Posture Detection and Correction System using IOT: A Survey

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Abstract - *The growing technology in the world is rapidly transforming the way people lead their lives. Industrialization and urbanization have brought an enormous increase in sedentary lifestyle to the modern world. Indulged in technology, people are often found abandoning their good posture and being hunched over for really long hours. Good posture is of utmost importance for leading a healthy lifestyle and it is said that back pain is the third most common reason for people to visit the doctor. Yet, knowingly or unknowingly, people compromise on one of the most essential traits of what makes them human; the ability to walk upright. The aim of this paper is to identify efficient techniques used in posture detection and correction.*

Key Words: **IOT, Posture Detection, Posture Correction, Arduino, IMU MPU, Android, Circuit.**

1. INTRODUCTION

Our posture changes every second throughout our lives and it is also known that some postures if practiced for a long period of time may cause severe spine diseases and adversely affect our health. Now a days, in fast growing industrial age, every company needs speed in manufacturing to cope up with the customer enhancement and flourishment of the company they work for a long period of time in incorrect posture without noticing. Incorrect posture for a long period of time is responsible for major back related problems. The estimated number of working days lost in 2013/14 due to back disorders was 2.8 million (UK). These sort of problem keep on increasing day by day as the people are quite busy in their schedule. People often ignore their body posture while doing their daily activities, but our posture should actually stand at the top of our health concerns but mostly people are not able to make a conscious effort towards maintaining their correct posture. Negligence towards maintaining a posture that doesnot put our spine at risk is important, as not doing so can cause shoulder, back pains, reduced lung function, gastrointestinal pains, scoliosis, and postural syndrome and there are a range of other diseases that can severely affect our day to day lives.

2. LITERATURE SURVEY

Author C. C. Lim and his group from University Malaysia Perlis first describe human body features and movements they fully explained neck conditions around curvical region and taking all body back parts into considirations they designs and developed their device which detect back posture of the human body. The device works on its main function which was accelerometer. By leaning forward and backward it detects bad posture when certain readings of the accelerometer have been met successful then buzzer start to goes off which informs users about his/her bad posture. [1]

Q,W.Oung and group, University Malaysia Perlis (UniMAP) in their research they first explained about the Parkinson's disease (PD) about how this disease always happens to elderly person and their full explanation in their research was for a population that is moving towards an elderly stage of development, Parkinson's disease (PD) is characterized in the second place for the most common chronic progressive neurodegenerative illness in the world after Alzheimer's disease, which regularly affects older generation. In the next 30 years, this amount is estimated to double due to the increase in the number of ageing people, as age is the leading key risk feature for the start of PD. There are a variety of medications, such as levodopa available to treat PD. With the latest advancement in healthcare technology, current researches permit the monitoring of PD with the application of wearable sensor technology. From previous studies, researchers have realized the application of wearable sensors as a useful tool that had the capability to differentiate various types of PD symptoms using uni modal sensor or bi-modal sensors (accelerometer and gyroscope).Therefore, early diagnosis of PD through multimodal wearable technology can be considered for this aim. In their research, the data are collected using on-body triaxial wearable sensors (accelerometer, gyroscope and magnetometer) for classifying people with Parkinson (PWP) from healthy controls. [2]

Anne Schmitz and his group from University of Kentucky their study was about the motion of vivo joint angles during a squat using a single camera markerless motion capture system as compared to a marker based system. In this they explained the various angles of male and female body during squats. In their study they found that Markerless motion capture may have the potential to make motion capture technology widely clinically practical. However, the ability of a single markerless camera system to quantify clinically relevant, lower extremity joint angles has not been studied in vivo. Therefore, the goal of thier study was to compare in vivo joint angles calculated using a marker-based motion capture system and a Microsoft Kinect during a squat. [3]

In this research by Radiological Society of North America the quote"A 135-degree body-thigh sitting posture was demonstrated to be the best biomechanical sitting position, as opposed to a 90-degree posture, which most people consider normal," said Waseem Amir Bashir, M.B.Ch.B., F.R.C.R., author and clinical fellow in the Department of Radiology and Diagnostic Imaging at the University of Alberta Hospital, Canada. "Sitting in a sound anatomic position is essential, since the strain put on the spine and its associated ligaments over time can lead to pain, deformity and chronic illness. "The Researchers are using a new form of magnetic resonance imaging (MRI) to show that sitting in an upright position places unnecessary strain on your back, leading to potentially chronic pain problems if you spend long hours sitting. The study, conducted at Woodend Hospital in Aberdeen, Scotland, was presented today at the annual meeting of the Radiological Society of North America (RSNA). [4]

