IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 6, June 2021

DOI: 10.17148/IARJSET.2021.86155

ENTIRE BODY POSTURAL ANALYSIS ASSESSMENT DEVICE FOR COMPUTER OPERATORS

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Abstract: Smart chair for body posture monitoring is proposed for assessing the body posture of a person sitting on a chair. Monitoring of body posture is done in two phases with each phase being implemented as a separate node. While sensors are incorporated for identifying the body posture, voice messages and text messages are generated to alert when wrong body postures are sensed. The chair can be programmed to perform a specific task at a given point of time even without the physical intervention of a user. The Smart chair for body posture monitoring not only recognizes the poor body posture, but also alerts the person about wrong sitting posture. Thus, the proposed system is very effective in ensuring human health, besides the hardware implemented being less expensive.

Keywords: Body posture, posture detection, posture correction, Assessment device.

I. INTRODUCTION

Nowadays it has become an important factor to incorporate technology in our home and office spaces. The day-to-day activities are becoming more and easier making the place smart. Home automation development tools have become mandatory in homes as people are moving towards to the smart home concepts.

When the body is slouched and constricted, it prevents it from working optimally which results in a poor mood. When the body remains in a seated position for an extended period of time, all of your internal processes slow down. As a result, your energy levels decrease. You may start feeling irritable, tired or aggravated. Slouching also causes your body to compress and constrict. When in this position, your heart and lungs are forced to work harder to pump blood and circulate oxygen. This causes undue stress on your internal organs and your muscles. Sitting in an upright position with your shoulders and chest broad makes it easier to breathe. Sitting does more than just constrict your heart and lungs, it also constricts your intestines. This can make digestion uncomfortable and cause a lot of issues. If you are experiencing digestive distress, you may want to take a closer look at your posture and how much time you are spending sitting each day. Slouching has even been attributed to digestive issues such as acid reflux and hernias. Poor posture may do more than just weaken your digestive system; it may also cause you to develop that unsightly belly pouch that women dread. This paunch affects both heavy and thin women and can be attributed to slouching and poor sitting habits. Back, shoulder and neck pain are the most common effects of poor posture, and the most noticeable. Sitting in a slouched position at your desk for an extended period of time puts a great deal of stress on your upper body, especially if your body is not properly supported. The most common pain areas include:

- Lower back – 63%
- Neck – 53%
- Shoulder – 38%
- Wrist – 33%

In time, poor posture can also cause a misalignment in the spine and lead to even more pain. In addition, it also causes joint stress. Joints are protected by connective tissues that create a supportive cushion.

When you have good posture, the communication your brain sends via your spine comes fast and uninterrupted. Your brain stays in constant command of your body, using information gathered from each of the five senses, including sight. Over time, slumped or hunched posture affects the connection quality between the spinal cord and the brain. This creates a lag between your eyes seeing an object, your brain interpreting the image of the object, and your body responding to the object. In fact, poor posture can result in many health issues, including slowed circulation, shallow breathing, and blurred vision. But the relationship also goes the other way. If you have poor eyesight, you may squint, lean forward, or tilt your head into an unnatural position to see more clearly. These movements create muscle tightness in the shoulders, neck, and head. Over time, this maladjustment can decrease blood flow to and impulse connection with your eyes.

II. METHODOLOGY

Many embedded systems have substantially different designs according to their functions and utilities. The microcontroller located at the centre of the block diagram forms the control unit of the entire project. Embedded within the microcontroller is a program that helps the microcontroller to take action based on the inputs provided by the output of the sensors. This project consists of Microcontroller, Accelerometer, Pulse sensor, UV and IR sensors and LCD.

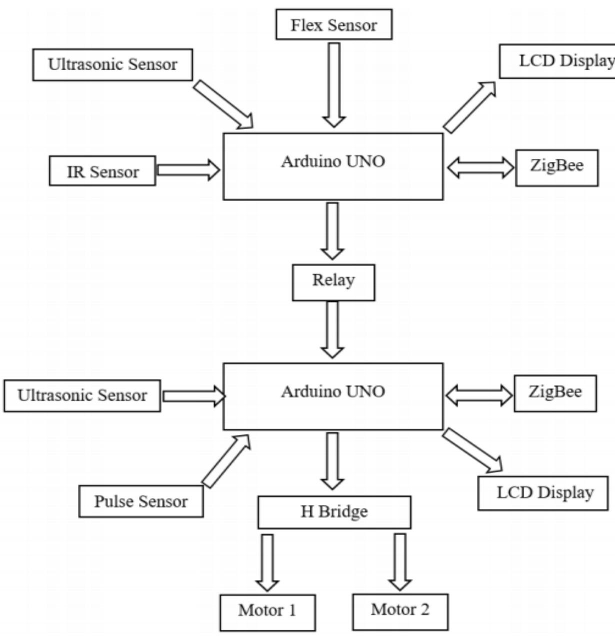

Fig 1: Block diagram

The project is divided into two nodes. These two nodes will be communicating with each other through ZigBee. Centralized Unit will be collecting information about all nodes.

