

IoT Based Smart Posture Correction Chair and Health Monitoring System

N. Muthamilselvi¹, Akhalya R², Bowiyadharshini B³, & Haripriya G⁴

¹Assistant Professor, Department of Bio Medical Engineering, Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

^{2,3,4}UG Student, Department of Bio Medical Engineering, Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu

Abstract: This project presents a system for monitoring posture health that evaluates and keeps track of significant health parameters using advanced sensors integrated with IoT (Internet of Things) technology. The posture health monitoring system observes an individual's posture and health metrics to provide real-time insights into their well-being. It incorporates a variety of sophisticated sensors, including MEMS, force sensors, temperature sensors, and position motors, which work together to monitor a person's posture and associated health indicators. An onboard power supply ensures a consistent voltage level, while the IoT module facilitates remote health monitoring through IoT-enabled applications. Health and posture alerts are delivered audibly through buzzers and visually via LCD screens. The position motor also assists in aligning the person's posture correctly. This system would benefit patients with posture-related health issues, individuals recovering from injuries, and those requiring continuous health monitoring. The posture health monitoring system embodies a comprehensive and forward-thinking approach to healthcare, utilizing real-time health status updates, data storage, and alerts to create thorough, timely health records. The goal of healthy outcome informatics is to improve quality of life more rapidly through early intervention.

Key Words: *IoT technology, MEMS sensor, force sensor, temperature sensor, position motor, alert system, LCD, buzzer*

1.INTRODUCTION

A revolutionary system designed for health and posture monitoring through IoT technology marks a significant leap forward in tackling health issues related to posture, utilizing wearable sensors, sophisticated data analysis, artificial intelligence (AI), and cloud connectivity. As desk jobs, smartphone usage, and sedentary lifestyles become more

prevalent, concerns regarding body posture and associated health issues—particularly musculoskeletal disorders that may lead to chronic pain and spinal problems—are on the rise. This posture monitoring solution leverages IoT technology with an assortment of accurate sensors, such as accelerometers, gyroscopes, pressure sensors, and electromyography (EMG) sensors, to observe movements, body alignments, muscle tension, and spinal well-being. A microcontroller unit (MCU) processes the information collected through enhanced signal conditioning before transmitting it to a mobile or web application via Wi-Fi, Bluetooth, or cloud-based IoT platforms. This functionality enables users to receive immediate feedback, visual representations of data, and alerts regarding necessary posture adjustments. Furthermore, users can analyse their activity and posture patterns using various algorithms integrated into cloud analytics. Over time, this monitoring system and the data it accumulates can support the development of tailored strategies for recognizing posture-related behaviours. In addition to groundbreaking methods for improving posture, the device can monitor a range of health metrics related to overall wellness, such as heart rate, respiratory frequency, muscle fatigue, and levels of physical activity. Users will be alerted about poor posture and forward head positioning, potentially helping to prevent injuries associated with improper postural practices. Physiotherapists may conduct remote assessments to evaluate patients' posture during treatment sessions. Older adults could experience enhanced mobility and receive warnings about potential falls. Athletes and fitness enthusiasts can gain more profound insights into their body alignment and positioning, consequently reducing their risk of

injury. However, several obstacles persist, including ensuring sensor accuracy, improving user comfort, extending battery life, and managing cloud data from wearable devices. Addressing these challenges will be essential as this technology evolves. With advancements in AI-driven predictive analytics, smart home devices, sustainable materials for wearables, and enhanced user comfort, there is significant potential for future improvements. As AI and IoT technologies advance, intelligent systems for posture and health monitoring are expected to become vital in our society, fostering a healthier, more efficient, and ergonomically aware community.

2.EXISTING SYSTEM:

Hospitals use various equipment to support patient health, but high patient volume can make assessing vital signs time-consuming. To address this, we aim to develop an intelligent chair that automatically detects vital signs when occupied. The data is instantly displayed on the chair's built-in screen or a connected Android device.