Yong-ren Huanga and Xu-feng Ouyang together they conducted their research about body's spinal position and presents an architecture for information capture and analysis of sitting posture using force sensor. We utilize force sensor and microcontroller to build a system for force information. We fix positions of force sensors on seat cushions firstly. Then, we design the circuits on microcontroller and obtain the data from sensors. There are different types of information in deferent sitting postures. We analyze and categorize the information for recognizing the sitting postures. This system could be utilized to detect the incorrect sitting postures for children, patients or elder people in the future.[5]

3. OBSERVATIONS

3.1. Techniques

Posture is the position in which a person holds their body upright against gravity when standing, sitting or walking. There are two approaches to determine posture, image-processing based and sensor-based. A sensor-based approach is implemented in two ways. One is by calculating the pressure distribution over different weight distributing surfaces. The other is by calculating the angular difference between current posture and a pre-determined good posture. The author states that the determination of sitting posture is mainly dependent on a chair and four sitting positions. Strength and ultrasonic sensors are installed inside the chair to acquire data. This is then processed using Principle Component Analysis to determine the condition of posture. This approach solves the problems faced by a person when sitting and it is advantageous for users like students who are seated at a desk for a long period. But, it does not help a person correct their posture or practice good posture throughout.

In another sensor-based approach to identify good sitting posture, two accelerometers are placed on different parts of a person's spine. With the help of two other sensors the goniometer and electrogoniometer the angle is calculated and posture is determined. This design is simple, effective and wearable but is only implemented on sitting positions. An application specific approach to posture detection, where the device warns computer users when they lean too close to the computer, is the "Postuino". The device is not wearable but is instead placed next to the computer and when the distance between the computer, user and device falls below a specified threshold, the device will alert the user. This is an innovative approach with a popular application and although it helps the user keep a safe distance from their electronic screen (i.e. computer), it does not help the user correct their actual back posture if the user is standing or walking.

In another approach an actuator is used as a bio-mechanical posture detection device. This actuator shows sensory activity through an avatar in the application with which the device communicates. It assesses the user's posture in the state in which the user is, i.e. sitting, standing, lying etc., to identify the user's movement state or transition between movement states. While this might be a more advanced and applicable posture detector, it is also a more complicated and non-economical solution to the problem.

Another technique uses inertial sensors for human posture detection in order to calculate three-dimensional angles of the human arm and hand. This information is recorded and later used to reconstruct it on a computer. This approach does not help rectify the back posture and does not give any feedback on how to correct it. However, an intelligent chair can be adopted in order to classify and correct the posture of the user. Neural Networks are trained to classify the posture based on pre-trained standard postures. Though the approach to the problem is creative, it does not suggest correction for all postures of the user.

A novel solution is presented for wireless and wearable posture recognition based on a custom-designed wireless body area sensor network (WBASN), called WiMoCA. Here, sensors are represented by triaxial integrated MEMS (microelectromechanical system) accelerometers. WiMoCA sensing node is designed to be wearable and low-power. It has a modular architecture to ease fast replacement and update of each component. The proposed method provides the complete implementation of a distributed posture recognition application. The objective of an additional approach is to detect user's postural changes, not to measure the pressure at each point precisely. The author Ricardo Barba, et al, states that the current mechanisms to detect postural changes are usually expensive, which greatly limits their use in effective computing. They have ruled out commercial solutions for two basic reasons: the need of adjusting the size of the sensors; the cost. To cope with the aforementioned challenges, their approach consists of combining several simple sensors so that they can be used together to form a posture sensor cushion.

