ISSN No:-2456-2165

Patient Health and Environment Monitoring System

B. Alex
School of Electrical and Electronics,
Lovely Professional University Punjab,India

Abstract:- In today's digital and fast paced world, the intersection of Digital technology and Health care is crucial for the development of various innovative health care systems. The convergence of healthcare and environment monitoring has created a whole new chapter for comprehensive assessment of the patient. This paper introduces a novel and innovative device that seamlessly amalgamates patient health data with real time environment data. The device is triggered by a ultrasonic sensor for effortless present selection. The device incorporates state of the art sensors, that includes Max30102 Heart rate sensor,MLX 90614 body temperature sensor, DHT11 for monitoring temperature and humidity, BMP180 pressure sensor, with NodeMCU microcontroller as its core component. This paper presents the architecture, implementation, and outcomes of the PHES and also highlights its potential to reshape the health care practices. The biomedical data that is obtained from the device is transmitted to the cloud in realtime. The "Blynk" cloud platform is utilized to monitor and store the information. In this way the paramedical staff/specialist can analyze and monitor the data anywhere as long as they have access to the cloud platform.

Keywords:- *Internet of Things(IOT), Nodemcu, Blynk.*

I. INTRODUCTION

The idea of modern health care is changing as we move more deeper into the digital world. The fusion of advanced technologies in the healthcare sector ignited a need for continuous monitoring that transcends the conventional clinical boundaries. This paper introduces the "PATEINT HEATLH MONITORING SYSTEM"(PHES), an innovative system that seamlessly monitors the individual health with real-time environmental sensing ability, guided by an ultrasonic sensor for wireless preset selection. This integration offers a holistic view of health determinants by allowing users to select specific parameters in real-life.

PHES harnesses a collection of state of art sensors, orchestrated by the NodeMcu microcontroller to capture the patient health and environment information. The inclusion of DHT11 sensor empowers PHES to monitor room temperature and humidity, which are the pivotal factors that effects the patient comfort and physiological balance. Moreover, the BMP180 pressure sensor helps to calculate the atmospheric pressure, which can subtly impact the physiological responses. The addition of the ultrasonic sensor provides an effortless interface for users to select different presets based on hand gestures in specified ranges, allowing for dynamic parameter display.

According to the Medical council of India(MCI), India boasts of impressive roster of 10.4 lakh registered medical specialists. However, 80% of them are involved in acute patient care. This indicates that there are around 8.32 lakh specialists available to provide hands-on assistance to patients[10].In contrast, the world health organization's recommended standard of 1:1000 doctor- patient reality for India is far away. Current ratio of 1:1568 illustrates the immense pressure on existing medical staff. Addressing these disparities and challenges requires innovative solutions that transcends traditional boundaries. Patient health and monitoring system(PHES) seeks to harness the power of Iot technology and empower both patients and health care professionals[12]. PHES strives to revolutionize healthcare practices and facilitate informed decision making. This paper explores the architecture, implementation, and initial outcome of PHES, demonstrating its capacity to address the multifaceted challenges plaguing healthcare system in India[10].

II. LITERATURE REVIEW

The Internet of Things(Iot) has ushered in a new era of possibilities in a variety of fields, with health care being the leading area of discovery. Wireless monitoring systems have become a central part of healthcare IoT applications. A proposed system, presented in [1], emphasizes wireless communication and mobility, connecting with smart devices to facilitate seamless data exchange. The system leverages an Android app to collect raw data, which is then analyzed to ensure patient well-being. Notably, age-based heart rate analysis is being used to detect cardiac abnormalities, highlighting the potential for IoT-enabled health diagnostics.

Continuing to expand in scope, other studies are exploring alternative technologies for wireless healthcare systems. The Raspberry Pi-3 and Arduino boards act as gateways, connecting real-time data acquisition to the cloud, as shown in [2] and [5]. These platforms demonstrate the versatility of IoT in healthcare, where a variety of hardware can be integrated for wireless data transmission and remote monitoring. The complexity of health monitoring is solved by wearable devices, as documented by [8] and [9]. This work highlights the non-invasive nature of smartwatches, showing how built-in sensors and firmware integration can enable continuous health monitoring. These examples highlight the complex balance between hardware and software to achieve effective IoT-based healthcare solutions.

