. However, their method can only identify the sitting posture of the upper body. The lower body cannot be identified. Moreover, the result of this method may be incorrect when someone passes by and is captured by the camera. The third category is pressure sensor-based methods. A matrix sensor mat or flexible pressure sensors were deployed on the chair to detect sitting postures.

Haeyoon Cho et al. [18] deployed several pressure sensors on a chair cushion and two ultrasonic sensors on the back of a chair. The pressure sensors and ultrasound sensor were used together for data collection. The collected data was then used by Convolutional Neural Network (CNN) and Lower-Balanced Check Network (LBCNet) to classify sitting postures. However, this method required many pressure sensors, and the hardware cost was high. And also developed a system that combined two ultrasonic sensors and 16 pressure sensors. The collected signals were processed by an Arduino board and then transmitted to the Naver Cloud Platform, where Convolutional Neural Network (CNN) and Lower-Balanced Check Network (LBCNet) were used for posture classification. The recognition results were displayed on an Android phone.

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Although the system achieved an accuracy rate of up to 96%, it required 18 sensors, resulting in relatively high hardware costs. In contrast, our SPRS (Sitting Posture Recognition System) uses fewer pressure sensors while achieving similar performance.

Qisong Hu et al. [19] first installed six pressure sensors on the hips, armrests, and back areas of a chair to collect pressure readings. They then used a look-up table to build an Artificial Neural Network (ANN) model for classification. Their results showed an accuracy rate of 97.8% and a computation time of 9ns.

Wenyao Xu et al. [20] proposed a system using an electronic textile (eTextile) pressure sensor on the seat cushion to classify sitting postures. The eTextile consists of fibers coated with a conductive polymer that contains pressure and strain sensors. The system collected pressure signals when a user sat on the cushion. After filtering background noise, Dynamic Time Warping (DTW) was adopted to classify postures. Their experimental results showed an accuracy rate of only 85.9%.

Jianquan Wang et al. [21] placed 81 pressure sensors on the hip of the chair and 90 pressure sensors on the back. They used Spiking Neural Network (Spiking-NN) to classify sitting postures, achieving an accuracy rate of 88.52%. However, their method requires sensor readings on the seat back, which can increase implementation cost.

Zhe Fan, Qilong Wan, Xu Ran et al. [22,23,24] used a large array of pressure pads on the hip area to collect users' hip pressure and converted the pressure signals into a pressure map. This pressure map was used to train a neural network model for classification. Although this method can correctly identify sitting postures, the hardware cost is relatively high, reaching USD 300 or more.

Haeseok Jeong et al. [25] proposed a hybrid sensor system consisting of six pressure sensors and six distance sensors placed on a chair. The collected pressure and distance readings were used to train a K-nearest neighbors (KNN) model for posture classification. Their results showed an accuracy of up to 92%. However, this method required the placement of distance sensors on the seat back, and the accuracy could be affected by users' body size and height.

Haeyoon Cho et al. [18] developed a system that combined two ultrasonic sensors and 16 pressure sensors. The collected signals were processed by an Arduino board and then transmitted to the Naver Cloud Platform, where Convolutional Neural Network (CNN) and Lower-Balanced Check Network (LBCNet) were used for posture classification. The recognition results were displayed on an Android phone. Although the system achieved an accuracy rate of up to 96%, it required 18 sensors, resulting in relatively high hardware costs. In contrast, our SPRS (Sitting Posture Recognition System) uses fewer pressure sensors while achieving similar performance.

III. EXISTING METHOD

In the current scenario there is no existing system that monitors change in the sitting posture of the human body. Through time it has been seen that human body requires less sitting time and more of walking around. Any change in this requirement results to various disorders relating to change in eye pressure, or pain in the spinal cord or neck region.

IV. PROPOSED METHOD

By considering the necessities of the different efficient techniques in posture monitoring, few objectives are proposed in the present work. The main research objectives are listed below;

- The aim of this project is to cultivate good and correct sitting posture habits and promote better health in people who spend constant long hours sitting on chairs.

- The computer technology is growing in daily life, the key feature of this project is to eliminate any mental and physical disorders caused by improper body posture.

- To improve the quality of life.

