HUMAN POSTURE MONITORING

A MAJOR PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

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(Electronics & Communication Engineering)

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CHAPTER 1- INTRODUCTION

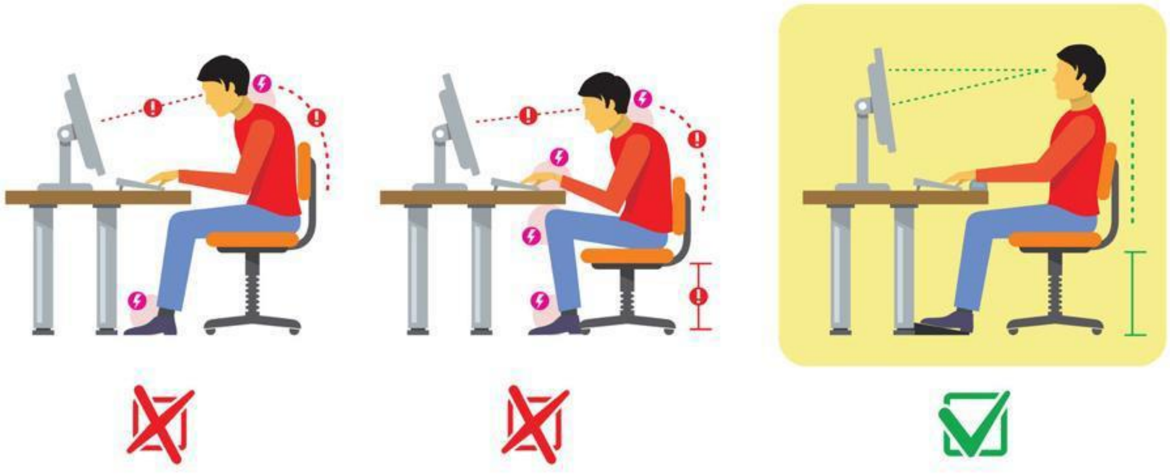


Figure 1.1: Bad posture effects the whole body

The last two decades have witnessed an exponential growth and tremendous developments in wireless technologies and systems, and their associated applications.Posture is the way people carry themselves, in the way they stand, sit, walk and perform tasks, and this posture has a substantial effect on their health. Maintaining a good posture allows the vertebras of the spine to be correctly aligned. Poor posture has been linked with bad health as well as lower performance. A study showed that having a slouched posture impacts the transverses abdominis muscle. It was shown that the thickness of the transverses abdominis muscle is significantly less when a person maintained a slouched posture. This transversus abdominis dysfunction is directly associated with low back pain. Low back pain is one of the leading cause of disability in the world, where it is estimated that around 80% of the world population will experience it at some point in their lives. Each year in the United States, around 50 billion dollars is spent on treating back pain. This problem can also be seen in the UAE where 62% of the young population report to suffer from back pain. Dr. Hilali Noordeen, an orthopedic surgeon at Burjeel Hospital in the UAE said that back pain caused by daily habits such as sitting on a chair with a hunchback, can have severe damaging effects in the long run. Moreover, another study showed that subjects asked to sit with a hunched posture, reported greater stress and thus lower performance. Maintaining the same position for a long time, even with good posture, is also considered a bad postural habit as the muscles in the spine may stop producing substances that are essential for normal biological operations. Therefore, keeping a good posture and changing one's position from time to time is considered important, if not necessary for maintain good health.

1.1 PROBLEM STATEMENT

A large number of the working population have office jobs that require long hours of sitting, and students spend most of their time on laptops devices leaning forward and these habits lay significant strain on the neck and back. In fact, after surveying 200 people of various age groups, 76% said that they do not practice good posture. Of those people, more than 90% said that they experience back pain occasionally to constantly.

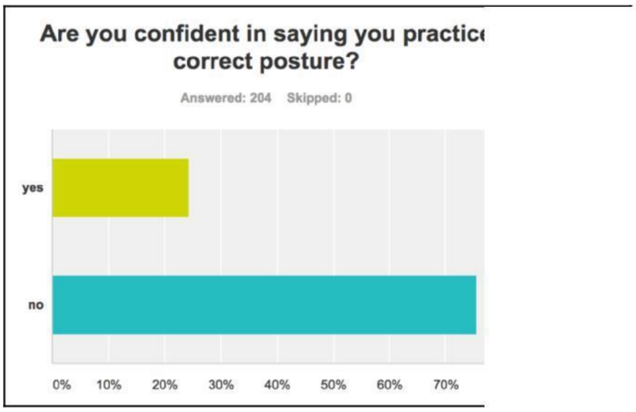


Figure 1.2: survey question 1

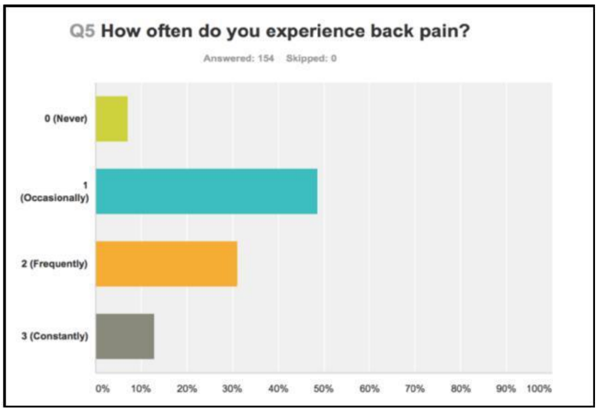


Figure 1.3: survey question 2

This unintentional repetition of poor posture every day slowly changes the body's structure and the body ends up adapting to it. Bad postural habits cause the chest muscles to tighten leading to an excessively curved back in the upper back or thoracic region as shown in figure 4 below. The muscles of the upper back loosen and eventually weaken. Therefore, we introduce a smart monitoring system that is used to enhance the quality of life by providing the support needed to maintain good posture and keep the body moving.

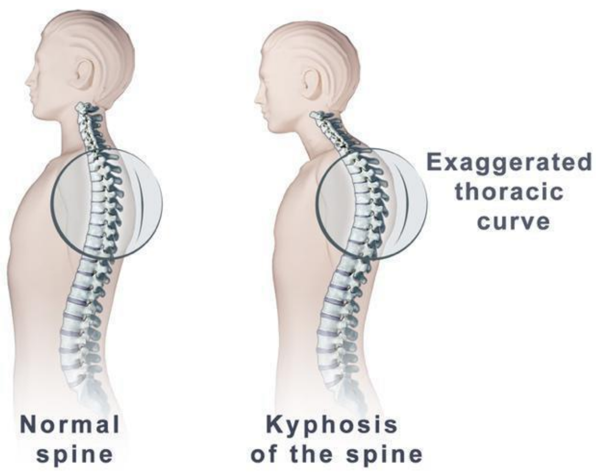


Figure 1.4: Normal Spine versus Kyphosis of the spine

The system will consist of a wireless wearable device that can be attached to a person's back and is used to alert the user in case of an unhealthy postural situations, such as sitting with a hunchback or remaining idle for long periods of time. By motivating the user to exercise posture control, we can help improve the user's ability to maintain an upright position of the spine on the long term with no external help, as well as reduce the possibility of future musculoskeletal problems and pain. The user will acquire awareness of their own posture using vibrational feedback, and correct it when necessary. With time, the device will unconsciously engrave the habit of maintaining a good posture, without the need for the user to be reminded. Such that, the user will be able to fix their own posture after continued use.

1.2 OBJECTIVES

1.2.1 BENEFITS

- Reduce chronic pain that results from poor posture.
- Decrease the stress and pressure on the spine.
- Prevent musculoskeletal disorders and structural deformity of spine.
- Train users to maintain good back posture until it becomes a daily routine.

1.2.2 FEATURES

- Compact and light.
- Wireless connectivity.
- Calibrated measurements to various users.
- Rechargeable battery.

