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DETECTION OF SITTING POSTURE THROUGH THE UTILIZATION OF FORCE SENSORS

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Abstract:

In light of the increasing number of people leading sedentary lives and working from desks, bad sitting posture is a common problem that causes musculoskeletal problems and pain in individuals. In order to increase ergonomic health and reduce related health risks, the goal of this project is to build an automated system for the real-time identification and evaluation of sitting position. The suggested method analyses people's sitting position by using force sensors that are integrated into the chair. By gathering information on pressure distribution and seat contact, these sensors allow for the real-time evaluation of ergonomic alignment. The technology is able to classify sitting postures into predetermined categories, such as ergonomic and non-ergonomic, by extracting important parameters including spinal alignment, shoulder position, and seat contact. Furthermore, the system has a foam roller attachment onto the chair, intended to offer consumers a therapeutic massage. The foam roller is engaged to provide targeted treatment to the problematic regions when the system identifies extended durations of poor sitting position that may be connected with discomfort or back pain. Through posture monitoring, this dual functionality not only encourages good seating habits but also provides proactive steps to reduce discomfort and improve user comfort when sitting for extended periods of time. The system's ultimate goal is to increase productivity and well-being by decreasing the frequency of musculoskeletal problems linked to extended sitting by providing users with customised feedback and insights on their sitting patterns.

KEYWORDS: Poor Sitting Posture, Musculoskeletal Problems, Force Sensor, Foam Roller

INTRODUCTION

With today's mostly sedentary lifestyle marked by extended hours in front of computers and workstations, the frequency of bad sitting posture has become a major worry. It not only makes people uncomfortable and causes musculoskeletal problems, but it also puts their health at serious danger. This project aims to provide an automated system for the real-time identification and assessment of sitting position using force sensors built into the chair in order to solve this urgent problem and enhance ergonomic wellness. This project's main goal is to use technology to counteract the negative consequences of bad sitting posture. The suggested method intends to give customers real-time data on their sitting postures by integrating force sensors into chairs, allowing them to make the required modifications to enhance ergonomic alignment. The system is able to classify sitting postures into predefined classifications by analysing the pressure distribution and seat contact data collected by these sensors. Based on parameters like spinal alignment, shoulder position, and seat contact, the system can distinguish between ergonomic and non-ergonomic positions. Additionally, this creative design provides two functions by attaching a foam roller attachment to the chair. This feature has a therapeutic function; it offers focused massage to reduce pain brought on by extended durations of bad sitting position. When the system notices prolonged periods of non-ergonomic sitting—which may be associated with pain or back pain—the foam roller activates to provide users with preventative therapy, improving comfort and lowering the likelihood of musculoskeletal problems.

The suggested system not only promotes better sitting practices but also takes proactive steps to alleviate discomfort and enhance user well-being during extended sitting periods by fusing posture monitoring with therapeutic intervention. The main objective of this project is to reduce the incidence of musculoskeletal issues linked to prolonged sitting by offering individualised feedback and insights on sitting habits. This will increase productivity and improve well-being.