DISADVANTAGES:

- **Data Security and Privacy Risks**
One of the most significant concerns in IoT-based health monitoring is data security and privacy protection. Since patient health data is transmitted over the internet and stored in cloud servers, it is vulnerable to cyber-attacks, hacking, and unauthorized access. Without strong encryption and security protocols, sensitive medical information can be

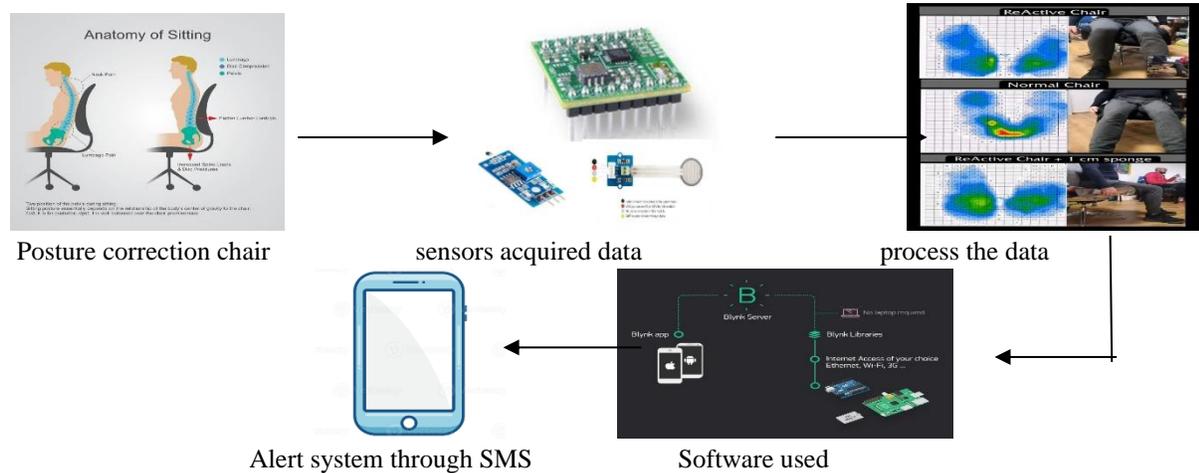
exposed, leading to privacy violations.

- **High Implementation and Maintenance Costs**
Deploying an IoT-enabled health monitoring system requires specialized sensors, cloud storage, high-speed internet connectivity, and data analytics infrastructure, which can be expensive. Additionally, regular maintenance, software updates, and sensor calibration add to the overall cost, making it less affordable for some healthcare institutions and individuals.

3.PROPOSED SYSTEM:

The system powers all components, guaranteeing that each device runs consistently and reliably. The MEMS Sensor monitors body posture by detecting changes in position and orientation angles, detecting deviations from the ideal posture. The Force Sensor gauges the pressure applied to the seat, detecting posture misalignment and prolonged sitting. The Temperature Sensor monitors body temperature for two reasons: 1. To oversee health conditions and 2. To alert users about increased temperature levels and evaluate any potential risks. When suboptimal posture or abnormal health events are detected, the buzzer sounds to inform the user. The LCD presents posture and monitored health metrics like body temperature and weight distribution or applied force. The IoT module facilitates remote data monitoring by uploading it to an application, enabling interaction with caregivers or healthcare providers in real time. The Actuator Motor adjusts the user's seating posture according to corrections recommended by the sensors, encouraging proper alignment and comfort.

FLOW DIAGRAM



ADVANTAGES OF PROPOSED SYSTEM:

- Real-Time Health Monitoring and Early Detection:

IoT devices continuously monitor vital signs such as heart rate, body temperature, blood pressure, and oxygen saturation, enabling early detection of health problems. Real-time monitoring assists in diagnosing potential health issues before they become life-threatening, lowering the chances of emergencies.

- Remote Patient Monitoring (RPM):

These systems allow healthcare professionals to monitor patients from remote locations, minimizing regular visits to hospitals. This is especially useful for geriatric patients, those with chronic illnesses, and post-operative patients, ensuring continuous care at home.

4.METHODOLOGY

The development of the IoT-based Smart Posture Correction Chair and Health Monitoring System was carried out through a systematic methodology that

integrates both hardware and software components to deliver real-time feedback and health monitoring. The methodology adopted is described below in sequential stages:

4.1 SYSTEM DESIGN AND PLANNING

The initial phase involved a thorough study of the ergonomic and health challenges frequently faced by IT professionals due to prolonged sitting. Based on this analysis, a detailed system framework was proposed, incorporating essential modules such as posture detection, temperature monitoring, seat occupancy sensing, and alert generation.

To visualize the system flow, a functional block diagram was created, illustrating the connection between sensors, the processing unit, and the output interfaces. The system was built using a low-power microcontroller with integrated Wi-Fi support, enabling IoT-based real-time data transmission and alert notifications.