1.2.3 GOALS

To reduce the repercussions of bad posture by designing a wearable device that detects and corrects poor posture via haptic feedback, and trains users to maintain posture through continuous use.

CHAPTER 2- LITERATURE REVIEW AND EXISTING TECHNOLOGIES

Despite widespread acceptance that work related spinal disorders and back pain can be prevented by fixing the posture through ergonomic solutions such as adjustable chairs or other modifications applied to the workstation, There exists very few reliable and accurate methods of continuously monitoring posture in any environment for postural modification. Recently, wearable sensing technologies targeting posture monitoring have been attracting increasing attention, making postural monitoring not restricted to a single location, thus enabling real time measurements and monitoring of posture. Different solutions for monitoring postural activity are reported in the literature, researchers working on such technologies are attempting to integrate wearable computing devices and sensors into textiles for data collection. However, due to the novelty of this field and unavailability of datasets and information on sensor development done by previous researches, most effort is still directed towards the development of the measuring method and accuracy. Thus, the integration of the sensors into a complete system as well as aspects like comfort, aesthetics and wearability are often neglected. Previous work can be classified into three categories in term of the adopted method of obtaining measurements:

First category of work is based on fiber optic sensors. These sensors use the intensity of light passing through as a measurement tool which is proportional to the bend in the sensor. Dunne et al. built up a system that relates the optical fiber sensor readings to the user's sitting posture. Fiber optic sensors were also used to measure seated spinal posture.

However, this solution is limited to seated bending back postures. Second category of work turns to make use of non-intrusive pressure sensors. Dunne et al. used textile piezo-resistive pressure sensors to measure shoulder and neck movements through registering the pressure between skin and textile. However no test was performed to detect the sensors reaction to movements of varying magnitudes. Third category of works explores the use of accelerometers. Hanson et. al. employed the use of accelerometers to measure joint angles with good accuracy results. Similarly, Van Laerhoven et al. and Martin et al. measured postural activities using accelerometers by attaching the to the pants. Lin et al. presented a multi-posture monitoring system using accelerometers embedded in a wearable vest. Moreover, a commercially available product, lumo lift, also helps monitor and coach upper body movements through the use of a gyroscope. The emphasis of this product however, is on the aesthetic integration of posture feedback to the wearable device rather than on reliable measurements. Some of the mentioned techniques above are not well suited to develop a wearable measuring system due to the weight of the sensor or to the impracticality of placing it on the user's back.

Because the measurements in the postural monitoring system are dynamic, accelerometers cannot give the same accuracy as in the static case. Thus, in addition to the inertial acceleration, the gravitation must also be considered. Accelerometers and gyroscopes are commonly incorporated for dynamic positional changes.

CHAPTER 3-PRESENT WORK

3.1 REQUIRMENTS AND SPECIFICATIONS

After taking into account all the existing technologies and studies performed in this area as discussed in the literature review section, a detailed description of our design is presented in the following section. This section will discuss all the requirements our system will be based on, and the various components and technologies the system will encompass. Moreover, we discuss the several hardware components and their specifications and we portray the iterative design and concept generation process, shedding light on how we came up with our final design structure.

3.1.1 WEARABLE SYSTEM REQUIREMENTS

The following requirements should be followed when coming up with design alternatives for the system:-

- Marketable

The design of the system is one of the most important factors in wearables. For example, Size and weight are very critical. The design should be small, light and comfortable to the user to be worn under the shirt conveniently.

- Safety

Safety is highly important as well. The system must not heat up especially when it’s placed directly on the skin. The design shouldn’t also cause skin reactions.

- Reliability

The system should be reliable in terms of power consumption and data accuracy. Since wearable devices are powered by batteries and are required to be ON almost all the time, they consume a lot of power. Reducing their power consumption is considered challenging because the capacity of the battery is limited since the overall size has to be small.

Therefore, wearable should operate at ultra-low power. If Bluetooth is intended to be used, then Bluetooth Low Energy is the best choice for reducing power consumption.
In order to insure data accuracy, the sensor will be calibrated to meet different heights and body shapes for accurate results.

- Feedback System

The system should provide feedback to the user via haptic. In system's design, a vibration motor will be placed in order to alert the user (with vibrations) when poor posture is detected. Vibration motors should be energy efficient, small and flat.

3.1.2 MODULES REQUIREMENTS

Following the wearable system requirements, below is a detailed description of each of the modules that the system will include. Some modules were added after the first prototype due to testing with various sensors and components. Moreover, each module or component has a verification method in order to make sure that the requirements are reached.

Table 3.1: Requirements of modules

MODULE	REQUIREMENTS	VERIFICATION
Flex Sensor **Tilt Sensor**	The bending of the flex sensor should be accurately measured along the horizontal axis of motion. It works as a mechanical switch with metallic ball inside which completes the circuit.	Check the detection of back slouching and bending through an MCU while placed on a person. Whenever metallic ball moves towards conducting plate LED glows otherwise no conduction will be there.
Vibration Motor	Buzzes for a specific period of time only (while user is slouching) and stops vibrating when	Connect it to Arduino board through an output digital pin and apply slouching case with a

	good posture is maintained.	period of time set in the program to send a high signal to the motor.
Battery	The voltage supplied should be greater than 3V, and device it shouldn't heat up.	Measure the power consumption of each component to ensure good power consumption for a wearable device. Place the battery on the back and test if it heats up.

3.2 DESIGN ALTERNATIVES

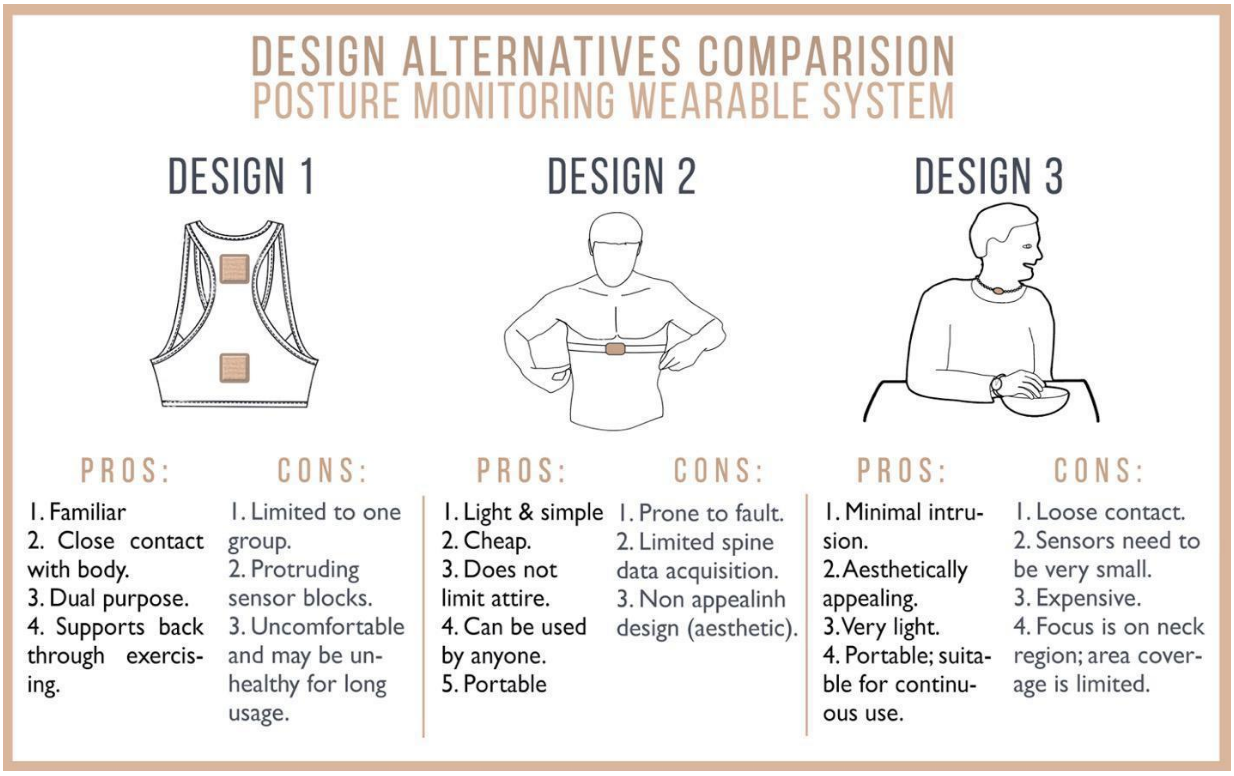


Figure 3.1: Design alternatives

1) Undershirt

An under-shirt, as depicted in figure 4, covers a large area of the spine and gives us more flexibility with sensor placement. However, people might not be comfortable wearing it throughout the day as it needs to be tight around the body in order for the sensor to collect correct angle measurements and there might be protruding parts. Moreover, sizing might be an issue to people of various heights as sensor placements may differ.