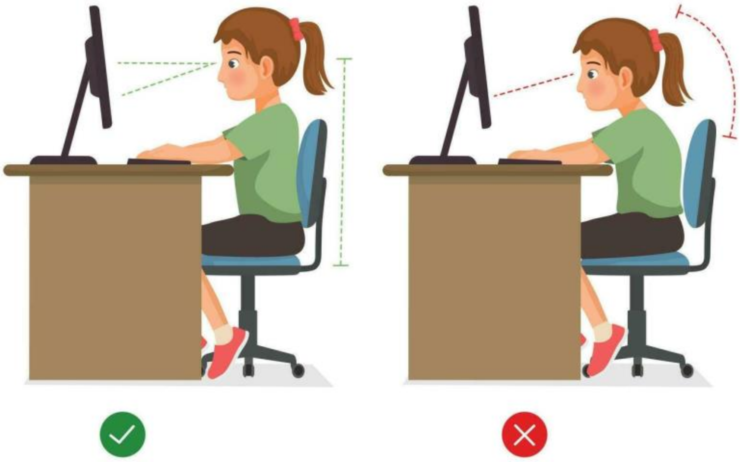

Fig.1 Sitting Posture

The suggested system can include cutting-edge features in addition to its main capabilities to increase its efficacy in boosting ergonomic wellness. Through extensive analysis of user data gathered over time, the system may improve posture detection skills, guaranteeing increased precision and dependability when offering suggestions and comments. In addition, the system could have programmable options that let users tailor their experience to suit their unique tastes and ergonomic requirements. Users may, for instance, modify the frequency and intensity of the massage offered by the foam roller attachment or the sensitivity of the force sensors. This degree of personalisation guarantees that the system successfully satisfies each user's distinct requirements while also improving user pleasure. Furthermore, the system can include gamification components to support sustained adoption of good seating patterns and long-term behavioural change. The system can encourage users to interact with the ergonomic input and follow advised sitting patterns by including features like success badges, prizes for keeping good posture, and progress monitoring. Gamification increases the chance of positive behaviour change by making the experience more engaging and entertaining as well as by fostering a feeling of accomplishment and accountability. Additionally, the system could support wearable technology and mobile apps in order to accommodate a range of user preferences and demands. Even when they are not at their workstations, users will be able to check their posture data and get real-time feedback on how they sit. Additionally, by giving users extra support and feedback, wearable technology like smart clothes or braces that correct posture might enhance the system and improve users' ergonomic experiences. The suggested system would be more successful in boosting ergonomic health if it included these cutting-edge features and functions. It would also establish the system as a full solution to the problems connected with extended sitting in today's modern lifestyle. The system has the ability to completely change how people approach and maintain good seating habits by utilising technology and innovation, which will eventually increase productivity and well-being both at work and outside of it.

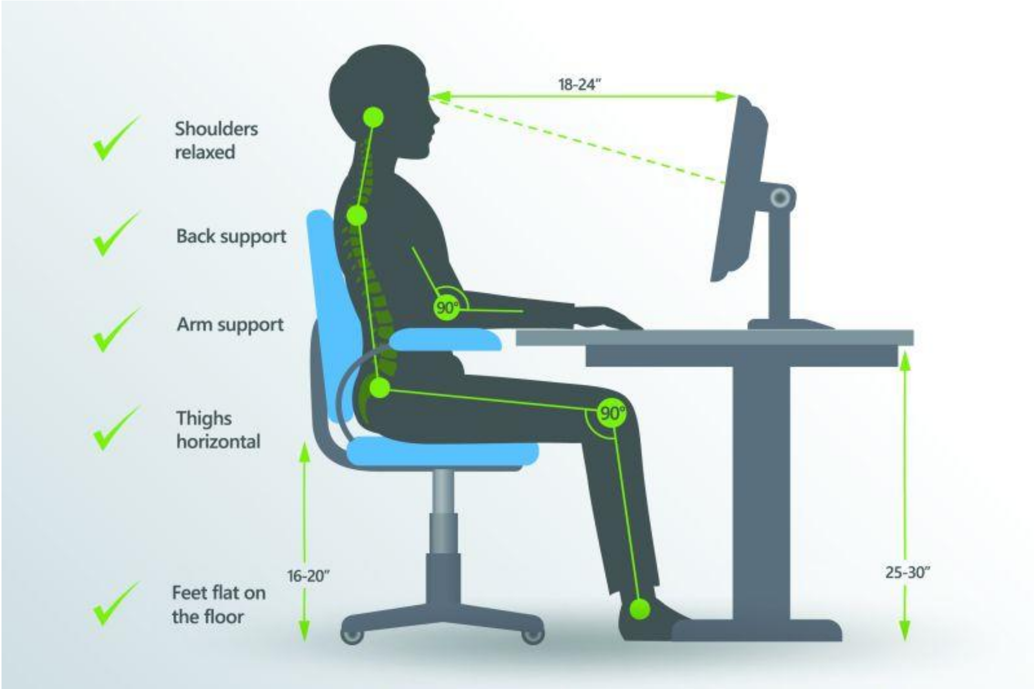

Fig.2 Appropriate posture for sitting

LITERATURE SURVEY

1. **A Smart System for Sitting Posture Detection Based on Force Sensors and Mobile Application.**