Node 1: At the core of node 1 is Arduino Microcontroller. An LCD is provided to display required messages. Sensors are used to monitor the movements of certain parts of body. A voltage regulator ensures constant voltage for node 1. Zigbee standard is used for serial communication between node 1 and node 2. Upon power up to node 1, the infrared sensor of node 1 senses the presence of a person on the chair, the relay gets energized. The relay, being connected to node 2, powers up the node 2 eliminating the need for an additional source on node 2.

Node 2: Arduino micro controller is used in node 2. Sensors are used to determine the distance of the person from the computer screen. Two DC motors used in node 2, for up and down movement of chair respectively. H-bridge is the driver circuit used for the motor. Zigbee standard is used for serial communication between node 1 and node 2. A voltage regulator provides a regulated power supply to node 2.

An Infrared Sensor (IR sensor) is used to determine if an operator is present on the chair or not. The whole setup turns on only if a person is seated on the chair in order to minimise wastage of energy occurred while turning ON the device at all times.

UV Sensors, Flex sensors and accelerometers are placed on the chair according to the position of detection of posture. A series of ultrasonic sensors are places on the back rest of the chair to monitor the positioning of the person's spine. The flex sensor however, serves a purpose of checking if the positioning of the person's leg is as per the prescribed positioning. It is placed near the end of the knees, where the bend value gives an insight on whether the positioning of the knees and legs are appropriate.

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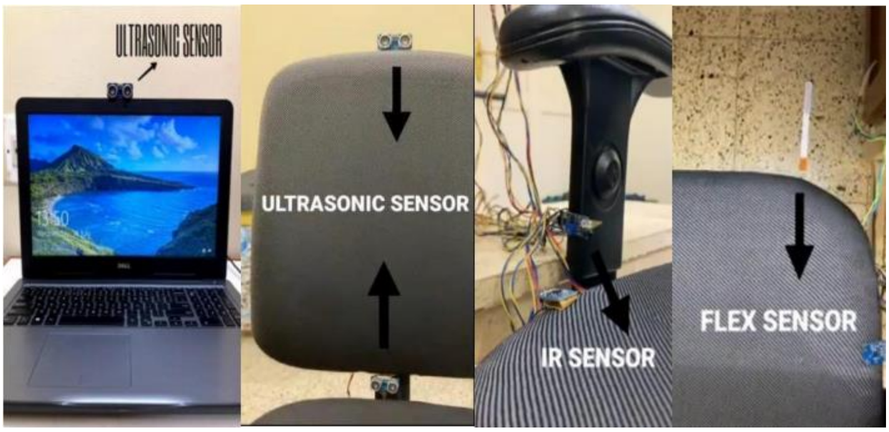