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BLOCK DIAGRAM :

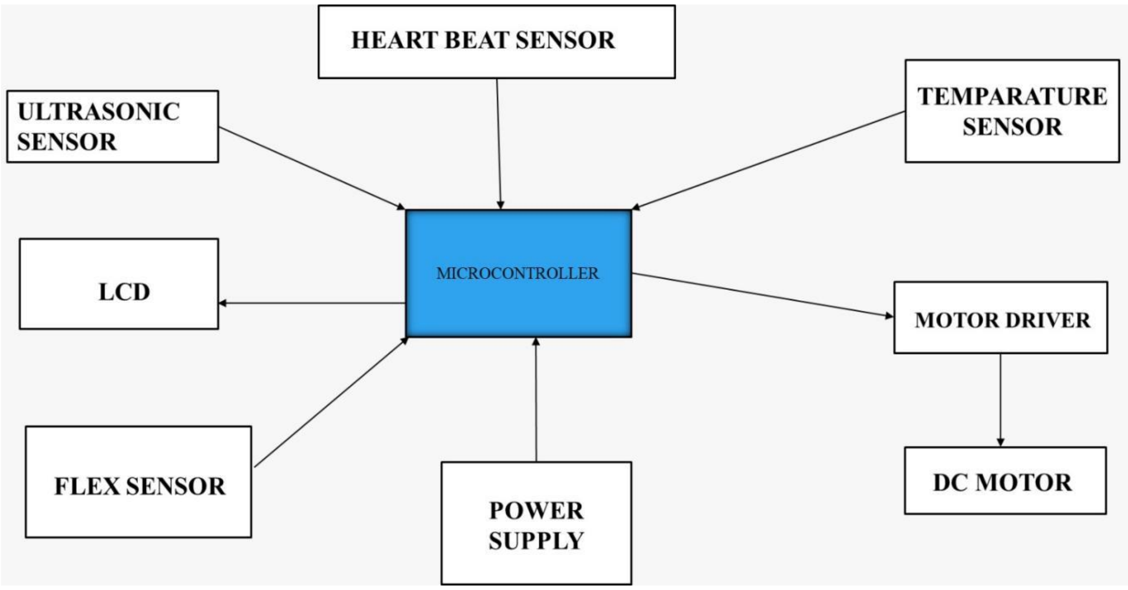

Fig 1: Block Diagram

V. COMPONENTS

ARDUINO UNO

Arduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using Tx and Rx pins. Thereare many versions of Arduino boards introduced in the market like Arduino Uno, Arduino Due, Arduino Leonardo, Arduino Mega, however, most common versions are Arduino Uno and Arduino Mega.

A. DS18B20 TEMPERATURE SENSOR

The temperature sensor in Arduino converts the surrounding temperature to voltage. It further converts the voltage to Celcius , Celcius to Fahrenheit, and prints the Fahrenheit temperature on the LCD screen.

B. PULSE SENSOR

The pulse sensor/ Heart Beat Sensor is a plug-and-play heart-rate sensor for Arduino. A pulse wave is the change in the volume of a blood vessel that occurs when the heart pumps blood, and a detector that monitors this volume change is called a pulse sensor. An alternate name of this sensor is heartbeat sensor or heart rate sensor. The working of this sensor can be done by connecting it from the fingertip or human ear to Arduino board. So that heart rate can be easily calculated.

C. FLEX SENSOR

A flex sensor or bend sensor is a sensor that measures the amount of deflection or bending. Usually, the sensor is stuck to the surface, and resistance of sensor element is varied by bending the surface. These sensors are classified into two types based on its size namely 2.2-inch flex sensor & 4.5-inch flex sensor. The size, as well as the resistance of these sensors, is dissimilar except the working principle.

D. ULTRASONIC SENSOR

As the name indicates, ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception an optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head.

E. DC MOTOR

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

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F. MOTOR DRIVER

The motor driver is use to control speed and direction of a motor; speed of motor can be controlled with PWM (Pulse width Modulation) Technique. By adjusting the average voltage, the average voltage depends on duty cycle and direction of motor can be control by just inversing the flow of current through a motor, this can be done using an H-bridge.

G. LCD DISPLAY

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. To establish a good communication between human world and machine world, display units play an important role.