   Slavomir Matuska et al., 2020 proposed the entire system is made up of a cloud server, client stations, smartphones, and a configurable number of chairs. Six flexible force sensors, an external battery power supply, and an Arduino microcontroller-based electrical gadget are included with each chair. The cloud solution is stored on the QNAP network-attached storage. It uses the Mongo database for data storage, Node-RED for logic, and the Message Queuing Telemetry Transport (MQTT) broker for communication.

2. **Posture Detection and System Using IOT**

   Nitesh Sahani et al., 2020 presented the system, when the user is sitting or standing in a slouched position, the device will buzz or vibrate to alert them. It will also instantly transfer data over Bluetooth to the phone's app. The phone app will track the user's motions and provide a variety of back posture options for sitting and standing.

3. **A Smart Chair with Posture Recognition and Temperature Monitoring System**

   Dr. A. Udhaya Kumar et al., 2022 measures the chair's bending level using a flex sensor. A force sensor will sound an alarm if someone sits for more than eight hours straight, and a mems sensor will keep an eye on the chair's posture. Additionally, a temperature sensor has been incorporated to track the rise in body temperature caused by prolonged sitting. A position motor will automatically return the chair to its original sitting position.

4. **Posture Detection and Alert System Using Flex and Accelerometer Sensors**

   T Kavitha et al., 2023 aims that the flex sensor, buzzer, accelerometer module, and microcontroller comprise this gadget. The accelerometer module is used to measure the angle of the neck, and the flex sensor is utilized to detect the bending movement of the spinal cord. The microcontroller, which receives data from both sensors and interprets it to decide if the posture is proper or not, is connected to the data. The buzzer notifies the user to adjust their posture if it is off.

5. **Smart Spine Posture Detector**

   Dr Girish Mundada et al., 2022 build a system, through a vibrating reaction, the user will be made aware of and reminded of their position, allowing them to make necessary adjustments. The technology gradually in-stills in the user the habit of retaining proper posture when outside without constant reminders.

6. **Human Posture Detection System Using Real Time Self Calibrating Algorithm**

   M Suresh Anand et al., 2019 developed the device that prompts the user to adjust their posture, and the accelerometer determines the user's upper body axis. Human posture and activity are calculated using a Real-Time and Self-Calibrating

Algorithm Based on Triaxial Accelerometer Signals. The posture value and the threshold value are compared by the device. The Intelligent Chair Sensor - Classification and Correction of Sitting Posture threshold value for typical human posture is 7. The gadget still requires the user to adjust their posture using the buzzer or vibrator if the value rises above the threshold limit for a minute. Using Wi-Fi, the gadget transmits the posture value to the server when the buzzer or vibrator is triggered. Users generate monthly reports using the website. The report includes the frequency of device posture reminders.

7. **Alert System for Posture Correction**

S Y Pattar et al., 2022 says that three flex sensors have been employed in the proposed system to check for hunchbacks and rounded shoulders. Two flex sensors have been positioned on either side of the spine, in the area between the rhomboid major and the scapula, or shoulder bone. The third one, which measures frontal bending, is 98 positioned on the lumbar area. This voltage divider circuit, which tests the flex sensor's bending, is created by connecting these flex sensors in series with 47kohm resistors. A 9V battery serves as the Arduino's power source. This is designed to warn the user when their poor posture is maintained for an extended amount of time. By manipulating the button, the user controls this procedure.