2) Back strap

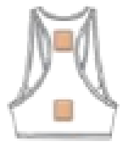
The strap can be discreet since it can be worn under clothes, and can be worn everyday. It is light and comfortable and allows us to use a muscle flex sensor to measure muscle strain and detect stressed muscles which is also an issue related to posture. However, a downside to this implementation is how the accelerometer can be used to detect degree of bending to detect bad posture.

3) Necklace

Unlike the above options, this one does not target the back directly. It aims to detect posture by monitoring the movement of the neck and projecting this into quantifiable posture data. This design is more visible than the previous two and may not be preferred by the user, since it is considered to be gender specific.

An analysis of the costs and the benefits for each of the three designs has been made and recorded in the Table shown in the next page. The undershirt strap scored the highest but the back strap suited in terms of meeting our objectives and constraints. This design enables the use of several sensors and enables the calculation of the thoracic angle directly from the thoracic spine movement.

The next step in the design cycle was component selection. Thus, it was decided that it would be a good solution to start with a computing and sensing unit that encompasses plenty of features as to not limit the system. Therefore, the size at this stage was not put into consideration but rather the usefulness.

	 Design 1	 Design 2	 Design 3
Objectives			
1) Safety	1	1	1
2) Reliability	1	0.5	0
3) wearability	1	0.5	0.5
4) cost	0.5	1	0
Constraints			
Power consumption must not exceed 800 mAh per 15 hours.	0.5	1	0.5
Size and thickness must not exceed 2.5 cm. Weight should not exceed 70 grams.	0	0.5	1
Can be used with various activities such as sports. (Versatile)	1	0	0
Should cover more than 3 vertebras of the spine	1	0.5	0
Error tolerance of ± 5%	1	0.5	0
Final Score			
	7	5.5	3

3.3 SYSTEM OVERVIEW

3.3.1 SYSTEM DESIGN

In this section, the main parts of the system and its functions are represented by the block diagram. Then, the flowchart clarifies the data flow in the system and the decisions made to control events.

1. BLOCK DIAGRAM

The postural monitoring system contains three main parts which are sensor unit, control unit and power unit as shown in figure 6 below.

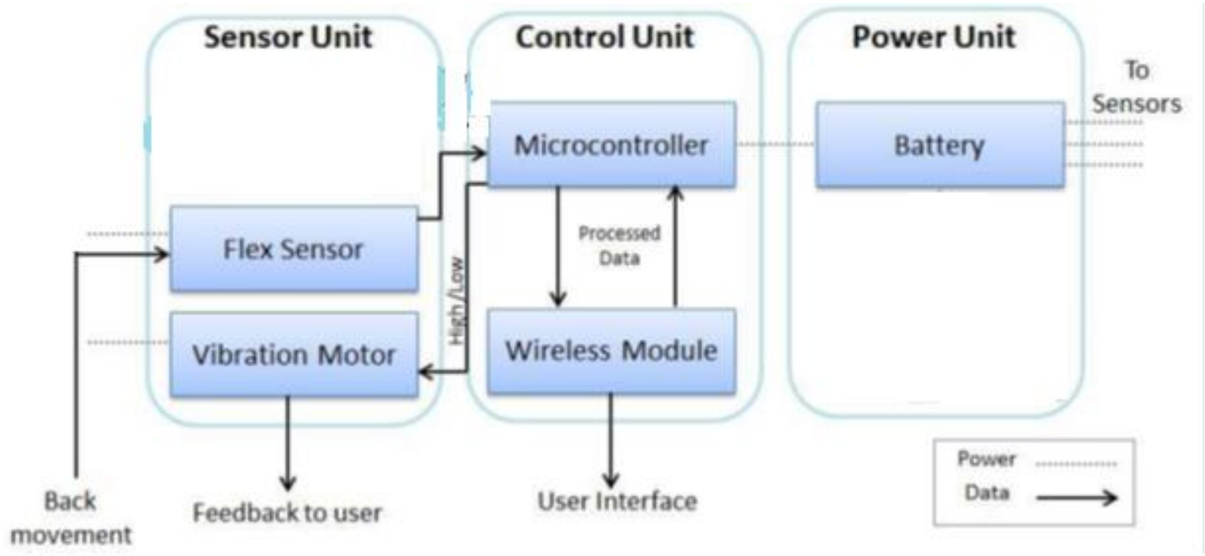


Figure 3.2: System block diagram

The sensor unit mainly collects data based on the user's movement of the back or more specifically, the spine. This data is then sent to the control unit for data processing. The control unit makes decisions based on the rotational data along with flex sensor data obtained from the sensor unit. Both sensing units and control units are powered by the power unit. It is responsible for supplying power to the whole system though a battery.

2. SYSTEM FLOW CHART

The data flow and the decisions taken by the microcontroller is explained in the figure below and it's followed by a description that will clarify each case in the chart.

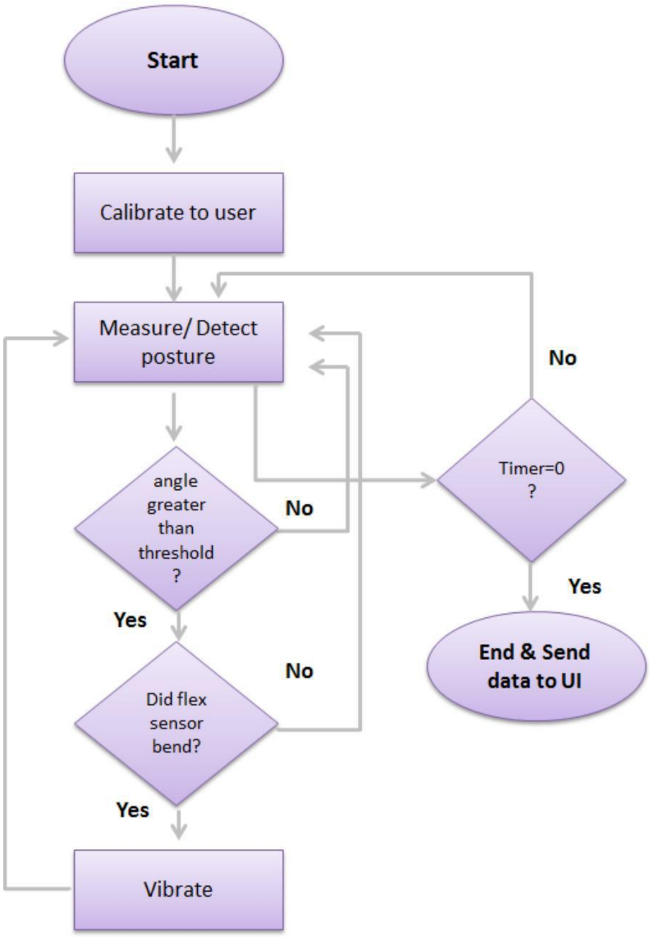


Figure 3.3: Flowchart of the Microcontroller

1) Start – Device is turned on.