Another approach uses three main sensors - Accelerometer, Gyrometer and Bluetooth module. In this approach, the accelerometer measures the tilt of the body, the gyrometer measures the movement in the body and Bluetooth helps in connecting the belt with the phone app designed to display the readings. The Arduino has been programmed for different gestures and positions of the body that a person undergoes in everyday life. Although seeming efficient, the belt measures the tilt of the lumbar region, when in fact, the actual tilt happens at the thoracic (i.e., the upper back) region of the spine. This could result in inaccuracy in posture correction. One of the implementations suggests use of sensors (acceleration sensor) embedded in a smart phone contrary to the ones that require separate hardware components for the same. However, attaching the sensor to the phone and the phone to a belt is not a feasible solution as there is a risk of dropping the phone every time any rigorous activity is performed. Moreover, people use their phones extremely frequently, and for the most part of the day, it will be on their hands and not the belt.

3.2. Functional Analysis

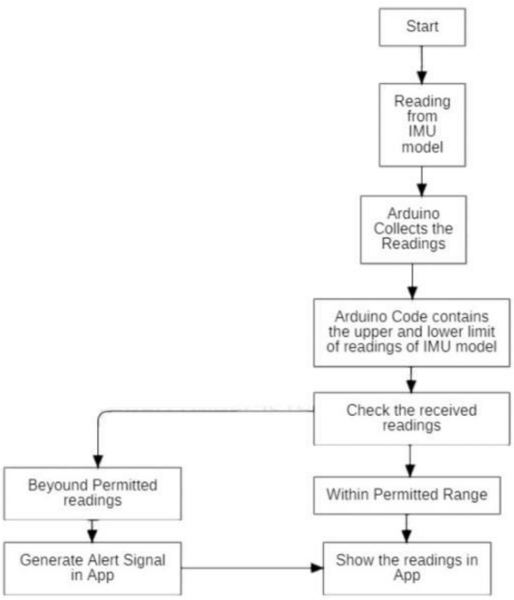

Fig-1: Flowchart of Posture detection and correction device

3.2.1. Input

For accelorometer, gyroscopic sense the input readings is taken from IMU MPU sensor in user's device then that reading is sent to user's android app via bluetooth module.

3.2.2. Process

The device which we are going to make can be placed behind upper back of user's body.

When user sit or stand in a bad posture the buzzer in the device switched on and alert user that he/she standing or sitting in a bad posture. The readings data is going to be send via bluetooth module to user's android app.

The android app is going to monitor user's posture and give user output accordingly.

3.2.3. Output

The Device will buzz or vibrate and alert the user that he/her is sitting or standing in slouch posture and send data via bluetooth to phone's app immediately.

The phone's app is going to monitor user's body movements and give user output of various body back posture in sitting or standing position.

3.3. Effecient components in designing of posture detection and correction system

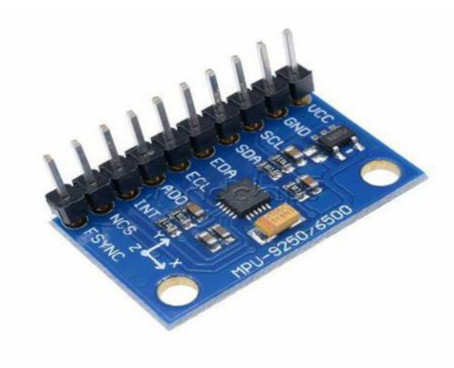

Fig-2: IMU MPU

The MPU-9250 is a 9-axis Motion Tracking device that combines a 3-axis gyroscope, 3-axis accelerometer, 3-axis magnetometer and a Digital Motion Processor™ (DMP) all in a small 3x3x1mm package available as a pin-compatible upgrade from the MPU-6515. With its dedicated I2C sensor bus, the MPU-9250 directly provides complete 9-axis MotionFusion™ output. The MPU-9250 MotionTracking device, with its 9-axis integration, on-chip MotionFusion™, and run-time calibration firmware, enables manufacturers to eliminate the costly and complex selection, qualification, and system level integration of discrete devices, guaranteeing optimal motion performance for consumers. MPU-9250 is also designed to interface with multiple non-inertial digital sensors, such as pressure sensors, on its auxiliary I2C port.

