## TITLE:

# IOT BASED SMART WEARABLE POSTURE DETECTED ALERT & HEATING COOLING THERAPY SYSTEM

## INTRODUCTION:

The way people hold themselves, in terms of how they stand, sit, move, and perform activities, is known as posture, and it has a significant impact on their health. The vertebrae of the spine can be aligned properly by maintaining good posture. Poor posture has been related to both poor health and poor performance. A study found that slouching has an effect on the transverses abdominis muscle. When an individual maintains a slouched pose, the breadth of The transverse abdominis muscle has shrunk substantially[1]. Low back pain has been attributed to intransitive abdominis dysfunction. Low back pain is one of the most common causes of disability worldwide, with an estimated 80% of people suffering from it. It is projected that 80 percent of the population will experience it at some point. Back discomfort costs about $50 billion per year .In the United Arab Emirates, 62 percent of the young population reports suffering from back pain. Back discomfort can be caused by ordinary actions such as hunching over in a chair. Furthermore, a study found that subjects who were asked to sit in a hunched position registered more stress and therefore lower performance. As a result, maintaining good posture and changing positions on a regular basis is considered critical, if not essential, for maintaining good health[2].The Expected outcome is as shown in figure 1.

Figure 1:Expected output

## LITERATURE REVIEW:

The gyro-meter 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[3].

The main objective is to detect the correct or incorrect posture by detecting the changes occurring in human spinal cord movement using sensors i.e., flex sensor. Device also contains the accelerometer sensor to detect the angle of the neck movement of the user[4].

A very first significant attempt at a smart cushion designed with a textile yarn having arrays of piezoelectric sensing devices was presented. This Smart Cushion system designed for sitting posture monitoring uses a re-sampling-based method to calibrate the sensor values to overcome offset, scaling, crosstalk, and rotation effects. The system was developed to verify seven different sitting postures and was having more than 80% accuracy[5].

Young people regularly experience back issues as a result of spending extended periods of time crouched over computers, iPads, and phones. Using computers and smartphones continuously can result in a number of back issues, including neck and low back pain. as well as kyphosis, if no steps are taken to maintain good posture. On top of the vision cameras, several posture monitoring systems are constructed. These devices deliver live images that can be used to check someone's posture evolution. Systems can alert users when their posture is improper by comparing images of the user's present posture with images of the proper posture[6].

The IOT-Based Smart Chair for Posture and Health Monitoring is a cutting-edge solution to enhance ergonomics, posture correction, and health monitoring by leveraging lot and sensor technology[7].

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. Therefore, they 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 [8].

The tilt angle in relation to gravity and linear acceleration is provided by the inertial sensors. Inertial sensors are used by researchers in the fields of V industry, medicine, and aerospace. Inertial sensors are often used because they meet the need for portability[9].

Posture monitoring system based on the knowledge of spine curvature provided by the change of inductance felt by inductor sensors a read out unit collects and transmits the inductance fluctuation data to the computer. The computer analyses the data and categories them based on the collected posture data. The feedback system that informs when poor posture is identified consists of two vibrio feedback sensors. The left or right bend of a posture cannot be detected by the inductance sensors. The spine's curvature can be measured using optical fibre sensors[10].

This project  reviews the status quo of wearable sensing systems for human motion capture and posture recognition from three aspects, which are monitoring indicators, sensors, and system design[11].

Table 1:Literature Review comparison

| S.No | Author(s) | Technique Used | Limitations Identified by Author | Improvement in Our Project |
|---|---|---|---|---|
| 1 | Greeshma Karanth, Niharika Pentapati | Gyrometer, Bluetooth, Arduino, Mobile App | Measures lumbar tilt, but actual tilt occurs in thoracic region; phone-based solution not feasible | Focus on thoracic region tilt; dedicated wearable sensor system avoiding reliance on smartphone placement |
| 2 | T. Kavitha et al. | Flex sensor, Accelerometer, ESP32, Buzzer, Cloud | Limited to neck and spine angle; basic alert system | Expanded coverage with improved sensor placement; IoT-based personalized alerts and real-time analytics |
| 3 | Shreyansh Singh et al. | Piezoelectric textile sensors, Smart cushion, ARM MCU | Cannot identify all correct postures; bulky and not user-friendly | Lightweight wearable form factor with optimized ergonomics and cloud connectivity |
| 4 | Amulya G et al. | Flex sensor, Accelerometer, Arduino UNO, IOT App | Depends on visual comparison; may lack real-time accuracy | Real-time detection with automated feedback; sensor calibration for accuracy |