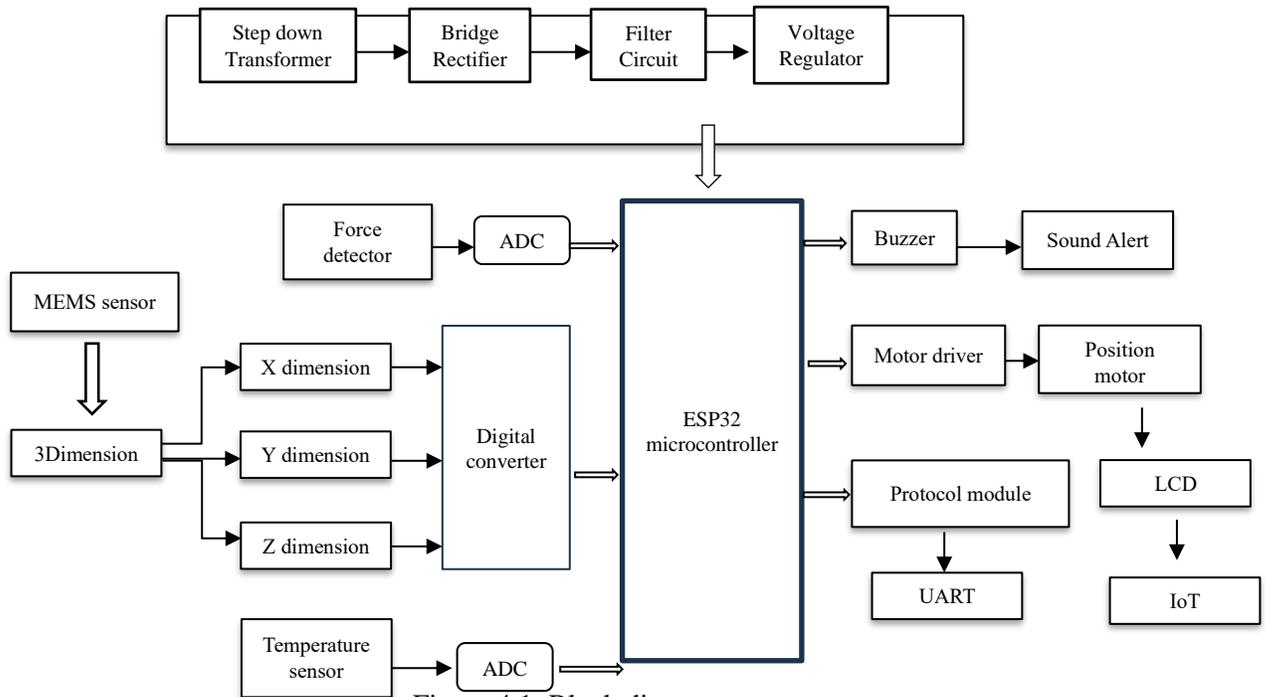


Figure 4.1: Block diagram

4.2. HARDWARE COMPONENTS:

4.2.1. ESP32 MICROCONTROLLER:

The ESP32 family of low-cost, low-power system-on-a-chip microcontrollers has dual-mode Bluetooth and Wi-Fi. The ESP32 family includes integrated antenna switches, RF baluns, power amplifiers, low-noise

receiver amplifiers, filters, and power-management modules. It utilizes a single-core RISC-V microprocessor, a dual-core Xtensa LX7 microprocessor, or a dual-core Tens ilia Xtensa LX6 CPU. Using TSMC's 40 nm technology, the Chinese company Espresso Systems, based in Shanghai,

created and produced the ESP32. It is an alternative to the microcontroller ESP8266.



Figure 4.2.1: ESP32 MICROCONTROLLER

4.2.2.MEMS

The low-power, three-axis angular rate sensor A3G4250D may offer previously unheard-of stability at the zero-rate level in addition to sensitivity throughout temperature and time. The observed angle rate may be transmitted to the outside world using an I²C-compatible interface or a standard SPI digital interface thanks to the device's IC interface and sensing element. STMicroelectronics uses a specific micro-machining process to create inertial sensors and actuators on silicon wafers.

A customized circuit that is trimmed to more closely resemble the characteristics of the sensing device may be built thanks to the high degree of integration made possible by the CMOS technology used to manufacture the IC interface.