2) Calibrate to User - The microcontroller will create a reference in the first 10 seconds the user wears the device and stands still for calibration.

3) Measure/Detect Posture – The angle is being calculated by the microcontroller.

4) Did Flex Sensor Bend? - Microcontroller checks if the flex sensor bent. If it did, then it means that the user is slouching, but if it didn't, it means that the user is bending.

5) Vibrate - If poor posture is detected (based on the previous two cases), the microcontroller sends a high signal to the buzzer which will cause it to vibrate to notify the user to adjust their posture.

6) Timer = 0? – This means that previously calibrated posture doesn't have to be maintained and the user can move.

7) End & Send to User Interface - The angular data will be sent to a use interface so the user can keep track with his progress.

3.3.2 HARDWARE SELECTION

This section lists the modules used in the system design and it includes the main three units which are the sensor unit, control unit and power unit as previously mentioned. The selection of the modules was made based on studies of the specs, availability of the components and experimental results.

1) FLEX SENSOR

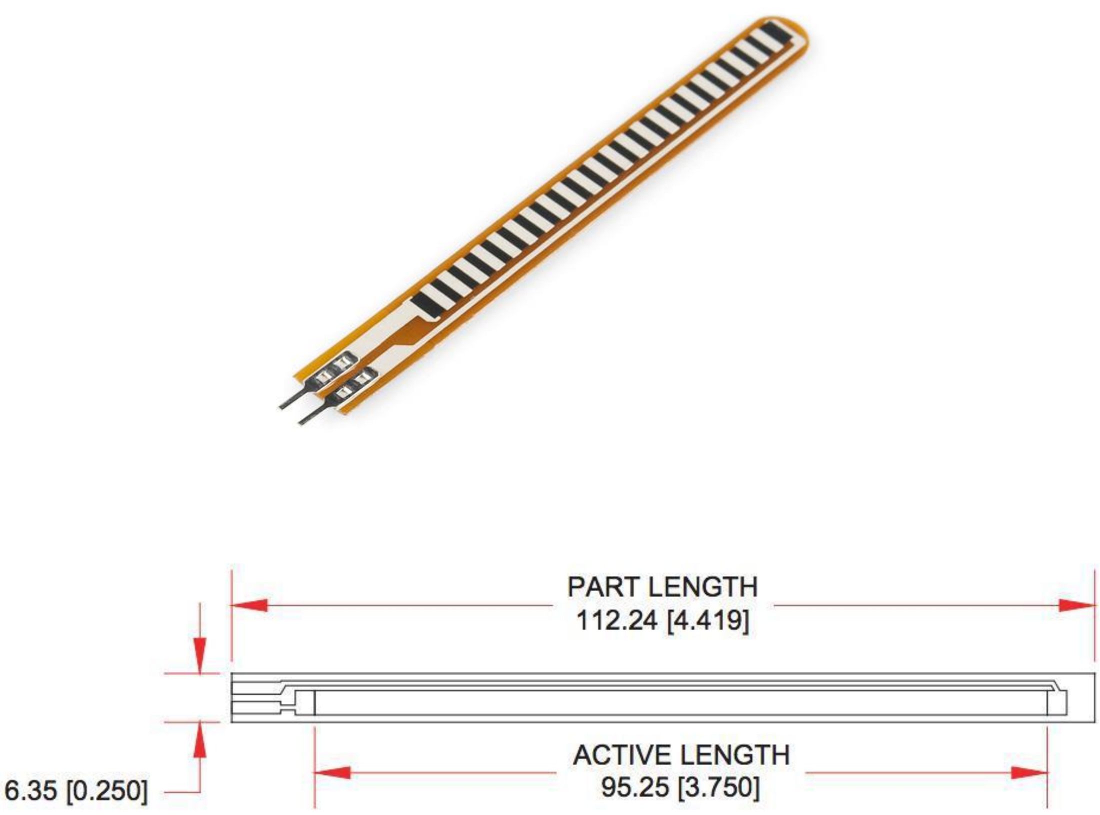


Figure 3.4: Flex Sensor

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. Since the resistance is directly proportional to the amount of bend it is used as goniometer “ an instrument for the precise measurement of angles. This flex sensor or bend sensor is also called flexible potentiometer. This flex sensor has two contacts and can be easily used with a breadboard, but personally I prefer soldering jumper wires with the flex sensor so that it can be easily interfaced with other circuits. It works just like an ordinary potentiometer or variable resistor, the only difference is that, the flex sensor resistance changes with the bending while the resistance of an ordinary variable resistor changes as we rotate the nob.

There are some other types of the flex sensor but the one you can see on the screen is a conductive ink based flex sensor.

The specifications of the sensor are:

Mechanical Specifications:

-Life Cycle: >1 million

-Height: 0.43mm (0.017")

-Temperature Range: -35°C to +80°C

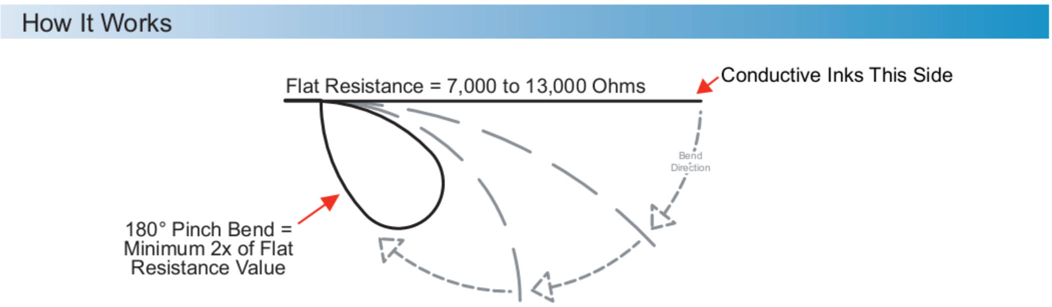
Electrical Specifications:

-Flat Resistance: 10K Ohms ±30%

-Bend Resistance: minimum 2 times greater than the flat resistance at 180° pinch bend (see "How it Works" below)

-Power Rating : 0.5 Watts continuous; 1 Watt Peak

How it works?



2.) TILT SENSOR

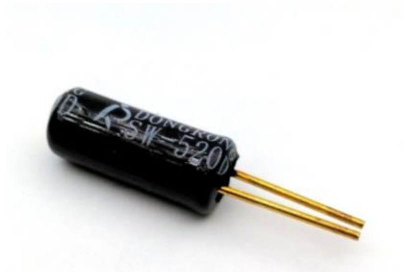


Figure 3.5: Tilt Sensor

It works as a mechanical switch with metallic ball inside which completes the circuit.

A **tilt sensor** is an instrument that is used for measuring the **tilt** in multiple axes of a reference plane. **Tilt sensors** measure the **tilting** position with reference to gravity and are used in numerous applications. They enable the easy detection of orientation or **inclination**.

3.) VIBRATION MOTOR

Figure 3.6: Vibration Motor

It buzzes for a specific period of time only (while user is slouching) and stops vibrating when good posture is maintained.

Precision Microdrives currently produces coin vibration motors, also known as shaftless or pancake vibrator motors, generally in Ø8mm - Ø12mm diameters for our Pico Vibe range. Pancake motors are compact and convenient to use. They integrate into many designs because they have no external moving parts, and can be affixed in place with a strong permanent self-adhesive mounting system.

Due to their small size and enclosed vibration mechanism, coin vibrating motors are a popular choice for many different applications. They are great for haptics, particularly in handheld instruments where space can be at a premium:

- Mobile phones
- RFID scanners
- Industrial tools or equipment user interfaces
- Portable instruments
- Medical applications

Coin vibration motors are designed to be easy to mount. They come with either spring PCB connectors or a high-strength long life self-adhesive backing sheet that is pre-attached to the underside of the chassis. The adhesive allows for a secure mounting of the vibration motor to a wide range of surfaces such as PCBs or flat internal surfaces of the enclosure and makes manufacturing installation fast and clean.