H. POWER SUPPLY

A DC 5V power supply is a type of power supply that provides a regulated and stable 5V DC (direct current) output voltage. This low-voltage power supply is commonly used to power electronic devices that require a 5V DC supply, including microcontrollers, sensors, LED lights, USB charging devices, and other low-power electronic components.

I. POWER SUPPLY ADAPTER

The power adapter serves the purpose of converting AC voltage to a single DC voltage for your computer. It operates as an external battery for your computer so that the computer's size does not need to be so large. A computer uses many different DC voltages. One is provided by the power adapter and the other is provided by internal circuits in the computer itself. These combined give the computer what it needs. The power adapter serves as the battery that is providing specific energy and volts to a specific computer it is plugged into.

J. WIRES- A cable is a thick wire or a bundle of wires, often covered in insulation, which is used to transmit electricity or telecommunication signals.

A. SOFTWARE REQUIREMENTS

ARDUINO IDE

Arduino IDE where IDE stands for Integrated Development Environment – An official software introduced by Arduino.cc, that is mainly used for writing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this software that is an open source and is readily available to install and start compiling the code on the go.

Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module. It is easily available for operating systems like MAC, Windows, and Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.

The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

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VI. RESULTS AND DISCUSSIONS

Fig 1: LCD Display

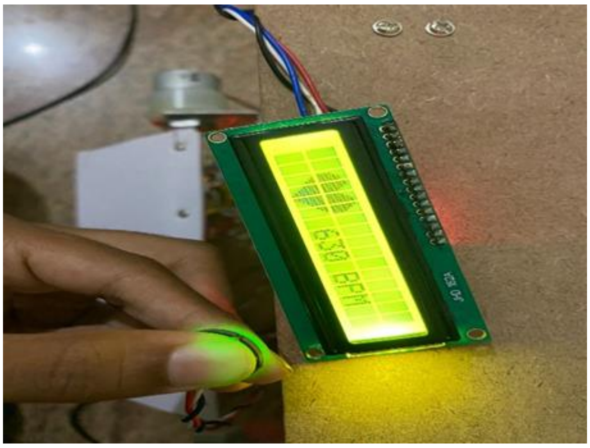

Fig 2: Heartbeat Monitoring

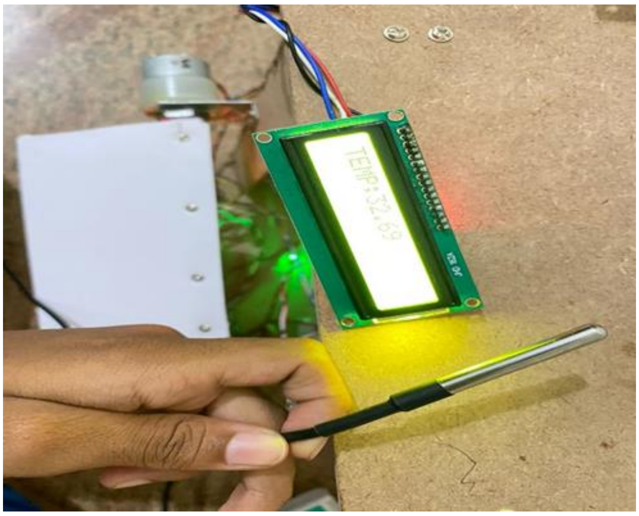

Fig 3: Temperature Sensor with LCD Display

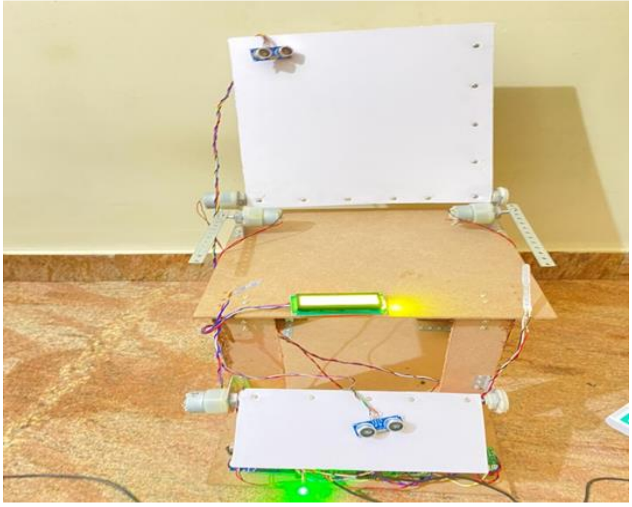

Fig 4: Smart Chair

Posture Detection:

- The Flex Sensor is attached to the chair's backrest or seat to detect body bending movements.
- As the user sits on the chair, the Flex Sensor measures the angle of the user's back or hips.
- The Ultrasonic Sensor measures the height of the user, ensuring proper posture alignment based on user height.

Posture Correction:

- Based on the input from the Flex Sensor and Ultrasonic Sensor, the Arduino determines if the user's posture needs correction.
- If poor posture is detected, the Arduino activates the DC Motor attached to the chair.
- The DC Motor adjusts the chair's backrest or seat to correct the user's posture automatically.

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VII. ADVANTAGES AND APPLICATIONS

A. ADVANATGES

- This type of system helps to eliminate hunchback effect occurring due to much bending of the spinal cord.
- Helps eliminate poor moods such as depression and stress resulting from slouched position.
- Energy levels are also increased since internal processes of the body are well maintained, thereby eliminating moods like irritation, tiredness or aggravation.
- Sitting upright position with chest and shoulder broad makes breathing easier.
- Digestive distress occurring due to improper posture can also be eliminated by using this technique.

B. APPLICATIONS

- Ergonomics and Workplace Safety: A smart chair with a sitting posture classifier can be used in offices and workplaces to promote proper ergonomics and reduce the risk of musculoskeletal disorders. It can detect and alert users when they are adopting poor sitting postures, such as slouching or hunching over, prompting them to correct their posture and maintain a healthier position.

- Physical Rehabilitation: Smart chairs with posture classifiers can be valuable tools in physical rehabilitation settings. They can help therapists and patients monitor and analyze sitting postures during rehabilitation exercises, ensuring that patients maintain correct positions while performing specific movements or exercises. The chair can provide real-time feedback and reminders to help patients improve their posture and ensure proper alignment during recovery.

- Fitness and Wellness: Smart chairs can be utilized in fitness centers or home gyms to enhance workout routines. By analyzing sitting postures, the chair can provide guidance on correct form and alignment during exercises that involve sitting or support, such as weightlifting or core strengthening. It can help users optimize their workout sessions and reduce the risk of injuries caused by improper posture.

- Posture Training and Correction: Individuals who want to improve their posture can benefit from a smart chair with a posture classifier. The chair can offer real-time feedback and reminders, helping users develop and maintain good posture habits throughout the day. This can be particularly useful for people with sedentary lifestyles or desk jobs, promoting better spinal alignment and reducing the strain on neck, shoulders, and back.

- Elderly Care: Smart chairs with posture classification can be employed in elderly care facilities or homes to monitor and promote better posture among seniors. The chair can alert caregivers or family members when a user maintains a poor posture for an extended period, helping prevent discomfort, pain, and potential health issues associated with incorrect sitting positions.

- Gaming and Virtual Reality: In the realm of gaming and virtual reality, a smart chair with a posture classifier can enhance the immersive experience and improve the user's comfort. By detecting the sitting posture, the chair can adjust its configuration or provide feedback to ensure that gamers maintain an ergonomic position while playing. This can help reduce fatigue, increase gameplay efficiency, and prevent gaming-related injuries.

VIII. CONCLUSION

The project is designed using structured modeling and is able to provide the desired results. It can be successfully implemented as a Real Time system with certain modifications. Science is discovering or creating major breakthrough in various fields, and hence technology keeps changing from time to time. Going further, most of the units can be fabricated on a single along with microcontroller thus making the system compact thereby making the existing system more effective. To make the system applicable for real time purposes components with greater range needs to be implemented.

IX. FUTURE SCOPE

For project demo concern, we have developed a prototype module. In future, this project can be taken to the product level. To make this project as user friendly and durable, we need to make it compact and cost effective. Going further, most of the units can be embedded along with the controller on a single board with change in technology, thereby reducing the size of the system.

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