This paper navigates the technical complexity of PHES, demonstrating its sensor fusion, data processing, and communication protocols. By seamlessly integrating health and environmental information with user-guided controls, PHES aims to clarify the correlation between individual health and external factors. This broadens the mindset of the people for personalized health interventions and lifestyle optimizations. The resulting data from the PHES empowers the individual to make rational choices about their health and environment. This convergence is extremely important, especially in countries like India, where the health care sector is struggling with a growing imbalance between the lack of medical expertise and availability of medical professionals.

➢ *Proposed Desgin*

The Patient Health and Environment System (PHES) represents a new approach to integrated healthcare and environmental monitoring, powered by Internet of Things (IoT) technologies. This design includes a complete system architecture that seamlessly combines sensor data collection, wireless communication, and real-time data analysis. The proposed design is based on smart devices for wireless communication, intuitive control through ultrasonic sensors and data visualization on a cloud platform "Blynk". The following sections detail the components and interactions of the PHES.

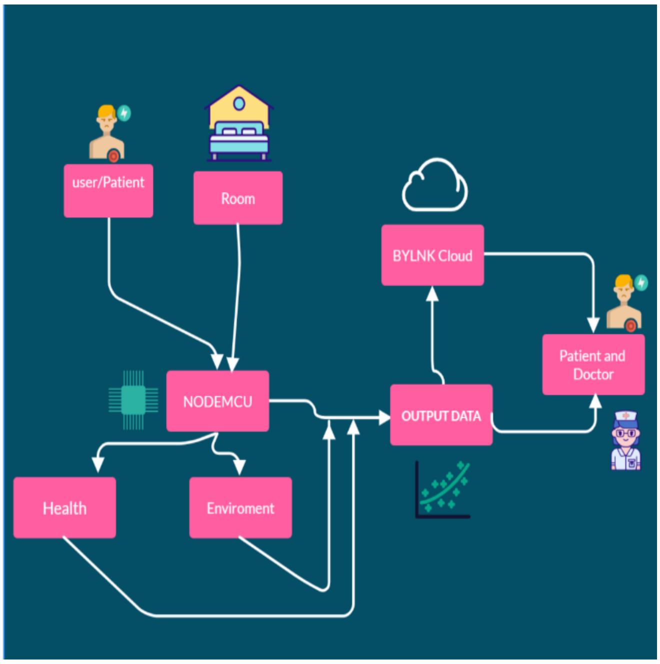

Fig 1 Block Diagram

Figure 1 shows the Block diagram of the proposed design.

- *Ultrasonic Sensor: -*

The ultrasonic sensor acts as an intuitive control interface, allowing users to select specific health and Environment parameter presets through hand gestures. This sensor initiates parameter changes and triggers data collection based on user interaction. The presets are selected based on hand movement at a specific distance from the ultrasonic sensor. Upon the waving the hand in a certain range, the desired present is selected.

Table 1 Ultrasonic Sensor

Distance(cm)	**Preset**
30-25	Room Temperature
25-20	Room humidity
20-15	Room pressure
15-7	Heart rate
7-0	Body Temperature

- *16x2 Lcd Display*

The Lcd display provides visual feedback by presenting health and environmental parameters. It provides a convenient real-time display for users and healthcare professionals.

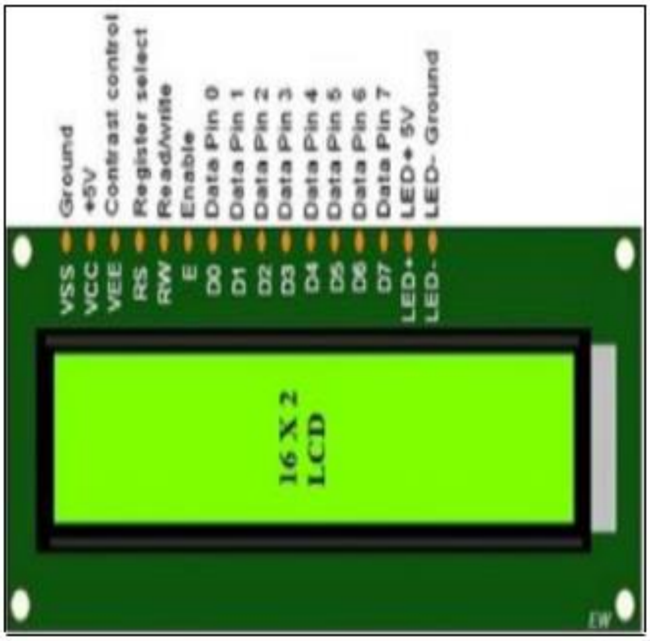

Fig 1 16x2 Lcd Display*I2C Module*

As the LCD display does not support I2C communication and NodeMCU is limited with data pins, we use the I2C module that acts as a bridge between the NodeMCU microcontroller and the 16x2 LCD, supporting communication and data display on the LCD.