8. **A Prototype Model for Wearable Posture Monitoring System with Vibration Sensor**

Lakshmipriya et al., 2020 says that the push button, LED, MPU 6050, Arduino Nano, are comprised of the entire system and the connections are done. The Arduino Nano combines the functions of an indicator, sensor, and interrupter. It assists in gathering and processing data detected by the MPU 6050 and facilitates the LED's illumination upon the touch of a button to initiate an interrupt. The three-axis gyroscope and three-axis accelerometer that make up the MPU6050 sensor allow it to measure the spinal cord's orientation in all three dimensions. The sensor will initialise a starting value for comparison after the user presses a push button to interrupt. The Arduino will alert the user if it detects a deviation from the calibrated value.

9. **A Smart Chair Sitting Posture Recognition System Using Flex Sensor and FPGA Implemented Artificial Neural Network**

Qisong Hu et al., 2020 proposed an FPGA that implements an artificial neural network, an ADC board, and a range of six flex sensors make up the smart chair system. The system's output is the sitting posture's categorization result. They chose seven sitting positions that are associated to health. The sitting positions are as follows: (a) straight sitting; (b) reclining to the left or right; (c) lounging; (d) bending backward; (e) crossing one's legs; and (g) crossing one's legs. The following rationales inform the selection of the seven distinct postures. The positions (a) and (d) are quite typical. Postures (b) and (c) have the potential to induce contractures and worsen muscular imbalances, whereas posture (e) might lead to an increase in muscle tension and subsequent discomfort. Pelvic obliquity, coronal imbalance, sagittal imbalance, and postures (f) and (g) might all be caused by.

10. **Smart Indication System for Spinal Cord Stress Detection**

Jose Anand et al., 2019 suggested a system that tracks the position of the human spine continually. Together with the person's assistance, the device corrects posture and prevents bending of the spine. Through the prevention of additional deformity development, the device aids individuals with scoliosis. The user receives notification via audio message or buzzer if they bend too far. When there are anomalies, the guardian or doctor receives information via SMS, and the GPS attached to the suggested gadget is also used to communicate the person's whereabouts.

METHODOLOGY

- Design: The first step in developing is to design a techno chair to detect the posture of the sitting. This includes defining the overall system architecture, hardware components and algorithms that will be used to process the data. This design should also include safety and reliability considerations.
- Sensor selection: The next step is to select the sensors that will be used for the construction of techno chair. This includes considering factors such as accuracy, precision, sensitivity, cost and compatibility with the system design.
- Signal processing: Once the sensors have been selected, the signals from the sensors must be processed and analysed to obtain meaningful information about the pressure of the sitting position. This process typically involves signal conditioning, filtering and feature extraction algorithms.
- Here in this chapter the system implementation requirements of the project. The sensors are used in the project for analysing the pressure of sitting position.

Force Sensing Resistor:

For the purpose of this project, force sensing resistors are utilised to gather pressure data as we sit. When we sit in different postures, we will experience varying pressure levels. These data will be gathered by the force detecting resistor and sent to the Arduino Uno, which is the micro controller. The techno chair will function normally if the pressure is within normal range. The vibration motor receives a signal from the sensor that indicates a rise or reduction in pressure, which then activates the foam roller to provide the individual a massage. After that, the individual can sit in their typical posture.

Structure and Mechanism:

The FSR402 is made of a flexible, thin polymer film that has conductive particles inserted in it. These particles move closer together when force is applied to the sensor's surface, which lowers the resistance across the sensor. Precise force measurement is possible because of this resistance change that is proportionate to the force exerted.

Qualities:

- **Sensitivity:** The FSR402 has a high degree of sensitivity and can pick up on even minute variations in force.
- **Range:** From mild touches to strong pressures, it is capable of measuring a broad variety of forces.
- **Durability:** Suitable for long-term uses, it is made to survive frequent usage and a variety of climatic conditions.
- **Compact form:** Its lightweight and compact form makes it simple to integrate into a wide range of applications and systems.
- **Simple Interface:** Makes integration into electrical systems easier by requiring less external circuitry for functioning.
- **Cost-Effective:** In comparison to other sensing technologies, it offers precise force sensing at a comparatively low cost.
- **Versatility:** Fit for a variety of uses, such as consumer electronics, automobile controls, robotics, and medical devices.