4.)TRANSMITTER and RECEIVER

- **Transmitters**

A radio consists of several elements that work together to generate radio waves that contain useful information such as audio, video, or digital data.

- **Power supply:** Provides the necessary electrical power to operate the transmitter.
- **Oscillator:** Creates alternating current at the frequency on which the transmitter will transmit. The oscillator usually generates a sine wave, which is referred to as a *carrier wave.*

- **Modulator:** Adds useful information to the carrier wave. There are two main ways to add this information. The first, called amplitude modulation or AM, makes slight increases or decreases to the intensity of the carrier wave. The second, called frequency modulation or FM, makes slight increases or decreases the frequency of the carrier wave.
- **Amplifier:** Amplifies the modulated carrier wave to increase its power. The more powerful the amplifier, the more powerful the broadcast.
- **Antenna:** Converts the amplified signal to radio waves.

> **Receivers**

A receiver is the opposite of a transmitter. It uses an antenna to capture radio waves, processes those waves to extract only those waves that are vibrating at the desired frequency, extracts the audio signals that were added to those waves, amplifies the audio signals, and finally plays them on a speaker.

- **Antenna:** Captures the radio waves. Typically, the antenna is simply a length of wire. When this wire is exposed to radio waves, the waves induce a very small alternating current in the antenna.
- **RF amplifier:** A sensitive amplifier that amplifies the very weak radio frequency (RF) signal from the antenna so that the signal can be processed by the tuner.
- **Tuner:** A circuit that can extract signals of a particular frequency from a mix of signals of different frequencies. On its own, the antenna captures radio waves of all frequencies and sends them to the RF amplifier, which dutifully amplifies them all.

Unless you want to listen to every radio channel at the same time, you need a circuit that can pick out just the signals for the channel you want to hear. That’s the role of the tuner.

The tuner usually employs the combination of an inductor (for example, a coil) and a capacitor to form a circuit that resonates at a particular frequency. This frequency, called the *resonant frequency*, is determined by the values chosen for the coil and the capacitor. This type of circuit tends to block any AC signals at a frequency above or below the resonant frequency.

You can adjust the resonant frequency by varying the amount of inductance in the coil or the capacitance of the capacitor. In simple radio receiver circuits, the tuning is adjusted by varying the number of turns of wire in the coil. More sophisticated tuners use a variable capacitor (also called a *tuning capacitor*) to vary the frequency.

- **Detector:** Responsible for separating the audio information from the carrier wave. For AM signals, this can be done with a diode that just rectifies the alternating current signal. What's left after the diode has its way with the alternating current signal is a direct current signal that can be fed to an audio amplifier circuit. For FM signals, the detector circuit is a little more complicated.

➢ Transmitter and Receiver Module

An RF Module (Radio Frequency Module) is a small electronic circuit used to transmit and/or receive radio signals on one of a number of carrier frequencies. RF Modules are widely used in electronic design owing to the difficulty of designing radio circuitry. RF Modules are most often used in medium and low volume products for consumer applications such as garage door openers, wireless alarm systems, industrial remote controls, smart sensor applications, and wireless home automation systems.

The operating frequency of RF module can be varied. But we offer two kinds of, one of them is 433 MHz and another is 315 MHZ. The transmission occurs at the rate of 600bps – 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

Specification:-

- Frequency: 433 MHz
- Modulation: ASK
- Receiver Data Output: High – 1/2 VCC, Low – 0.7v
- Transmitter Input Voltage: 3-12V (high voltage = more transmitting power).
- Receiver Input Voltage : 3.3-6V (high voltage = more receiving power)

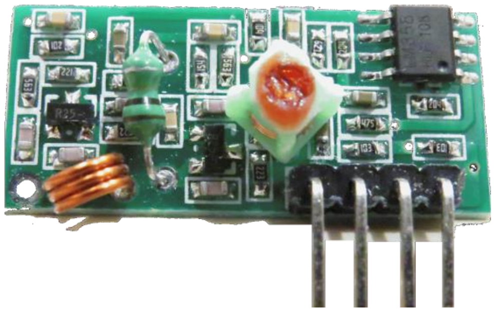


Figure 3.7: Receiver Module

Table 3.2: Rx module Pin description

Pin No	Function	Name
1	Ground(0V)	Ground
2-3	Serial data output pin	Input
4	Supply voltage (3.3V-6V)	Vcc
5	Antenna	Ant

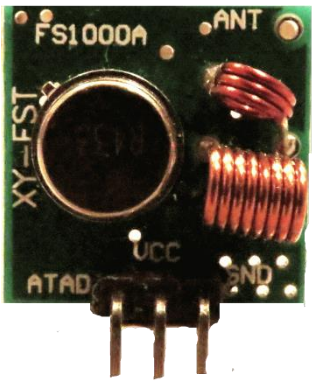


Figure 3.8: Transmitter Module

Table 3.3: Tx module Pin description

Pin No	Function	Name
1	Antenna	ANT
2	Serial data input pin	Output
3	Ground(0V)	Ground
4	Supply voltage (3V-12V)	Vcc

Wireless Transmitter Modules allow your Arduino to wirelessly comunicate with other arduinos, or with radio frequency (RF) controlled devices that operate in the same frequency (433Mhz in this case).They work in pairs, meaning you need both a receiver and a transmitter to comunicate with each other.

5.) ARDUINO UNO

The Arduino Uno has ATmega328 microcontroller . It has 6 analog inputs 14 digital input/output pins (of which 6 can be used as PWM outputs), an ICSP header, a 16MHz crystal oscillator, a power jack, a USB connection , and a reset button. It AC-to-DC adapter or battery to get started it contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable, it features the Atmega328 programmed as a USB-to-serial converter. The Arduino Uno is different from all the other boards in that, Arduino uno does not use the FTDI USB-to-serial driver chip

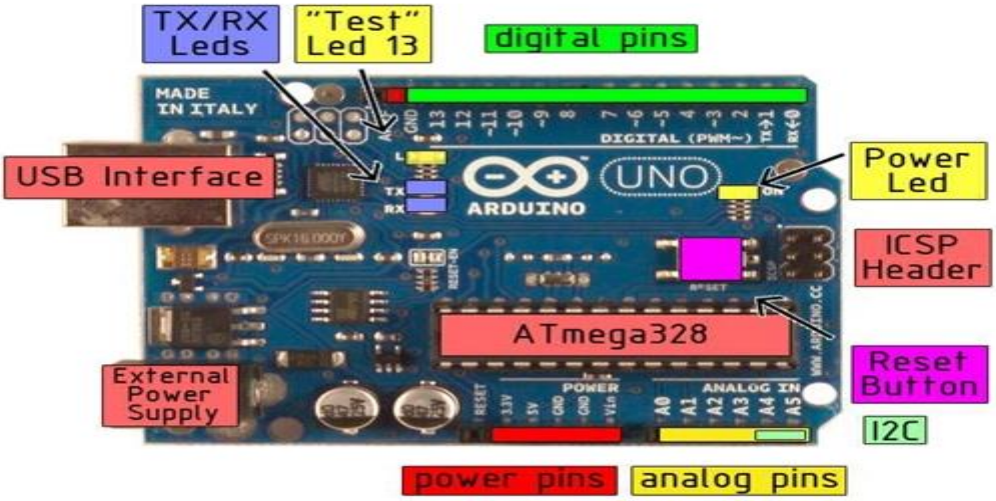


Figure 3.9: Arduino Uno

Table 3.4: Arduino Specifications

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)

Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB ofwhich0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

The power pins are as follows:

• VIN.

The input voltage to the Arduino board when using an external power source (unlike 5 volts from the USB connection or other regulated power source). It is possible to supply the voltage through this pin or, if the voltage is supplied via the power jack, access it via this pin.