| | | | | |
|---|---|---|---|---|
| 5 | Arthi M, Dr. J. Savitha | ESP32, Vital sign sensors (HR, BMI, SPO2), Cloud, Web App | Complex multi-functional setup; posture detection may be secondary | Focused, streamlined system for posture with optional health data as an enhancement |
| 6 | Vildana Delić et al. | Accelerometer (Y-axis), LCD Display, Buzzer | Single-axis accelerometer limits posture accuracy | Multi-axis sensor fusion (accelerometer + gyroscope) for comprehensive motion tracking |
| 7 | Wai Yin Wong, Man Sang Wong | 3 Gyroscopes, 3D Accelerometer, Smart garment, Bluetooth | Sensor accuracy depends on placement; garments may be intrusive | Improved wearable form with optimal sensor placement and wireless feedback mechanism |
| 8 | Emilio Sardini et al. | Optical Fiber Sensors, Inductor Sensors, Bluetooth | Sensitive to placement; cannot detect left/right bending | Use of multi-sensor approach to detect multiple types of curvature and misalignment |
| 9 | Xlixin Huang et al. | Multiple wearable sensors (review study) | Theoretical; identifies need for accuracy, comfort, data security | Real-world implementation based on reviewed best practices, with emphasis on comfort, accuracy, and feedback loop |

## Proposed work:

The proposed system is a low-power, smart wearable designed to continuously monitor a user’s spinal posture, detect harmful or poor postures in real time, and provide corrective feedback. In addition to standard posture alerts (vibration and mobile notifications), the system integrates localized heating and cooling elements to enhance muscle relaxation and comfort The develop wearable may be of the form as  shown in  figure 2.

The posture monitoring system uses an Inertial Measurement Unit (IMU) — which includes an accelerometer and a gyroscope — to measure the orientation and movement of the spine. Optionally, flex sensors can be added along the back to measure bending or curvature more precisely.

The raw data from these sensors are combined using sensor fusion techniques  to obtain an accurate estimation of body posture. Then, threshold-based or lightweight machine learning algorithms classify t, sitting straight, slouching, bending).he user’s posture in real time as correct or incorrect .

- Alerts: When poor posture is detected, the system issues immediate haptic feedback (vibration) and optionally sends a mobile notification.
- Heating Effect: For muscles that are tense due to prolonged poor posture, the wearable can activate a low-level heating pad to increase blood flow, relax muscles, and improve flexibility.
- Cooling Effect:For users experiencing inflammation or fatigue, the device can deliver localized cooling to reduce swelling, numb discomfort, and aid post-activity recovery.

Figure 2:Smart Wearable jacket

**METHODOLOGY :**

The proposed system is operates on 3.3V power supply, initially when its turned on after wearing the system will get initialized by the node MCU and the connectivity will be established and checked by sending the handshaking signals between user mobile and our system, once the connectivity is established, the IMU and flex will be functioning and on varying the posture by user more than said minimal timer set the node MCU will get input signals from sensors whose data get compared with restore data set of ideal postures and if the comparison found inappropriate or not accordingly the signal and alert notification for correcting the posture of user is sent on app and displayed as well as the vibrational motor will actuated which make user aware about improper.When the user requires either heating or cooling for relief, the system can be manually activated to provide the desired warm or cold effect for proper comfort and recovery.