Fig 2 I2c Module

- *Dht11 Sensor*

The DHT11 sensor measures temperature and humidity through a humidity-sensitive capacitor and temperature sensing element. The humidity-sensitive capacitor changes its capacitance (C) as humidity changes, causing changes in the time it takes to charge and discharge. The sensor measures this time and converts it to relative humidity.

$$\text{Relative humidity(Rh)} = (C - C_{min}) / (C_{max} - C_{min}) * 100$$

To measure temperature, the sensor uses a thermistor to measure the ambient temperature. The sensor converts the resistance value of the thermistor into a digital temperature reading. The relationship between the resistance of the thermistor (R) and the temperature (T) can be described using the Steinhart-Hart equation:

$$1/T = A + B * \ln(R) + C * (\ln(R))^3$$

Where T is the temperature in kelvin and is converted into Celsius, R is the resistance of the thermistor, and A,B,C are coefficients specific to thermistor's characteristics.

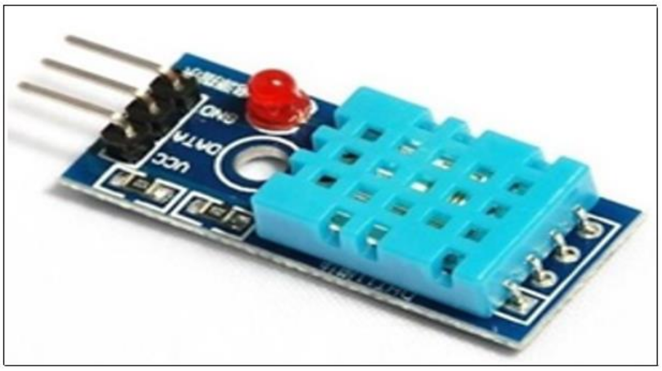

Fig 3 Dht11 Sensor

So when the user waves the hand in range of 30 to 25 cm , Room temperature is selected and in range of 25 to 20 cm Room humidity is selected. When the respective preset is selected by the user, the PHES monitors the data in real time and seamlessly uploads the data to the Blynk cloud.

- *Bmp180 Pressure Sensor*

The BMP180 sensor uses a piezoelectric mechanism to measure barometric pressure. This mechanism is based on the deformation of the silicon diaphragm under the action of applied pressure. This distortion causes changes in the resistance of the integrated piezoelectric elements. The BMP180 sensor measures the difference between the applied barometric pressure and the internal reference pressure. This pressure difference is then converted to a digital value by an analog-to-digital converter (ADC).

$$\Delta P = D / 2^n * S - OFF$$

Where n is the number of bits, S is a scale factor, OFF is a offset. Once the pressure difference is calculated, it is added to the reference pressure to obtain actual atmospheric pressure (p).

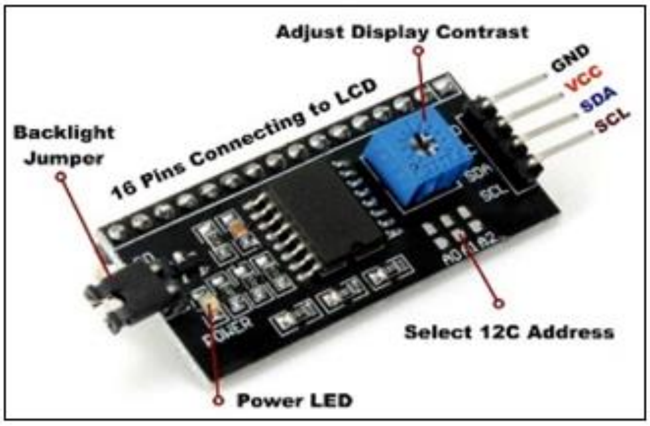

Fig 4 Bmp180 Pressure Sensor

So when the user waves the hand in the of range 20 to 15 cm, Room pressure is displayed on LCD. when selected the PHES monitors the pressure in real time and send to the data to the cloud.