Figure 4.2.2: MEMS SENSOR

4.2.3. TEMPERATURE SENSOR

The first slave was communicated with using an LM35 temperature sensor. As a result, the engine's temperature is ascertained and its level is provided. The temperature in Celsius has a linear relationship with the output voltage of the LM35 series precision integrated-circuit temperature sensors. Because it enables straightforward Centigrade scaling without needing the user to subtract a sizable amount of constant voltage from its output, the LM35 offers an advantage over linear temperature sensors with Kelvin calibration.



Figure 4.2.3: LM35

The LM35 can achieve an average accuracy of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 3/4^{\circ}$ over the whole -55 to $+150^{\circ}\text{C}$ range without further trimming or calibration. The LM35's linear output, low output impedance, and precise internal calibration make it very easy to connect with control or readout circuitry. It is possible to employ a variety of power sources or just one. Self-heating occurs outdoors at less than 0.1°C since it only uses 60 μA from its supply. The temperature ranges in which the LM35 and LM35C function are -55° to $+150^{\circ}\text{C}$ and -40° to $+110^{\circ}\text{C}$ (or, more precisely, -10°).

4.2.4. FORCE SENSOR:

A substance that alters resistance in response to pressure or force is known as a force-sensing resistor. "Force-sensitive resistor" is another name for them, and the abbreviation "FSR" is also occasionally used. Note that Interlink Electronics, Inc. is the owner of the trademark "FSR".

The conductive polymer used to make force-sensing resistors changes resistance linearly when force is applied to its surface. Usually, they come as a polymer sheet or screen-printing ink. Both electrically conducting and non-conducting particles are scattered throughout the matrix that makes up the sensing film. The sub-micrometer-sized particles are intended to improve mechanical qualities, increase surface durability, and reduce temperature dependency.

Particles come into touch with conducting electrodes when a force is applied to the sensing film surface, changing the film's resistance. Force-sensing resistors, like other resistive-based sensors, need a very straightforward interface and are capable of operating effectively in challenging environments. The advantages of FSRs over conventional force sensors are their inexpensive cost, superior shock resistance, and compactness (typically less than 0.5 mm in thickness). Their poor precision is a drawback; measurement readings might differ by 10% or more.



Figure 4.2.4: FORCE SENSOR

4.2.5. BUZZER

A buzzer, commonly referred to as a beeper, is a type of signaling device. The term "buzzer" originates from the harsh sound produced by buzzers, which were electromechanical devices operated by low voltage AC line current at 50 or 60 cycles. Beeping and ringing are two prevalent sounds utilized to signify that a button has been activated. In this inventive buzzer circuit, a speaker, a relay, and a small audio transformer are all connected in sequence. When the switch is enabled, the relay will operate through the primary of the transformer and the closed relay contact. As the relay operates, the normally closed contact will open, cutting off the power to the relay. The cycle quickly resets when the connections are interrupted. fast enough that the current pulse induces variations in both the primary and secondary of the transformer. Consequently, the speaker's tone defines the relay's operating frequency. One method to "tune" the tone is by using Capacitor C. As capacitance increases, the buzzer tone diminishes; 0.001uF is the standard value.



Figure 4.2.5: BUZZER

4.2.6. MOTOR DRIVER:

The L293D H-bridge driver is the most widely used driver for bidirectional motor driving applications. This L293D IC allows the DC motor to run in both directions. Two DC motors may be operated concurrently in either direction with the 16-pin IC L293D. Given that it features two H-Bridge circuits, it suggests that a single L293D IC may power two DC motors. The L293D can provide gentle power to both

tiny and big motors. Two examples of H-bridge motor control circuit construction techniques that include relays, transistors, and other parts are L293D and L298.



Figure 4.2.6: MOTOR DRIVER

4.2.7. LCD DISPLAY:

In the proposed IoT-based Smart Posture Correction Chair and Health Monitoring System, an interactive data visualization component is a 16x2 Liquid Crystal Display (LCD) with an I2C interface. LCD is used as an embedded system user interface to display the ergonomic and physiological data that is required. With two lines of sixteen characters each, the module is well suited to show short but relevant messages such as temperature readings, real-time heart rate readings, posture status (e.g., "Correct Posture" or "Slouch Detected"), and user-specific alerts or reminders.