## BLOCK DIAGRAM:

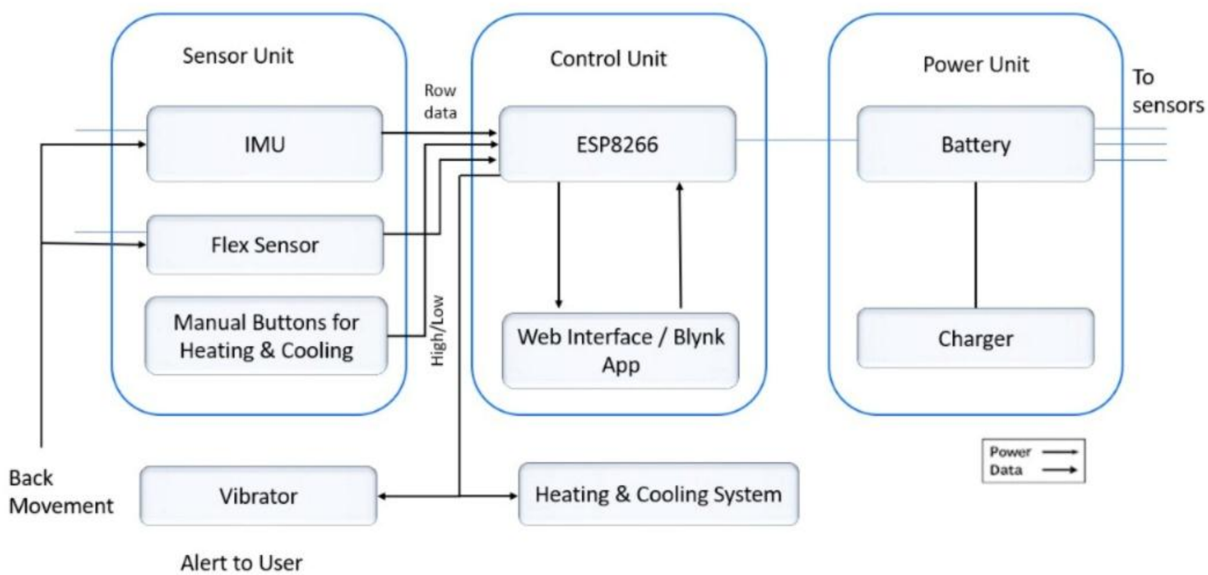


Figure 3:block diagram of IOT based smart wearable posture detected ,Alert & Heating Cooling Therapy system

1. Sensor Unit

This unit senses posture and takes manual input:

- IMU (Inertial Measurement Unit):
  Detects the body's motion or inclination (back movement). It sends raw data to the ESP8266 to check if posture is correct.
- Flex Sensor:
  Measures the bending of the back. When excessive bending is detected, it indicates poor posture.
- Manual Buttons for Heating & Cooling:
  Allow the user to manually select whether heating or cooling is required.

The sensor data (raw data and high/low signals) is sent to the control unit.

2. Control Unit

This is the brain of the system.

- ESP8266 (Wi-Fi Microcontroller):
  It receives posture data from the IMU and flex sensors.
  - If the data indicates bad posture, it activates the vibrator to alert the user.
  - It also manages heating and cooling control based on manual input or automatic logic.
  - Sends posture and temperature status to the Web Interface / Blynk App for monitoring and control.
- Web Interface / Blynk App:
  Displays sensor readings and allows the user to remotely control the heating or cooling system through Wi-Fi.

3. Power Unit

This unit powers the system.

- Battery:
  Supplies power to all components including sensors, control unit, and actuator systems.
- Charger:
  Recharges the battery when connected to external power.

4. Output Units

- Vibrator:
  Activated when wrong posture or excess back movement is detected — gives an alert to the user.
- Heating & Cooling System:
  Controls the temperature as per user input or sensor feedback. It receives commands from the ESP8266.

The system is designed to monitor back movement and posture and provide real-time feedback to the user.

It consists of three main sections: Sensor Unit, Control Unit, and Power Unit.

**Working Principle of the Project**

This wearable system is designed to monitor spinal posture in real-time and provide corrective feedback through vibration alerts and thermal comfort.. It uses a combination of motion sensors, wireless communication, and embedded control logic to detect poor posture and notify the user instantly. The block diagram is as shown in figure 3

- System Initialization

When the device is powered on, the Node MCU microcontroller initializes all connected components.

A calibration phase begins: the user stands still for ~10 seconds, allowing the system to record a reference posture using the IMU (MPU-6050) and Flex Sensor.