Foam Roller:

Foam rolling helps in the release of lactic acid produced by our body after exercise and myofascial tightness. Helps in our speedy recovery. Enhances muscle health and overall flexibility while reducing fascial rigidity. With a foam roller, we may massage ourself to different degrees of intensity. It works really well to increase range of motion, flexibility, and joint mobility. It not only eases muscular soreness but also relaxes and repairs fascia. One type of myofascial release that you may perform on our own body is foam rolling. It relieves or massages the tension in the muscles and fascia. By applying pressure, the roller helps release any "knots" that may have formed in our tissue and muscles. Release Tension in the Muscles. This approach relaxes and repairs the fascia while also reducing muscular soreness. The Foam Roller is Excellent for Physical therapy. The foam roller has three distinct zones for massaging: the thumb, finger, and palm zones. This ergonomic design imitates the hands of a therapist.

INTERFACING FORCE SENSING RESISTOR, VIBRATION MOTOR WITH ARDUINO UNO

- Connect the Arduino UNO to the power supply
- The force sensing resistor is connected to the Arduino UNO
- Program the Arduino board to receive the input from force sensing resistor
- Measure the posture pressure of the individual who is sitting
- Then vibration motor is connected to the Arduino UNO
- Program the board to receive signal to the motor from force sensing resistor
- Test the connections by sending a signal from the sensors
- Program the board to activate the foam roller
- At last, connect this hardware setup to the chair in which the person sits
- Test the connections and troubleshoot it any issue that may arise during the process
- Once the components are interfaced properly, test the complete system by measuring the pressure of the sitting position

BLOCK DIAGRAM

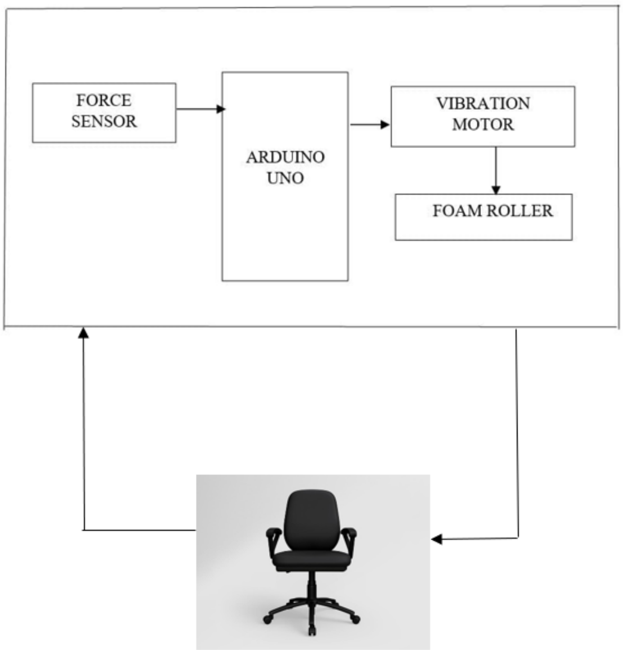

Fig.3 Block Diagram

RESULT

This project endeavors to create an innovative solution for detecting sitting posture by leveraging force sensors embedded within seating surfaces. Through the analysis of pressure distribution data, the system aims to accurately assess spinal alignment and weight distribution in real time, offering immediate feedback to users. By promoting healthier sitting habits and mitigating musculoskeletal disorders associated with poor posture, this technology has the potential to enhance overall well-being in diverse settings, from office chairs to vehicle seats, contributing to a healthier and more productive society. In addition to its core functionality, the system will be designed with scalability and accessibility in mind, ensuring that it can be easily integrated into existing seating infrastructure without significant modifications. The use of cost-effective components and efficient algorithms will enable widespread adoption across various demographics, including office workers, drivers, and individuals with mobility impairments. Furthermore, the project will prioritize user experience, incorporating intuitive interfaces and customizable settings to accommodate diverse user preferences and needs. Through rigorous testing and refinement, the system aims to achieve optimal performance and reliability, ultimately empowering users to make informed choices about their posture and well-being in everyday settings.

