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Discussion on bad sitting posture recognition

Manikandan S.
manikandanbmeengineer1@gmail.com
Rajiv Gandhi College of Engineering and Technology, Puducherry

Mohamed Ashfaq A.
ashfaqanwer15@gmail.com
Rajiv Gandhi College of Engineering and Technology, Puducherry

Dharanibalan B.
novashang001@gmail.com
Rajiv Gandhi College of Engineering and Technology, Puducherry

Gowrishankar K.
gowri200@yahoo.com
Rajiv Gandhi College of Engineering and Technology, Puducherry

ABSTRACT

Currently, an increase in the rate of spinal cord problems among young people and adults is due to the improper sitting posture like slouching and hunching. This bad posture is due to the usage of computers, smartphones and other portable devices for long hours. In the recent years, there has been huge development in sitting posture monitoring systems to prevent the spinal and neck pain, Which are not only monitors the posture in real-time and also provide the feedback to improve their posture. The main aim of this survey paper has to provide a review of the recent advancement in the posture monitoring system. A detailed study has been carriedout about the various sensing technology used to measure the sitting and reading posture in real time and the feedback based on the measured data. This paper explores the various monitoring system classification based on the portability and ease of use of the system.

Keywords— *Portable monitoring system, Sitting posture, Sensors*

1. INTRODUCTION

Nowadays most of the adult and young people living a sedentary life. A sedentary life has been more dangerous due to the high risk of health problems like obesity, heart diseases, diabetes, and anxiety. Sitting for a long period of time can cause varicose veins, this will be lead to the clotting of blood in the leg, which in turn leads to many problems. Indian medical statistics say that India may become the capital of osteoarthritis in the world of having 60 million cases, in this 40% are youth by 2050. It has been increasing all over the world due to the bad sitting posture, which causes neck and spinal pain. Most of the people affected by spinal and neck pain are younger population due to failing to maintain good sitting posture. The common problem said by the young people are stiff neck, this is mostly associated with age groups of 40, but it will affect even the young people due to the usage of computers, smartphones and other portable devices. The shoulder pain and tightness of the shoulders are due to the usage of smartphones in an improper position. In the normal posture, head weighs about 5 kg, after 15 degrees of tilt over the forward the weight will be about 12kg. The level of stress increases with increase in the tilt angle of head. The number of mobile phone users in the world has been around 5 billion. It just growing up to 67 % in china of having 1.5 billion mobile devices and the next one has been India having 1.1 billion mobile devises.

The major problem faced by the people in the 21st century is the text neck syndrome [1]. The text neck has been due to the frequent forward head flexion while using smartphones for a long time. It will cause cervical spinal degeneration and cause spinal, neck pain and headache. The technology which has been used to monitor the sitting posture will be differentiated based on the portability of the system, used to measure the posture. The technology which has been commonly used to measure the posture is pressure sensor.

This will be mostly placed on the chair. The IMU sensor is also used to measure the posture, it has been highly used in the portable sitting posture monitoring systems. Due to cost effective and smaller in size and with reliable accuracy. The systems are not only used for monitoring purpose, it will also use to remind the user to correct their posture in real time. The data which has been collected during the process is useful for further analysis and for providing the proper feedback. In this paper, an overview of various researchers about the sitting posture monitoring system based on the portability and ease of use was presented. The paper contains four sections, in section II we described the various posture monitoring system based on the portability and sensor technology. In section III, we discussed the various advantages and disadvantages of the system. In section IV, we conclude with the future advancement and overview of development of posture monitoring systems.

2. MONITORING SYSTEMS

In this section, the various posture monitoring system for people who are extensively using their computers, Smartphones and other portable devices has been discussed. The monitoring systems are classified according to the portability of the system.

2.1 Stationary Monitoring Systems

The posture monitoring based on the chair is made up of various sensors such as pressure sensors, force sensors, accelerometer sensors. This chair based system varies with the sensing technologies and the sensor arrangements.

2.2 Pressure Sensor Based Monitoring Systems

Research by li jian-rong [2], proposed a monitoring system used with the sensor array consists of 64 conductive rubber structure as shown in Fig 1, which sense the change in pressure. The microcontroller is used to acquire the sensor data in the digital format and those sensor data are sent to the processing module with the help of wireless transmission module. After the processing of the data the output has been visualized as a color image based on the sitting posture.