- Posture Monitoring

The IMU continuously tracks angular movement along X, Y, and Z axes.

The Flex Sensor detects bending of the spine, especially useful for slouching detection.

These sensors send raw data to the Node MCU, which compares it against the calibrated reference.

- Decision Logic

If the posture deviates beyond a set threshold for a sustained duration:

The system checks whether the flex sensor has bent (slouching) or not (bending).

Based on this logic, it determines whether the posture is incorrect.

- Feedback Mechanism

If poor posture is detected:

The Vibration Motor is activated to alert the user.

A notification is sent wirelessly to the mobile app via the Wi-Fi module.

The OLED Display shows real-time posture status (e.g., “Posture OK” or “Slouch Detected”).

- Thermal Comfort Enhancement

If poor posture persists or the user activates it manually:

The Heating and Cooling module is triggered to provide cooling or heating.

This improves comfort during long wear sessions and encourages posture correction.

A MOSFET or Relay controls the Peltier module based on microcontroller signals.

A heat sink and fan are used to manage thermal dissipation.

- Power Management

The system runs on a 3.7V Li-ion battery, regulated to 3.3V or 5V as needed.

A TP4056 charging module ensures safe recharging.

Power is distributed to all units: sensors, microcontroller, feedback modules, and display.

- User Interface

The mobile app receives posture data via Wi-Fi.

It displays posture history, alerts, and allows manual control of the Peltier module.

The OLED display provides instant feedback on posture and system status.

- Pain Relief and Healing

Heating therapy increases blood flow, tissue metabolism, and nerve conduction, which can reduce muscle spasms and improve flexibility. Cooling therapy, conversely, reduces blood flow, inflammation, and nerve conduction velocity, alleviating pain and swelling.

- Heating for muscle relaxation and increased flexibility Applying heat to muscles can increase blood flow to the area, helping to relax tight or sore muscles. A posture device can use this to provide comfort and reduce pain after long periods of maintaining an incorrect position. In cold environments, heating can also help prevent muscle stiffness.
- Cooling for reducing inflammation and fatigue For individuals who experience pain or inflammation due to prolonged poor posture, localized cooling can reduce swelling and numb the affected area for pain relief. This can also be used to help cool the body after exertion to reduce the risk of muscle soreness.

As far as concerning the need of the project two major parts are very important in this design and those are, controller board with wireless connectivity feature and IMU to give more than 6 degree of freedom(DOF) data to process the position of the user in different conditions of movement. Thus we used Node MCU as our central control board and MPU 6050IMU unit for angular data measurement and positional data measures, also we fixing the flex sensor to measure the spine moment for achieving more correct and accurate response to raise an alert signal and make and corrective actionable decision before making and alert via notification and vibration motor. The system needs 3.7V power to operate. Additional requirement for implantation of this device is the access to the electronic testing platforms like, CRO setup and multi-meters for carry out testing and troubleshooting work. Soldering desk with solder Iron and solder gun is needed as a part of major working kits for fixing the assembly wires. For software part we just need a laptop enabled with internet and Arduino IDE installed onto it, with suitable library files accessible for handling