• 5V

In Arduino uno Voltage regulators are used to supply regulated voltage to the atmega328 microcontroller, you can find two regulators 5v and 3.3v regulators. The Arduino uno can be powered up using a 12v adaptor, or computer, or you can also connected any external power supply with the vin pin of the Arduino, so far the applied voltage is within the limits.

• GND.

Pin of earth.

• LED: 13. There on onboard led in Arduino uno which is connected with pin number 13 of the Arduino. this led can be turned on and turned off using the HIGH and LOW commands. So the led remains off when low and remains On when HIGH.

• 3V3. A 3.3 volt power supply generated by the on-board regulator. The maximum current consumption is 50 mA.

• Arduino uno has a default serial port on pin0 and pin1. Which are used for the serial communication, it can be used for the debugging purposes to check any error in coding and can also be used to communicate with other devices which make use of serial communication like for example, gsm module, Bluetooth module and so on, there are thousands of devices which uses serial communication.

• External interrupts: 2 and 3.

These pins can be configured to trigger an interrupt on a low value, a rising or falling edge or a change in value. See the attachInterrupt () function for details.

• Arduino uno has PWM"pulse width modulation ": these pins are 3, 5, 6, 9, 10 and 11.

Provide the 8-bit PWM output with the analogWrite () function. • SPI Bus: In arduino the spi bus lines are , 10, 11, 12 and 13. 10 is the ss, 11 is the mosi, 12 is the miso and 13 is the sck.

These pins are used for the devices which uses spi lines like for example the RFID module which is most commonly used. There can be thousands of other devices that make use of spi bus to communicate.

6.). RESISTOR

Resistors are electronic components that have a specific electrical resistance and are constantly evolving. Resistor resistance limits the flow of electrons through a circuit. They are passive components, in the sense that they consume only energy (and can not generate it).

Figure 3.10: Resistor

Resistors are generally added to circuits in which they integrate active components such as operational amplifiers, microcontrollers and other integrated circuits. Normally the resistors are used to limit the current, to divide the voltages and the pull-up I / O lines. Resistors can be manufactured in various ways. The most common type of electronic devices and systems is the carbon composition resistor. Fine granulated coal (graphite) is mixed with clay and hardened. The resistance depends on the percentage of carbon in clay; the higher this relationship, the lower the resistance. Pull-up resistance: In digital circuits, the pull-up resistor is a normal resistance connected to the high voltage power supply (for example + 5V or + 12V) and sets the input or output level of a device to "1". The pull-up resistor sets the level to "1" when the input / output is disconnected. When the input / output is connected, the level is determined by the device and replaces the pull-up resistor. Pull-down resistance: In digital circuits, the pull-down resistor is a normal resistance connected to ground (0V) and sets the input or output level of a device to "0". The pull-down resistor sets the level to '0' when the input / output is disconnected. When the input /

output is connected, the level is determined by the device and overwrites the pull-down resistor.

7.)JUMPER WIRES

Figure 3.11: Jumper Wires

These are 20cm long jumpers with male connectors on one end and female on the other. Use these to jumper from any male or female header on any board. Multiple jumpers can be installed next to one another on a 0.1" header.

3.4 CIRCUIT DIAGRAM AND WORKING

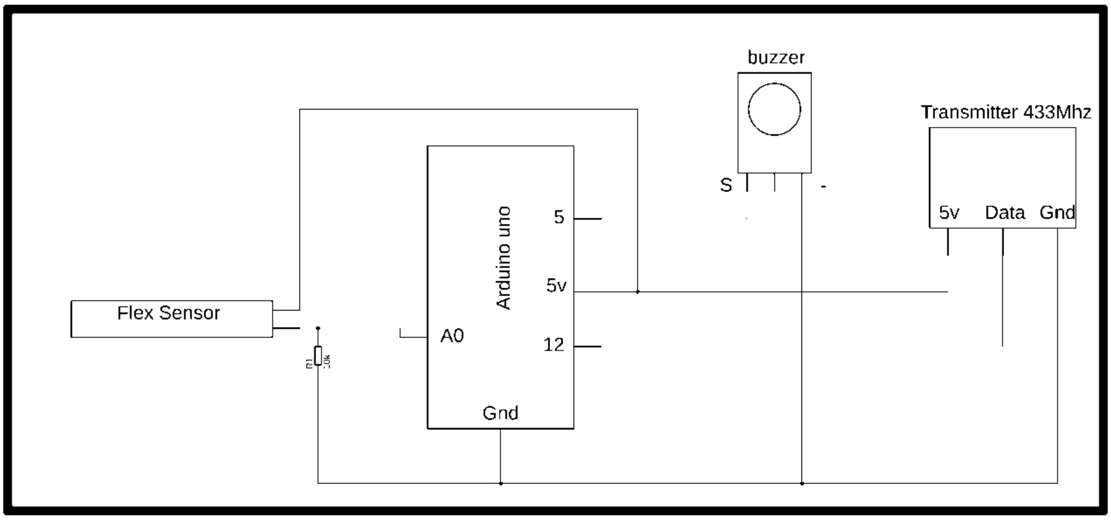


Figure 3.12: Circuit Diagram (Transmitter)

A10k resistor is connected in series with the flex sensor. A 5v from Arduino is connected with the flex sensor and ground is connected with the 10k resistor. This flex sensor and 10k resistor make a voltage divider. A wire from the middle is connected with the Analog pin A0 of the Arduino, the vibration motor's positive pin is connected with pin number 5 of the Arduino which is the PWM pin and the negative pin is connected with the ground.

A simple flex sensor is a resistive device that can detect bending through changes in the resistance across the sensor that is proportional to the amount of bending. The flex sensor is unidirectional as it detects bending in one direction, which is sufficient for our purposes. The flex sensor we will be using is the SEN-08606 4.5'' sensor. The output of the sensor is in volts and can be manipulated to display angle bending.

One side of the sensor is printed with a polymer ink that has conductive particles embedded in it. When the sensor is straight, the particles give the ink a resistance of about 30k Ohms. When the sensor is bent away from the ink, the conductive particles move further apart, increasing this resistance (to about 50k-70K Ohms when the sensor is bent to 90°).

All the components after soldering are installed on a hard board. For the components fixing we used the Hot glue Gun. We tried to keep the assembly as small as possible.

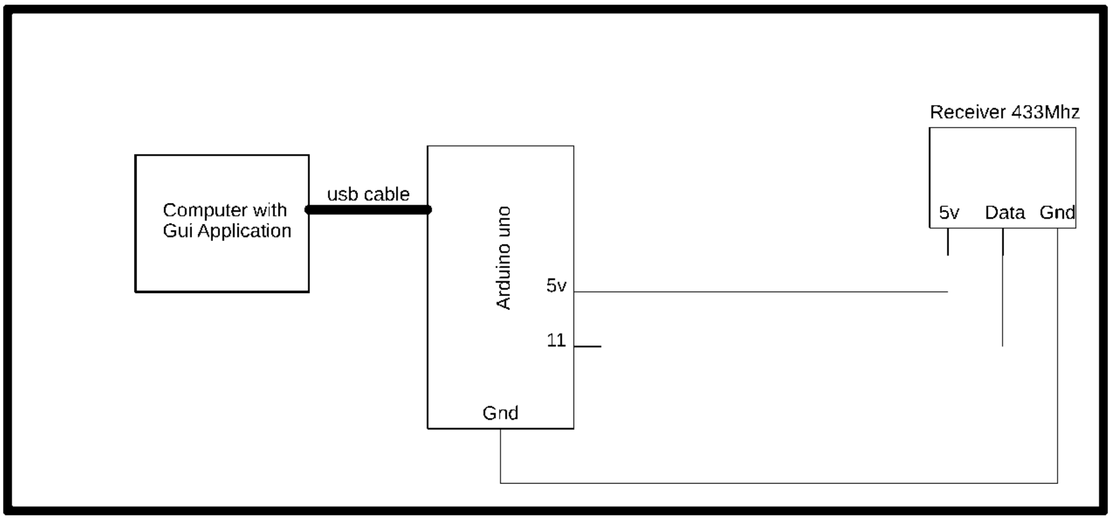


Figure 3.13: Circuit Diagram (Receiver)