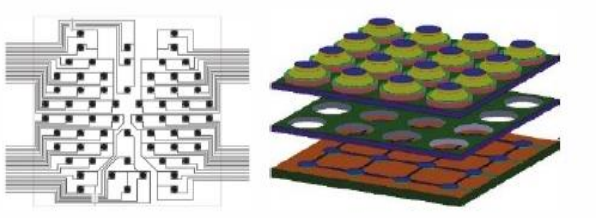

Fig. 1: Structure of sensor arrays

The sensor based monitoring system developed by Jawad Ahmad [3], consists of sensor pattern fabricated by the screen printing a piezo resistive ink. The main goal of this work has to design a printed and thin flexible sensor, which efficiently senses the pressure information from the contact of the body. The data from the seats had been processed and identification of sitting posture has been done. Finally the pressure data has been presented as a pressure map.

The system proposed by SuhanMuppavram [4], it uses the IOT (Internet of Things) to create an intelligent decision making system used to identify the various types of sitting posture. By using the pressure data obtained from the chair in a various sitting posture. It also consists of a real-time feedback system to provide alert notification to the user by means of the smartphone application. The system also generates a total summary of the sitting posture and activities over a long period of time. The proposed system as an accuracy of about 95%, which in turn provides a reduction in the wrong posture.

2.3 Design and Implementation

In [2], the system has been powered by 3.3V DC power supply, it will sense the change in voltage due to the change in pressure over the sensor array. The sensed data has been sending to the computer using Bluetooth module for processing. After the processing on the computer, the pressure distribution can be seen using MATLAB software as shown in figure 2.

In [3], the system provides the values of resistance decreases with an increase in pressure. Thus the proposed system provides the cost efficient flexible sensor array to measure the change in the electrical characteristics based on the pressure distribution over the sensor array as shown in figure 3. This system has been very much useful to the spinal cord injured patients who are all not able to shift their weight on their own and prevent them from a pressure ulcer.

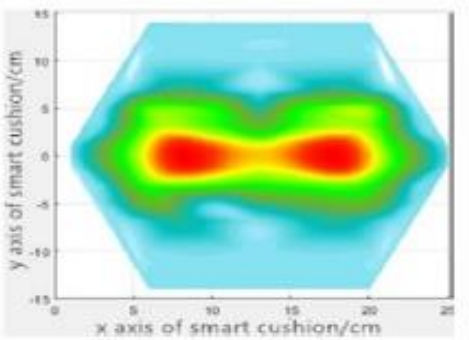

Fig. 2: Pressure distribution image

In [4], the main segments of the monitoring system are data acquisition, data storage, data processing, feedback, and reporting. The data acquisition segment consists of two parts one is sensor and another one is the microcontroller module, used to acquire the analog data from the sensor and converted into digital data for the transmission through the Wifi module. The data acquired are feed to the amazon web service (AWS) cloud server, which consists of the machine learning algorithm. The nearest neighbour machine learning algorithm which has been used to classify the sitting posture. The data which is return by the machine learning algorithm has been retrieved by the smartphone application, by this the user can have detail information about their time period of good and bad posture. The posture monitoring system uses the high range Flexifore A502 to measure the high and medium pressure areas and FSR 406 has been used to measure the lower pressure areas. It totally consists of eight sensors, two high range, and six medium range.

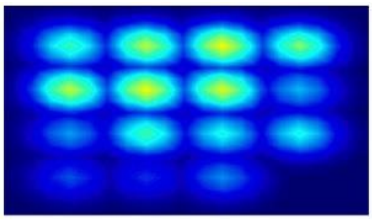

Fig. 3: Plot of pressure sensors

The system [4], uses the ATmega32A as the main microcontroller and it's connected to the ESP8266 Wifi module to transfer the data to the server. The software service used by the system is Elastic Cloud Compute (EC2) based on the Linux OS Ubuntu. In the smartphone application, if the user wants to access the server, they need to create the account, using their details like surname, name and email address. Whenever the user remains seated more than 15 minutes, a notification has been sent to the user through the smartphone application. If the user remains in good posture for long time, the system will remind them to take a break, Based on the time which as set by the user. The posture recognition is done by machine learning algorithm, the algorithm which has been used for this process is KNN (K nearest neighbour) because of its simplicity and accuracy. In this they have used 80% of the data was to train the algorithm and 20% of the data has been used for testing. It's having an accuracy of 95.42%.