IOT Operation

**FLOWCHART:**

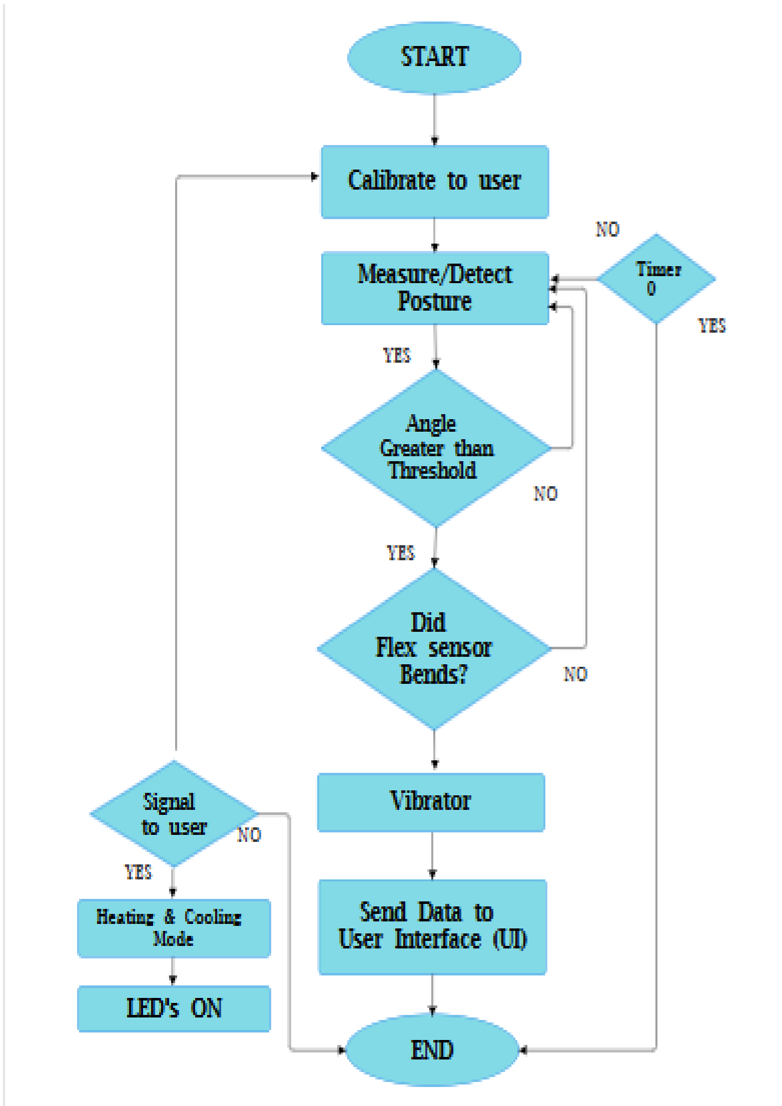


Figure 4:flow chart of IOT based smart wearable posture detected ,Alert &Heating Cooling therapy alert system.

**WORKS SUMMARY**

Data Acquisition: Sensors in the wearable device capture real-time physiological data related to the user's posture.

1. Data Transmission: The microcontroller sends this data wirelessly to a connected mobile device or directly to a cloud platform.
2. Data Analysis: Algorithms analyze the data to detect patterns of incorrect posture, such as prolonged static asymmetry or forward head posture.
3. Alert Generation: When an improper posture is detected, the system generates an alert to the user.
4. Feedback and Correction: Users receive feedback through visual warnings, vibrations, or auditory cues to encourage posture correction.
5. Long-Term Monitoring and Improvement: Cloud integration enables remote access to data, facilitating long-term tracking of posture habits and providing personalized recommendations for better posture and overall well-being

## HARDWARE AND SOFTWARE REQUIRMENTS:

1. Node MCU
2. ESP8266 Microcontroller with WI-FI
3. MUP-6050 IMU
4. Flex Sensor
5. Vibration Motor
6. Peltier Thermoelectric Module
7. Battery (Li-ion 3.7V)
8. Charging Module (TP4056)
9. Voltage Regulator
10. Mobile App(UI)
11. Connecting Wires,PCB/Breadboard .

## SOFTWARES:

1. ARDUINO IDE (for programming NodeMCU)
2. Mobile App(custom or Blynk)

## ADVANTAGES:

1. . Real-Time Posture Monitoring
   - Continuously tracks spinal alignment using IMU and flex sensors.
   - Immediate detection of poor posture helps prevent long-term musculoskeletal issues.
2. Instant Feedback Mechanism
   - Vibration motor alerts the user instantly when posture deviates.
   - Encourages active correction without relying on external reminders.
3. Thermal Comfort via Peltier Module
   - Provides heating or cooling based on posture duration or user input.
   - Enhances comfort during long wear, especially in varying climates.
   - Makes the wearable more user-friendly and appealing for daily use.
4. Wireless Communication (IoT Integration)
   - Sends posture data to a mobile app via Wi-Fi.
   - Enables remote monitoring, logging, and analysis of posture trends.

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