Fig 2: Placement of the sensors

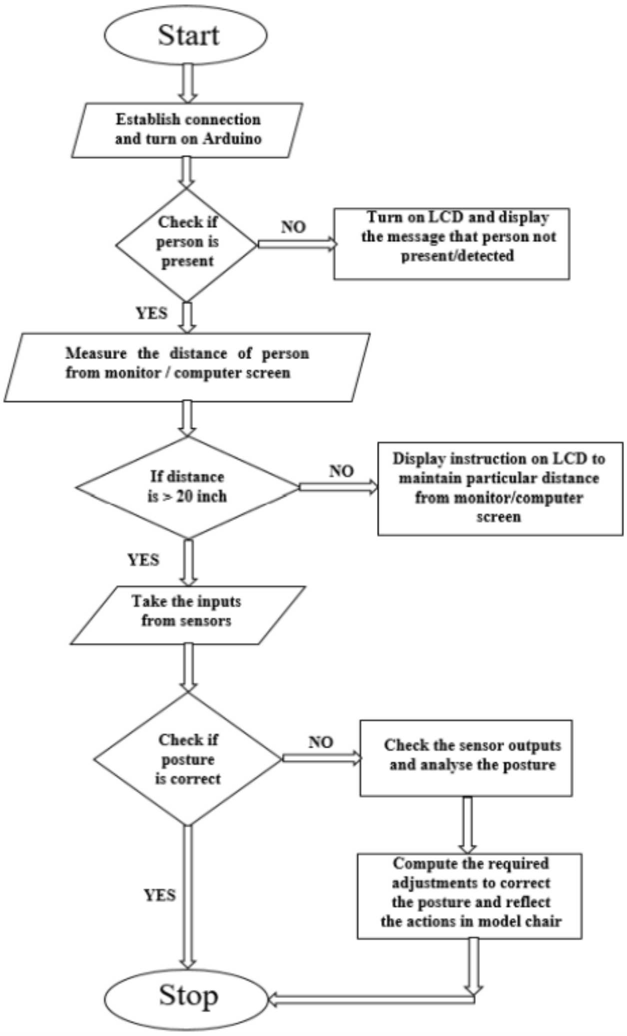

Fig 3: Flowchart describing the working of the design

The height of the chair is adjusted in accordance with the line of sight from the screen through the means of two motor, connected via motor driver. Another Ultrasonic sensor continuously monitors the distance of the user's face/eyes from the screen so as to maintain optimum distance from the screen (The recommended distance being 20 inches).

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The output of these sensors are given to the ADC unit of the microcontroller. Based on the program embedded within the microcontroller the voltages generated by the accelerometer are displayed on the LCD. If the person wearing these devices is sitting for a long time, also then a voice output will be generated until the person changes from sitting position to standing position or doing some physical activity. Voice output indicating change in position is activated on a periodically basis from time-to-time.
Every sitting posture is corrected using this equipment. Say the person wearing this device is bending more rather than sitting upright, then also the LCD output will be generated insisting him to sit upright.

III. RESULTS AND DISCUSSION

The model is able to continuously monitor changes in the posture of the person from the output of the sensors placed in the chair and measures the minimum distance of the person from the computer screen. The designed model calculates the distance of the person from the computer screen and provides the measured stretch in the form of output which will be displayed on LCD screen. The model can detect the presence of person on the model and provide the computed results of distance from the monitor.