The receiver side is very easy. As you can see it consists of the Arduino uno and a 433Mhz receiver. The Arduino uno board is connected with the laptop through a usb cable. The computer application communicates with Arduino uno through serial communication. The controller receives data wireless from the transmitter circuit and then give it to the computer application where it is displayed

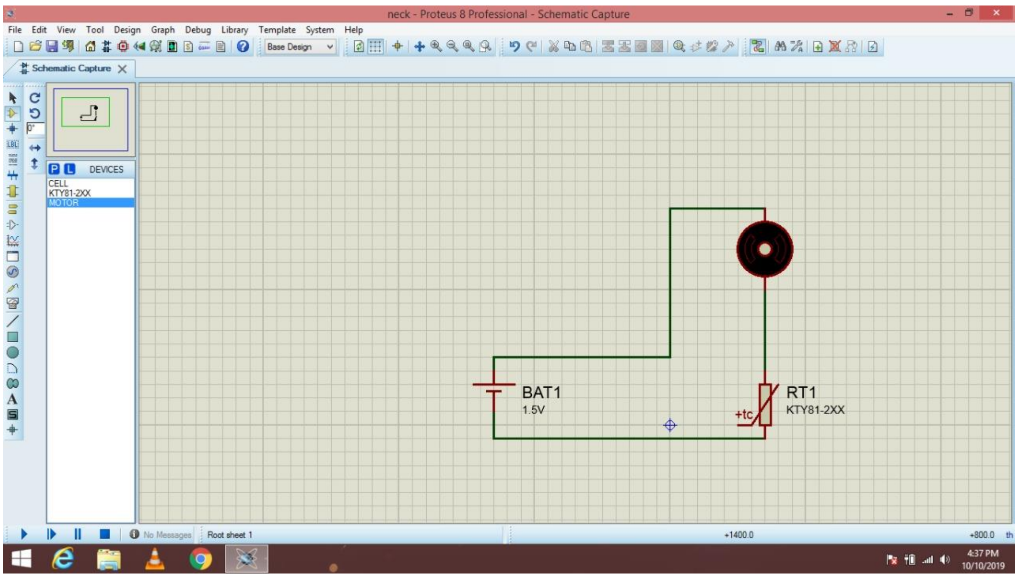


Figure 3.14: Circuit Diagram (Neck)

It consists of a vibration motor ,a tilt sensor , and a battery. The device is attached to user's neck via a non toxic adhesive. Whenever the user "does the bad posture" the metallic ball in the tilt sensor rolls over to the electrode, completing the vibration motor circuit. The motor starts vibrating, and the user is immediately alerted of their bad posture. When they correct their "neck position", the metallic ball in the tilt sensor rolls to the other end, breaking the circuit and stopping the vibration.

3.5 PROGRAMMING

3.5.1 Transmitter Programming:

```
#include <VirtualWire.h>
const int transmit_pin = 12;

int flexs = A0; // flex sensor is connected with pin A0 of the arduino
int flexdata = 0;
int motor = 5;

String str;
char cstr[100];
void setup()
{
    // Initialise the IO and ISR
 vw_set_tx_pin(transmit_pin);
 vw_setup(2000);     // Bits per sec
 Serial.begin(9600);

  pinMode(flexs, INPUT);
  pinMode(motor, OUTPUT);

}

void loop()
{
```

```
 flexdata = analogRead(flexs);
Serial.print("flex value;");
Serial.print(flexdata);
Serial.println("");
if( flexdata <30 )
{
    digitalWrite(motor, HIGH);
}

if( flexdata > 30)
{
   digitalWrite(motor, LOW);
}

   str = String(flexdata);
 str.toCharArray(cstr,100);
  vw_send((uint8_t *)cstr, 7); // change this number according to the sensor values
  vw_wait_tx(); // Wait until the whole message is gone
  delay(1000);
}
```

3.5.2 Receiver Programming:

```
#include <VirtualWire.h>
const int receive_pin = 11;

String message;
int rawvalue = 255;

void setup()
{
    delay(1000);
```

```
    Serial.begin(9600);  // Debugging only
    Serial.println("Time , Value");

    // Initialise the IO and ISR

    vw_set_rx_pin(receive_pin);

    vw_set_ptt_inverted(true); // Required for DR3100
    vw_setup(2000);  // Bits per sec

    vw_rx_start();       // Start the receiver PLL running

}

void loop()
{
    uint8_t buf[VW_MAX_MESSAGE_LEN];
    uint8_t buflen = VW_MAX_MESSAGE_LEN;

    if (vw_get_message(buf, &buflen)) // Non-blocking
    {
  int i;



  // Message with a good checksum received, dump it.
  //Serial.print("Got: ");

  for (i = 0; i < buflen; i++)
  {
      char c = (buf[i]);
            message = message + c ;

          //  Serial.print(message);
          //  message = "";
```

```
    // Serial.print(' ');
  }
  Serial.print("    ,");
  Serial.println(message);
    message = "";
   }

   delay(2000);



}
```

3.6 APPLICATION INTERFACE:

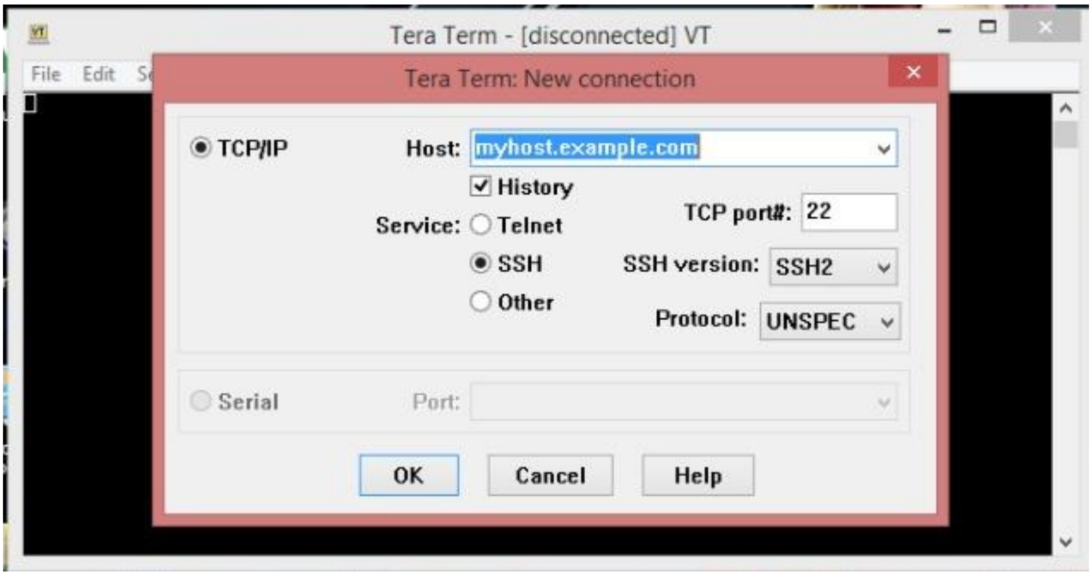


Figure 3.15: Application Interface (Tera Term)