2.4 Accelerometer Sensor Based Monitoring Systems

Yasuhiro Otoda [5] implemented a posture monitoring system using the accelerometer sensor to recognize the 18 types of sitting posture as shown in Table I. Each sitting posture has

been characterized by three main features. The first features are described by, how deeply the person sitting in the chair. The second feature is described by, whether the person's upper body is leaning left, center, and right side. The third feature is described by the person is leaning forward, backward or sitting upright. It has the capability to sense whether the person is sitting in the chair or not, by this it can able to measure the workers sitting time.

2.5 Design and Implementation

In [5], the posture monitoring system consists of eight accelerometers as shown in Fig 4. The six sensors are on the back side of the seat and the other two sensors are placed on the backrest of the chair. The placement of the sensor has been based on the location which allows us to measure the features according to Table 1. This system uses invensense's accelerometer sensor and Okamura Corporation's "contessa" as the chair. The machine learning algorithm used for posture recognition is random forest classifier. For training the algorithm they used datasets of about 1900 records, it consists of 20 participants, 19 postures and 5 repetitions each. By this the average accuracy obtained is 80.1% and the classification accuracy of the seat movement is 99.5%.

Fig. 4: Sensor Positions

2.6 Limitations

Even though these systems are cost effective and easy to use. The pressure sensor may impair the performance of the chair because it placed on the chair. If the system had been subjected to some minor imperfection of the sensor and the total result will be inaccurate and produce errors in the result. The major limitations of this type of pressure sensor based posture monitoring system, are specific to the environment like office and cannot be used anywhere else.

Table 1: Classification of sitting posture

Number	Sitting Position	Leaning of Upper Body	Leaning Left/Right
1	Deep	Upright	Left
2	Deep	Upright	Center
3	Deep	Upright	Right
4	Deep	Forward	Left
5	Deep	Forward	Center
6	Deep	Forward	Right
7	Deep	Backward	Left
8	Deep	Backward	Center
9	Deep	Backward	Right
10	Shallow	Upright	Left
11	Shallow	Upright	Center
12	Shallow	Upright	Right
13	Shallow	Forward	Left
14	Shallow	Forward	Center
15	Shallow	Forward	Right
16	Shallow	Backward	Left
17	Shallow	Backward	Center
18	Shallow	Backward	Right
19	Sitting/Leaving seat		

2.7 Wearable Monitoring System

The posture monitoring systems based on the wearable having more advantages than the chair based monitoring systems. Even though the chair based measuring systems have high accuracy but it is not that easy to use and costly when compared to the wearable systems. The main advantage of the wearable posture monitoring systems is, it can be accessible from anywhere and also for 24X7 real-time monitoring.

A posture monitoring system [6], composed of MEMS inertial sensors of extremely small in size and it has been accurate enough to sense the sitting posture of the body. It paired with a smartphone using the Bluetooth module for the transfer of data to the smartphone. The smartphone will perform data collection, data processing, visualization, and data analysis. The accelerometer and gyroscope data are continuously measured to get the angle of the sitting posture. If the measured value has been differed from the threshold value, then the vibration module provides the vibration to the user.

The monitoring system uses the smartphone's internal sensors and front camera to measure the angle of the neck and distance between the smartphone and face during supine position as in [7]. In the normal positon, the weight of the adults head is about 5kg, when bending at an angle of 15, 30, 45, 60 degrees it will increase the weight of the head by 12, 18, 22, 60 kg, it will drastically increase the load on the spine which in turn cause serious problems like headache, neck and spinal pain and even lead to surgery. For monitoring the neck angle and the distance between the smartphone and the face, the system uses the sensors, which are already built in the smartphone such as accelerometer, gyroscope and front camera. It provides the notification by means of the smartphone application whenever the user has been in improper position.

3. DESIGN AND IMPLEMENTATION

In [6], the location of placing the sensor has been divided into two, upper and lower parts of the spine, the placement of the sensor as shown in Fig 5. The IMU sensor module having 6-DoF (Degree of Freedom). It has been a combination of both accelerometer and gyroscope. The data from the IMU sensors has been transferred to the smartphone in real time using the Bluetooth module. The first phase of the monitoring system is to train the modules based on the initial angles of the sensors. After the training phase, the microcontroller will transfer the real time data of the IMU sensors module to the smartphone through Bluetooth device. The function of the smartphone is to collection of the data, processing of the data, analysis of data and visualization based on time. It uses the ECF (Explicit Complementary Filter) algorithm to constantly calibrate the sensor when angles of the sensor had been misplaced. The data from the smartphone will be synced with cloud server for personalized analysis.