The LCD's hardware interface is kept as simple as possible by including an I2C (Inter-Integrated Circuit) module. I2C-based LCDs only need two lines—Serial Data (SDA) and Serial Clock (SCL)—instead of the several digital pins used in traditional parallel communication. This saves I/O pins for other actuators and sensors in the system. The screen uses the HD44780 LCD controller, which is compatible with most microcontrollers, including the Arduino Uno used in this project, and runs at the standard 5V logic voltage.

The microprocessor, which receives inputs from posture-sensing sensors (like pressure or flex sensors) and physiological sensors (like temperature and heart rate sensors), continually updates the data on the LCD. Every time the system notices aberrant health readings or poor posture; it sends out alarm messages on the LCD so the user may take immediate corrective action. This method offers a direct and integrated type of feedback without the need for further computer-based or mobile interfaces.

4.3. SOFTWARE DESCRIPTION:

4.3.1. ARDUINO IDE

A variety of sensors, such as temperature, heart rate, and flex or pressure sensors (posture sensing), provide data to the Arduino Uno, the board's master controller, which is powered by the ATmega328P microcontroller, which is clocked at 16 MHz and features six analog input lines, fourteen digital I/O pins, and 32 KB of flash memory for firmware storage and real-time monitoring. Due to its principal processing function, the Arduino Uno is utilized in the planned Internet of Things-based Smart Posture Correction Chair and Health Monitoring System. The Arduino Uno decodes each of these inputs to ascertain the user's seating position and physiological condition. It alerts the user to abnormal values or bad posture by buzzing or displaying warning messages on the LCD screen using logic and predefined criteria.

Additionally, Arduino may use digital I/O pins, UART, or I2C to connect to external peripherals, depending on the device being used. Arduino's modular pin structure and simple hardware design make it ideal for quickly assembling and integrating several parts into an ergonomic observation platform, such as the one that was intended. Second, because of its exceptional interoperability with a large variety of sensors and modules, the open-source Arduino platform greatly increases the system's scalability.

4.3.2. BLYNK APP

IoT Blynk was affected by the Internet of Things. Its applications include data storage, sensor data presentation, remote equipment control, and data visualization.

The Blynk Server manages all of the communication between the hardware and the smartphone. You may use our Blynk Cloud or run your own private Blynk server locally. It is open-source, easily extensible to thousands of devices, and can be started on a Raspberry Pi.

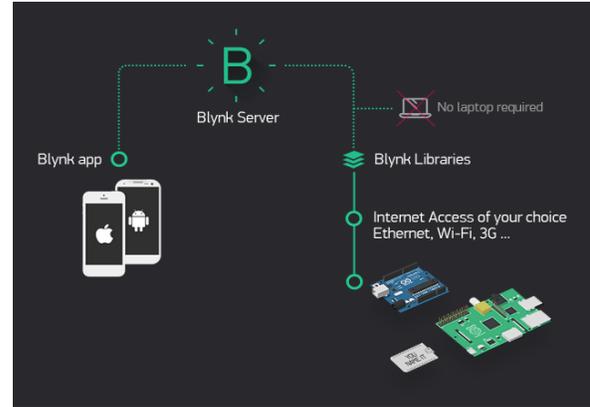


Figure 4.3.2: Blynk app

5.CONCLUSION

The incorporation of IoT-driven health monitoring systems has greatly changed today's healthcare environment, allowing for real-time patient observation, remote oversight, and decisions based on data. These systems deploy wearable sensors and intelligent medical devices to regularly gather and assess essential health information, enabling early detection, preventive measures, and better patient results. By reducing the need for regular visits to the clinic, IoT-based monitoring not only enhances patients' peace of mind but also contributes to lowering the workload on healthcare professionals.

6.RESULT



Figure 6.1

LCD display Showing system Startup Message



Figure 6.2

Mobile App Interface Showing Real-Time Monitoring



Figure 6.3

Displaying abnormal sitting position on LCD

Figure 6.1: During the hardware initialization phase, the LCD screen shows the message “SMART

POSTURE HEALTH MONITOR,” indicating that the system has been successfully powered on and is ready for use. This message confirms proper communication between the microcontroller and the connected sensors, ensuring the system is prepared to monitor posture data accurately.