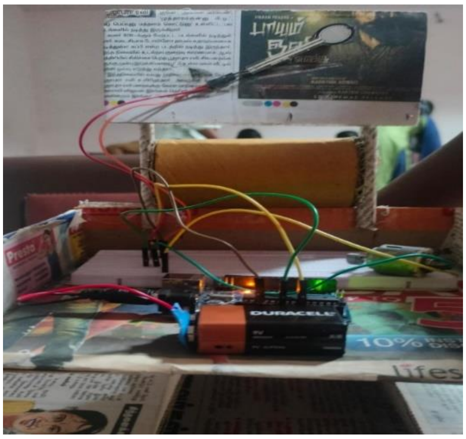

Fig.4 Hardware prototype

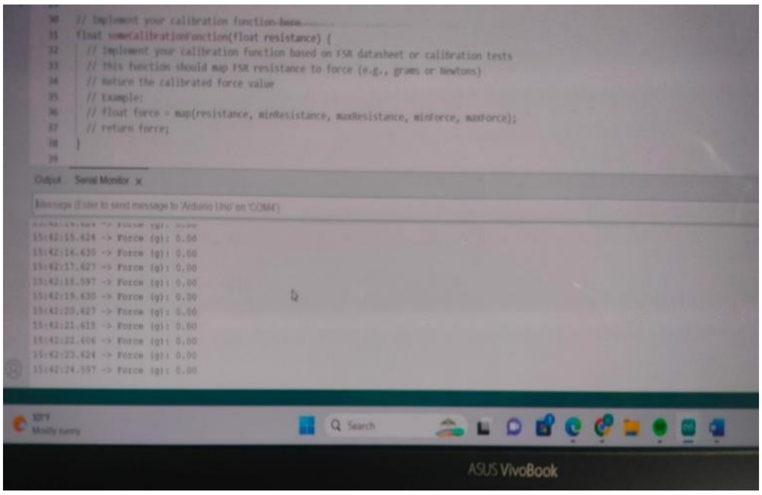

Fig.5 Force values

CONCLUSION

Biomedical Engineering is a field of study of bioengineering and technological concepts, which aims to develop equipment and devices for the provision of health care, where the physical, chemical, computer, mathematics and engineering principles are integrated into the study of biology, medicine, behaviour, health, and transplantation of organs, which aims to prevent, diagnose and treat diseases, in order to rehabilitate the patient and improve his health, and the specialty of medical engineering is at the forefront of the medical revolution, and is achieved through multi-disciplinary activities incorporating the other sciences with engineering principles. Biomedical engineers have developed many techniques that help to facilitate all aspects of life, and contribute to the saving and preservation of life.

The project report on the use of a force sensor to detect sitting posture concludes by highlighting the effective application of a useful and creative posture monitoring solution. We sought to address the rising concern of sedentary lifestyles and associated health hazards by incorporating a force sensor into a sitting device. We meticulously created, tested, and prototyped a system that could recognise different sitting positions in real time during the project. Our solution makes use of the force sensor's sensitivity and precision to provide a non-intrusive and effective way to analyse posture. It also delivers insightful information about user behaviour and encourages the adoption of healthy sitting habits. Important conclusions from our investigation and testing highlight how reliable and efficient the suggested posture detection method is. We proved the system's high degree of accuracy and consistency in differentiating between various sitting postures via thorough data analysis and validation. Additionally, our project report addresses the advantages and possible uses of the posture detection system in a number of fields, such as fitness tracking, healthcare, and workplace ergonomics. Our approach has the potential to minimise musculoskeletal problems, improve general well-being, and promote productivity in a variety of situations by raising awareness and promoting proactive posture control.

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