3.1 Detecting presence of person

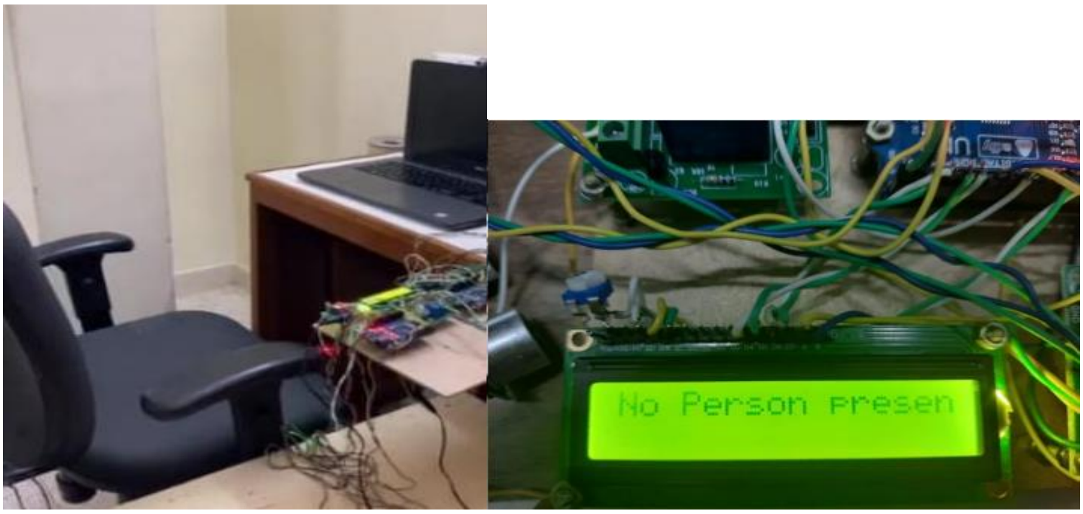

Fig 4: Condition when no user present

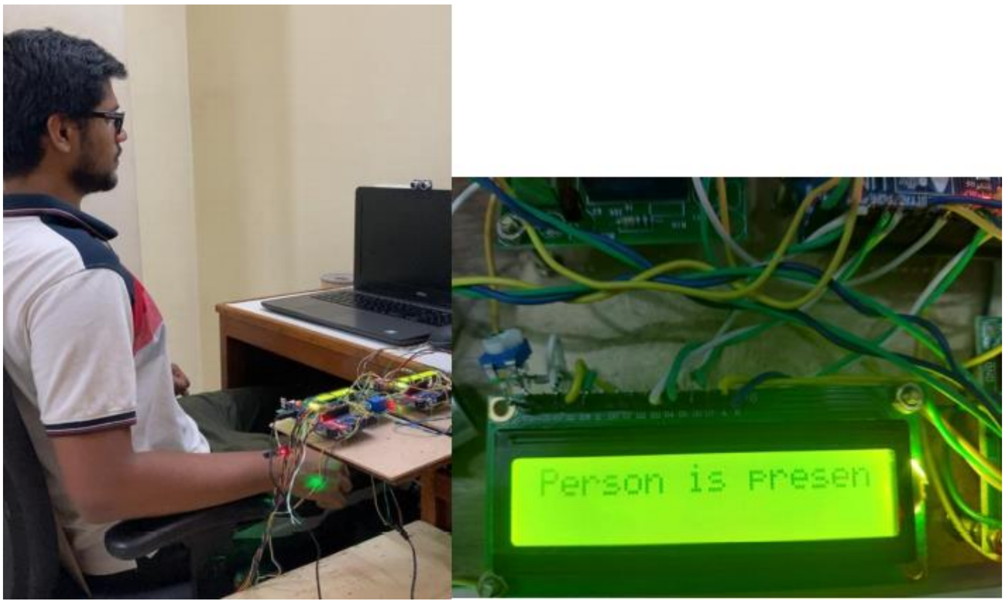

Fig 5: When user is present

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3.2 Determining distance from the Computer Screen

Through the means of an Ultrasonic sensor present in the screen, we can determine what distance the person is seated from the screen at all times. The medically recommended minimum distance to be maintained is 20 inches (51 cm). A message is displayed if the user is too close to the screen.

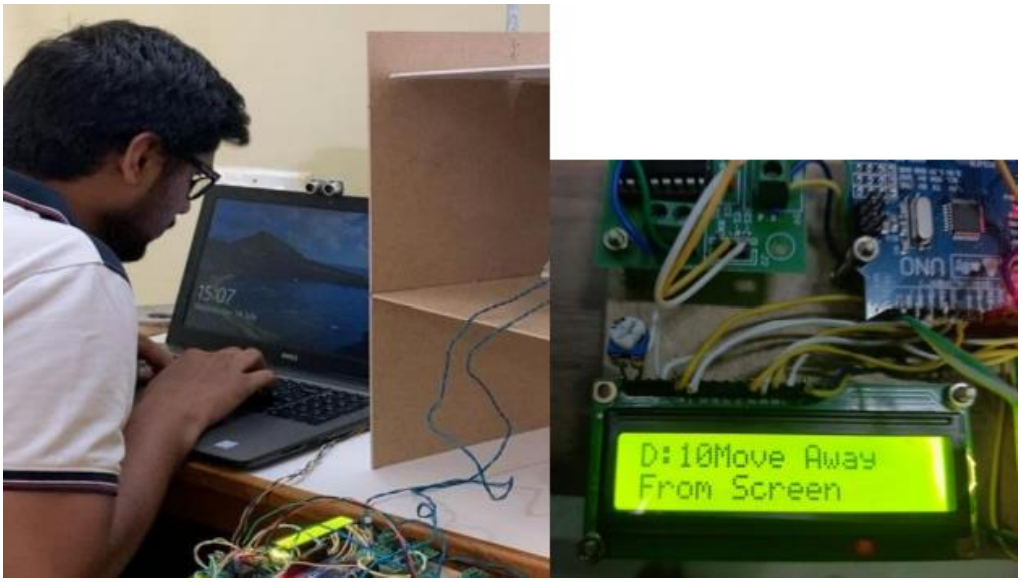

Fig 6: Condition when optimum distance is not maintained

3.3 Posture Analysis and correction

The system after detecting the presence of a person, identifies their posture by making use of various ergonomic tools and provides the determined results. Once the model has detected the bad posture of the individual the designed model initiates the command of correction.