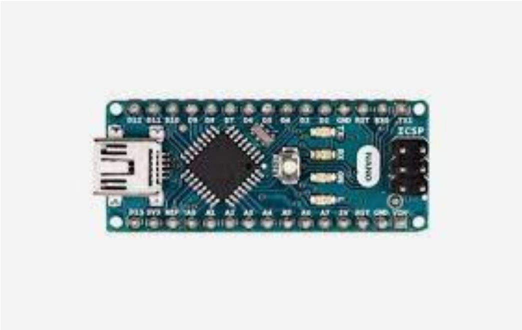

Fig-3: Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

Table-1: Comparison between Arduino Uno and Nano

Specifications	Arduino UNO	Arduino Nano
Processor	ATmega328P	ATmega328P
Input Voltage	5V/7-12V	5V/7-12V
Speed of CPU	16 MHz	16 MHz
Analog I/O	6/0	8/0
Digital IO/PWM	14/6	14/6
EEPROMM/SRAM[kB]	1//2	1/2
Flash	32	32
USB	Regular	Mini
USART	1	1

Above Table 1 Shows difference between Arduino uno and nano in Specification, Processor, Input Voltage etc. In Fig.4 left is Arduino nano and right one is Arduino UNO.

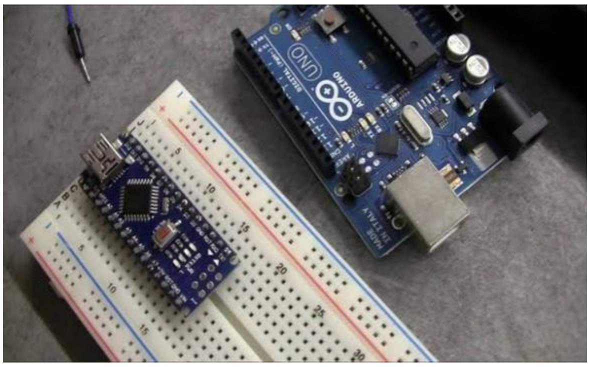

Fig-4: Arduino Nano and Uno

Fig-5: Buzzer

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

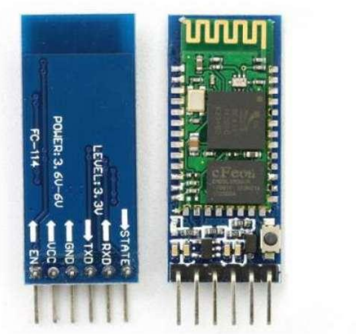

Fig-6: Bluetooth HC-05

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This serial port bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Rluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

4. METHODOLOGY

In one embodiment is a method of providing postural feed back comprising: receiving by a microprocessor at repeated intervals data from a tri-axial accelerometer, the microprocessor and the tri-axial accelerometer comprising a sensor device attached to a user, the sensor device further comprising memory, an actuator, and a power Source; normalizing by the microprocessor the received accelerometer data; determining by the microprocessor a postural description of the user based on the normalized received accelerometer data; and triggering by the microprocessor the actuator to output sensory feedback based on the postural description of the user. In another embodiment is a postural feedback apparatus comprising: a sensor device configured to be attached on a user, the sensor device comprising: a tri-axial accelerometer; an actuator, and a microprocessor configured to receive data from the tri-axial accelerometer about movement of the user; normalize the received accelerometer data; determine a postural description of the user based on the normalized received accelerometer data; and trigger the actuator to output sensory feedback based on the postural description of the user. A non-transitory computer readable medium having stored thereupon computing instructions comprising: a code segment to receive by a microprocessor at repeated intervals data from a tri-axial accelerometer, the microprocessor and the tri-axial accelerometer comprising a sensor device attached to a user, the sensor device further comprising memory, an actuator, and a power Source: a code segment to normalize by the microprocessor the received accelerometer data; a code segment to determine by the microprocessor a postural description of the user based on the normalized received accelerometer data; and a code segment to trigger by the microprocessor the actuator to output sensory feedback based on the postural description of the user.

5. CONCLUSIONS

From study of reference papers we came into a conclusion for making a very efficient and compact weareable device that can detect and correct our body back posture. We chose a very efficient method were arduino nano and IMU MPU as its main component is used so that it can be made compact were user can attach it easily on the back side of their body. The device can be made so that it can detect the bad back posture and alerting the user through buzzer alarm and sending data to android application via Bluetooth. The android application can be made to monitor the body back posture.

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