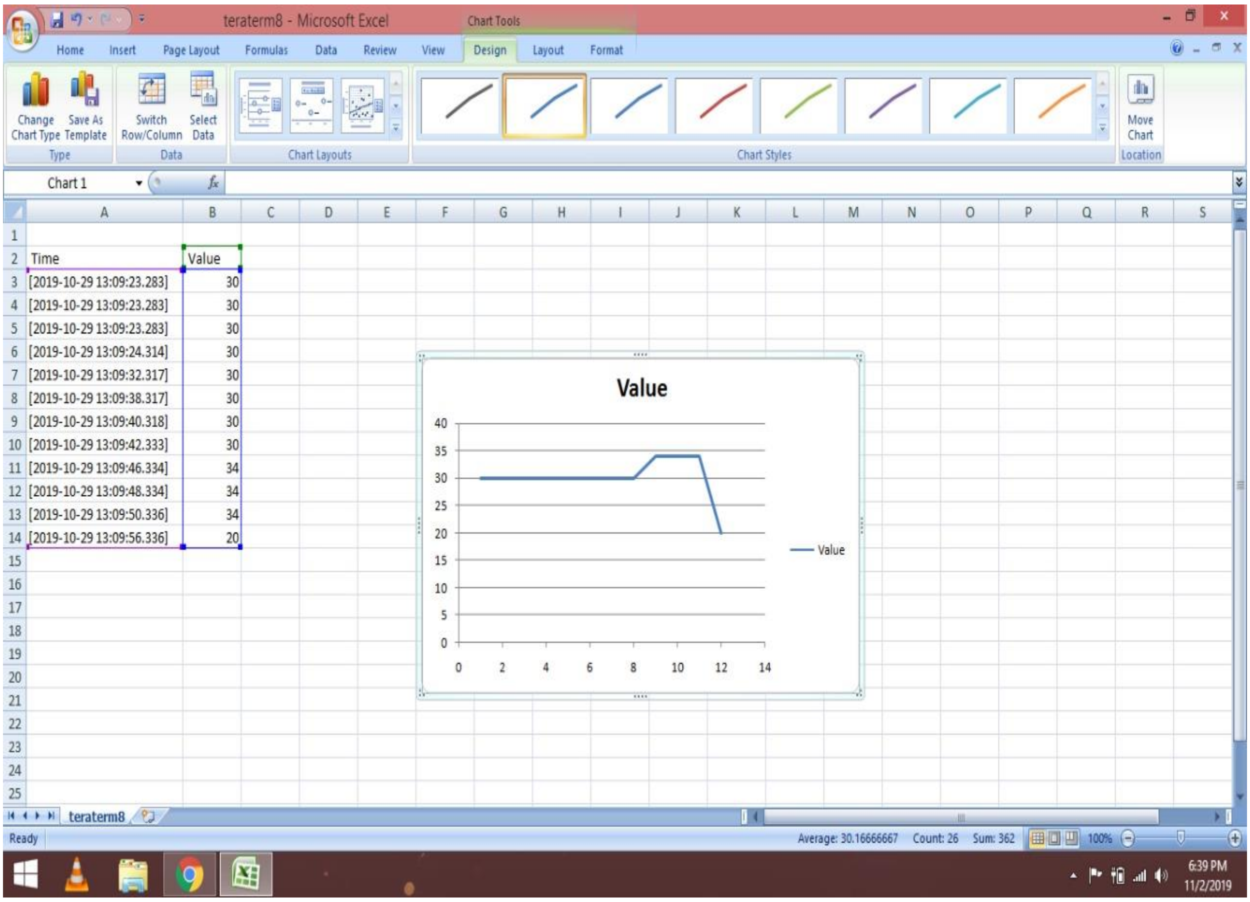


Figure 3.16: Application Interface (MS Excel)

CHAPTER 4- RESULT AND DISCUSSION

The total cost of our system came up to be Rs. 1955. The details of each purchase can be seen in the table below.

Table 4.1: Financial Statement

S.NO.	NAME	QUANTITY	PRICE (in Rs.)
1.	Arduino Uno	2	700
2.	Flex sensor	1	850
3.	Vibration motor	2	40
4.	Tilt sensor	1	15
5.	Transreciever module	1	150
6.	Batteries	2	50
7.	Wires, resistor, connectors	-	150

At the end of this project we successfully tested our project based on human posture monitoring. We did the entire test and we were really happy with the results, we successfully monitored the posture and successfully sent data wirelessly to the computer application.

CHAPTER 5- CONCLUSION AND FUTURE SCOPE

In this project we demonstrated a device for posture detection and correction via vibrational feedback. The system includes various hardware modules such as tilt sensor, flex sensor, vibration motors, microcontroller and a wireless module. The data is firstly collected from the flex sensor that is positioned on the spine. Then, the data will be sent to the microcontroller in order to calculate the angular values that can verify whether the user's postural behavior. If poor posture has been detected, then the vibration motors will vibrate accordingly to notify the user. The wireless module will connect the control unit by another device. The device will provide feedback to the user and display his daily posture routine. The main objective of this project was clarified that is to detect poor posture, train users to have a better posture until it becomes a habit and reduce chronic back pain that result from poor posture.

Future use:

This project can also be used to monitor the angle in a general way, this way it can be used for security purposes as well and based on our biomedical application it can also be used in automobiles technology and so on.

REFERENCES:

[1] H. Elayan, R. M. Shubair, and A. Kiourti, “Wireless sensors for medical applications: Current status and future challenges,” in Antennas and Propagation (EUCAP), 2017 11th European Conference on. IEEE, 2017, pp. 2478–2482.

[2] Emirates 24/7, "62% of young people suffer lower back pain", 2015.

[3]KnowHowMD,*Thoraciccurve*. http://www.knowhowmd.com/spine/disorders/kyphosis

[4]https://arduinobasics.blogspot.com/2014/06/433-mhz-rf-module-with-arduino-tutorial.html

[5] https://www.spectrasymbol.com/product/flex-sensors/

[6] Gatchel, R. J., Polatin, P. B., & Kinney, R. K. (1995). Predicting outcome of chronic back pain using clinical predictors of psychopathology: A prospective analysis. *Health Psychology, 14*(5), 415–420.

[7] Glassman, S.D.; Bridwell, K.; Dimar, J.R.; Horton, W.; Berven, S.; Schwab, F. The impact of positive sagittal balance in adult spinal deformity. Spine **2005**, 30, 2024–2029. [CrossRef] [PubMed]

[8] Hsiao, C.H.; Tang, K.Y. Examining a model of mobile healthcare technology acceptance by the elderly in Taiwan. J. Glob. Inf. Technol. Manag. **2015**, 18, 292–311. [CrossRef]

[9] Chang, S.J.; Im, E.O. A path analysis of Internet health information seeking behaviors among older adults. Geriatr. Nurs. **2014**, 35, 137–141. [CrossRef] [PubMed]

[10] He, B.; Bai, J.; Zipunnikov, V.V.; Koster, A.; Caserotti, P.; Lange-Maia, B.; Glynn, N.W.; Harris, T.B.; Crainiceanu, C.M. Predicting human movement with multiple accelerometers using movelets. Med. Sci. Sports Exerc. **2014**, 46, 1859. [CrossRef] [PubMed]

[11] Lee, J.S.; Su, Y.W.; Shen, C.C. A comparative study of wireless protocols: Bluetooth, UWB, ZigBee, andWi-Fi. In Proceedings of the IECON 2007 33rd Annual Conference of the IEEE Industrial Electronics Society, Taipei, Taiwan, 5–8 November 2007; pp. 46–51.

[12] Hentschel, M.; Haaksma, M.; van de Belt, T. Wearable technology for the elderly: Underutilized solutions. Eur. Geriatr. Med. **2016**, 7, 399–401. [CrossRef]

[13] Liu, J.; Sohn, J.; Kim, S. Classification of Daily Activities for the Elderly Using Wearable Sensors. J. Healthc. Eng. **2017**, 2017, 8934816. [CrossRef] [PubMed]

[14] Cha, Y.; Nam, K.; Kim, D. Patient Posture Monitoring System Based on Flexible Sensors. Sensors **2017**, 17, 584. [CrossRef] [PubMed]

[15] Nag, A.; Mukhopadhyay, S.C.; Kosel, J. Wearable Flexible Sensors: A Review. IEEE Sens. J. **2017**,17, 3949–3960. [CrossRef]