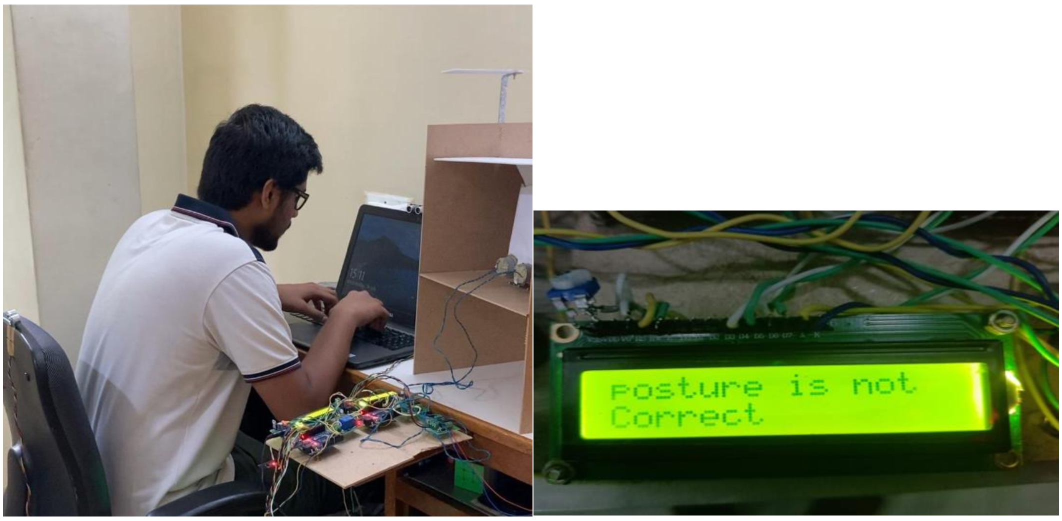

Fig 7: Incorrect Posture

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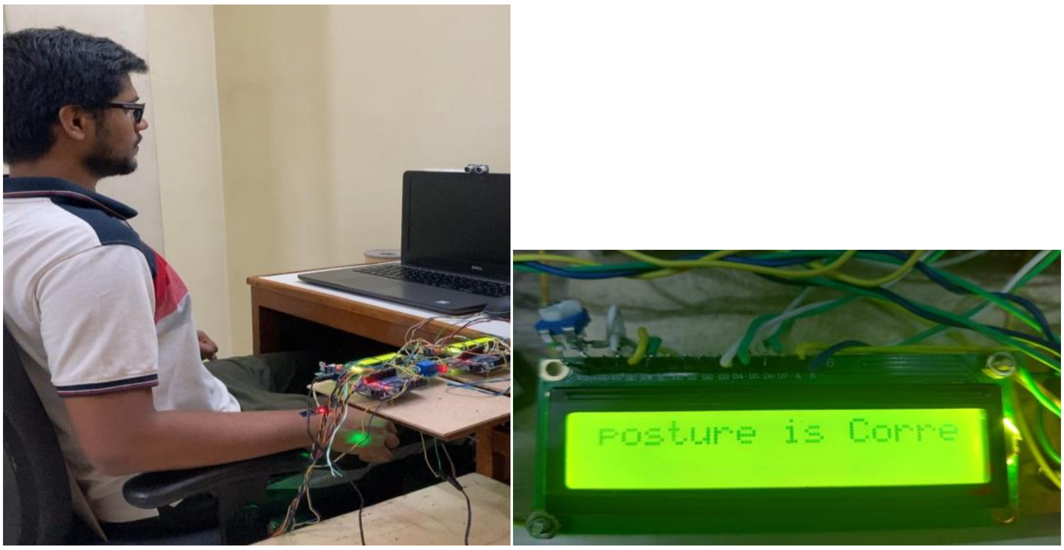

Fig 8: Posture Corrected

The command of correction is followed by the actions that are respected towards the change/correct the posture of the person. These actions include the movement of various parts of the model i.e., the backrest, the seat and the identification of head position. The amalgamation of the specified actions results in alignment of spine and hindquarters of individual and hence correcting the body posture of person.

Fig 9: Medically recommended correct posture

The project demonstration was developed and a prototype module was implemented. 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 more 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 and overall cost.

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IV. CONCLUSION

Body posture analysis is one of the most popular and widely used observational ergonomic assessment tools in various industries and services. Several studies were reviewed in order to provide an overview of this method's development, applications, validation and limitations so far. Future work is needed to support the predictive and concurrent validity and reliability of the method. The limitations discussed in this review did not hold the method's implementation back, on the contrary, it is currently used and remains a rapid to use tool with computerized checklist and tables available in public domain. Research is encouraged with larger sample size and more complex environments in order to assess work-related musculoskeletal disorders risk factors using this system.

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