Figure 6.2:

The IoT-enabled smart posture correction and health monitoring system underwent successful testing. As illustrated in the mobile application interface (Figure 1), the system effectively identified human presence with a sensor reading of 500 and tracked body temperature, which registered at 40°C. Real-time data visualization was implemented through gauge displays, and a built-in alert mechanism was activated

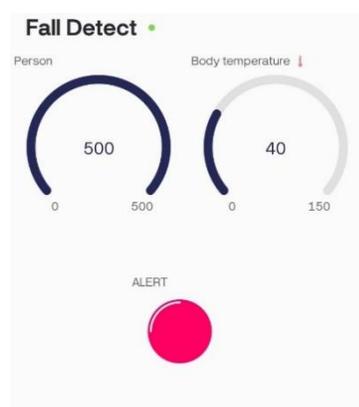


Figure 6.4

Fall detection interface with real-time alert.

Figure 6.4

The output interface of the fall detection system displays real-time information such as the number of individuals detected and their body temperature. In this scenario, the system detected a value of 500 under "Person" and recorded a body temperature of 40°C, which immediately activated an alert notification. This highlights the system’s capability to track vital parameters and respond swiftly to possible emergency situations.

Figure 6.5

Displays the notification panel from the system’s interface. Multiple alerts are shown, indicating that the sitting position is abnormal. These repeated notifications confirm the system’s continuous monitoring and real-time feedback feature. It helps users take immediate corrective actions to maintain a proper posture, reducing the risk of posture-related health issues.

for abnormal posture or temperature conditions. During evaluation, the system consistently delivered accurate and dependable feedback for both posture assessment and health status monitoring.

Figure 6.3:

During the hardware implementation phase, the system accurately detected incorrect sitting posture. As illustrated in this figure, the LCD screen displays the message “SIT POSITION IS ABNORMAL,” demonstrating the system’s ability to monitor posture in real time and trigger alerts. This verifies the effective coordination between the sensor and microcontroller in identifying user posture deviations reliably.

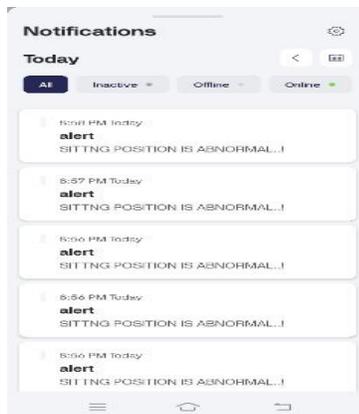


Figure 6.5

Notification alerts for abnormal sitting posture detection

Figure 6.6

Shows a pop-up notification from the Blynk application, triggered under the Fall Detect module. The alert message highlights that the sitting position is abnormal, indicating that the posture monitoring system has successfully detected and communicated a deviation from the correct sitting posture. This real-time alert function enhances user awareness and encourages immediate correction.

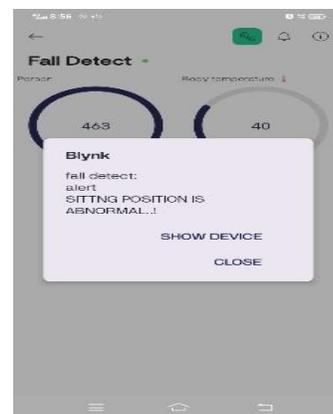


Figure 6.6

Blynk alert pop-up for abnormal sitting position detection

REFERENCE

- [1] M. M. Baig, H. Gholam Hosseini, and M. J. Connolly, “A comprehensive survey of wearable and wireless ECG monitoring systems for older adults,” *Medical & Biological Engineering & Computing*, vol. 51, no. 5, pp. 485–495, 2013.
- [2] S. Patel, H. Park, P. Bonato, L. Chan, and M.

- Rodgers, “A review of wearable sensors and systems with application in rehabilitation,” *Journal of Neuro Engineering and Rehabilitation*, vol. 9, no. 21, pp. 1–17, 2012.
- [3] K. Das, S. Feudally, and D. He, “Taxonomy and analysis of security protocols for Internet of Things,” *Future Generation Computer Systems*, vol. 89, pp. 110–125, 2018.
- [4] G. Fortino, P. Messina, W. Russo, and C. Savaglio, “Edge computing and social Internet of Things for future smart healthcare,” *Computer Communications*, vol. 153, pp. 244–256, 2020.
- [5] M. Chen, Y. Ma, J. Song, C. Lai, and B. Hu, “Smart clothing: Connecting human with clouds and big data for sustainable health monitoring,” *Mobile Networks and Applications*, vol. 21, no. 5, pp. 825–845, 2016