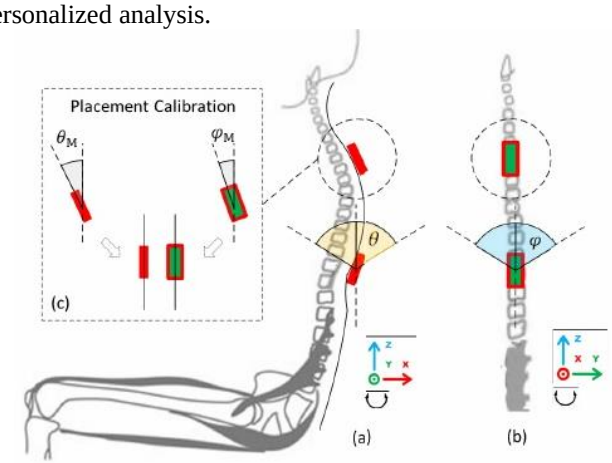

Fig. 5: Sensors located at upper and lower back

The posture monitoring system by Faisal arda [7], has the tendency to measure the neck angle and distance between the

user and the smartphone in the supine position as shown in Fig 6. In the supine position the user tends to lean forward towards the smartphone to see it. But in the sitting and standing position the user has the tendency to tilt their head towards the smartphone. The screen orientation and tilt angle of the smartphone have been measured by using smartphones built in sensors, such as accelerometer and gyroscope. For finding each angle of the accelerometer sensor in the smartphones, such as angle X, angle Y, angle Z by using the equations.

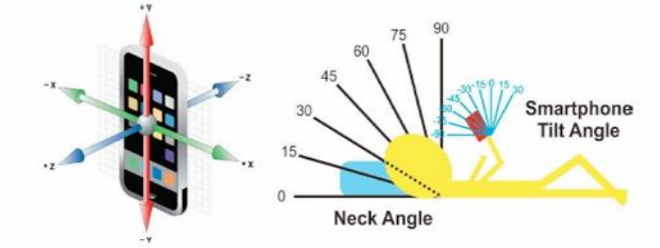

Fig. 6: Orientation of smartphone axes, neck and tilt angle

The important value of the sensor to measure the neck angle is the angle of the Z-axis, which has a value of about -10 m/s^2 to -2 m/s^2 during the angle of neck 0 to 45 degrees in supine position. To measure the distance between the user and smartphone has been done by using Google vision API. The safest distance to see the smartphone has been calculated by multiplying the smartphone screen diagonal length by 2. The monitoring system will alert the user when he tends to tilt his head to close to the smartphone by providing notification through the smartphone to inform them they are in improper neck position.

3.1 Limitations

The system developed by [6], doesn't have any alerting system to improve the posture of the user in real-time. And it only measures based on the spinal cord orientation. Another monitoring system by [7], has the capability to measure the neck angle, but it only focused on the supine position. It cannot be used in real life for all the scenarios.

4. DISCUSSION

The main aim of all these researches has to provide a sitting posture monitoring system with high accuracy, ease of use and portability to improve the lives of the user. The major sensors which have been used for posture monitoring are the pressure sensors [2]. Even though these sensors have high accuracy, but in the case of portability it cannot satisfy. When in the case of IMU sensors, it has cost effective, nowadays it has a high range of accuracy to measure the orientation. This sensor can be mounted in the chair to measure the posture of workers in office and other workplaces, which need to measure the worker's activity [5].

It can be used as a wearable monitoring system that has been embedded in the clothes, which provide a real-time measurement of the posture of the user [6]. This type of system will remind the user about their posture in real time by using the feedback module such as vibration, beep sound, notification to smartphone. All this system of sensors needs an additional controlling module for the processing, analysing of the data and the feedback. Most of the systems are integrated into the smartphone to provide instant feedback to the user about their posture. In some systems the data from the smartphone has been processed by the cloud server [4], which contains the algorithm for recognition of the posture. Although it will provide accurate results, the network connectivity is important for the process and data privacy has been a concern.

To provide a proper sitting posture monitoring system, it should be ease to use and portable and provide proper feedback to the user based on the need. The main thing taken into concern has been the data privacy to secure the user data in the database for future reference or own analysis.

5. CONCLUSION

We report the survey on the posture monitoring systems, which can measure the posture of the user in real time and provide feedback to improve the posture. There are various things that need improvement in the sitting posture monitoring system, the major ones are accuracy, portability, and ease of use. In the future, we are going to develop a sitting posture monitoring system, which has been highly portable and easy to use. It will provide real time analysis of the posture and prevent the user from problem which can be due to long hours of sitting.

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