- *Max30102 Heart Rate Sensor*

The MAX30102 sensor uses a process called photoplethysmography (PPG) to measure heart rate. PPG involves shining light, usually green or red, into the skin and detecting the amount of reflected light. The Changes in blood volume as blood flows through the arteries cause changes in the intensity of the reflected light. The sensor consists of a LED and a photodetector that measures the intensity of light transmitted or reflected through the skin. The blood absorbs light, and the amount of light absorbed varies with the change in blood volume due to the cardiac cycle. The sensor uses two LEDs of different wavelengths (usually red and infrared) to calculate the effects of skin pigmentation and improve accuracy. The red and infrared light signals are then compared to extract the pulsatile component.

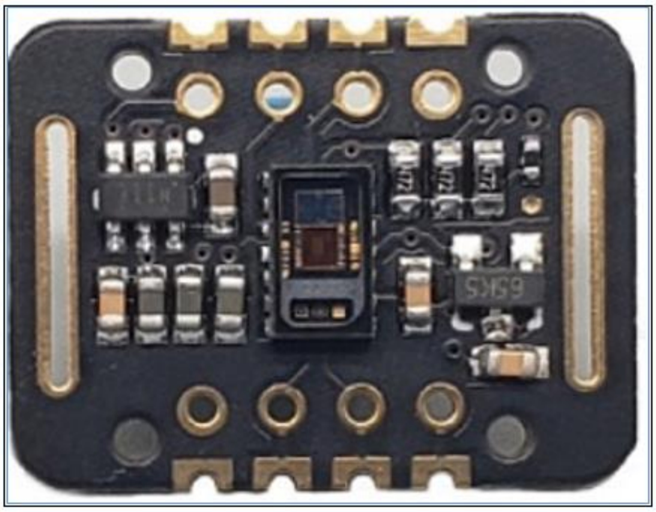

Fig 5 Max30102 Heart Rate Sensor

The calculation involves measuring the time between successive peaks of the pulsatile component of the photoplethys mography and this is typically done using a peak detecting algorithm. In the PHES, when the user waves the hand in the range of 15-7cm, the Node MCU communicates with Max30102 sensor, collects the PPG data, performs the peak detection and heart rate calculation and then provides real time heart rate readings

- *Mlx90614 Infrared Temperature Sensor*

The MLX90614 sensor uses two infrared sensors, one to measure the temperature of the measured object (object temperature) and another to measure the ambient temperature. These sensors detect thermal radiation emitted by the object and its surroundings. The sensor calculates the temperature difference between the object and its surroundings. This temperature difference is then added to the ambient temperature to get the temperature of the object.

$$Tobj = Ta + \alpha * (To - Vobj)$$

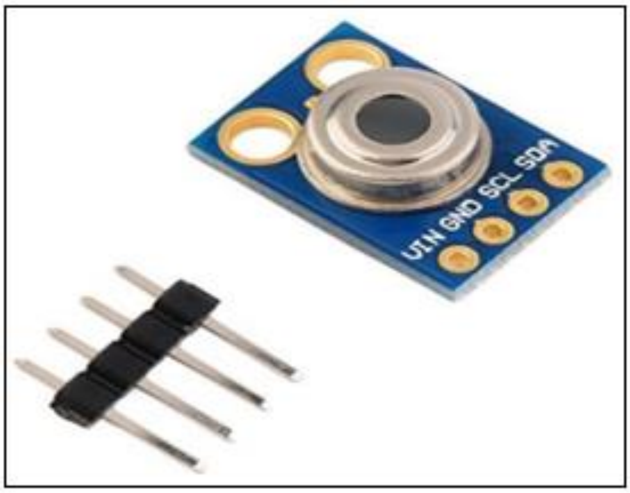

Fig 6 Mlx90614 Infrared Temperature Sensor

Where Tobj is object temperature or Body temperature, Ta is ambient temperature, α is the calibration constant, To is the raw output of the IR sensor for the object temperature and Vobj is the voltage corresponding to the object temperature.

- *Circuit Connection:-*

The NodeMCU can output only 3.3v and can only take input of 5v either through USB or Vin pin.

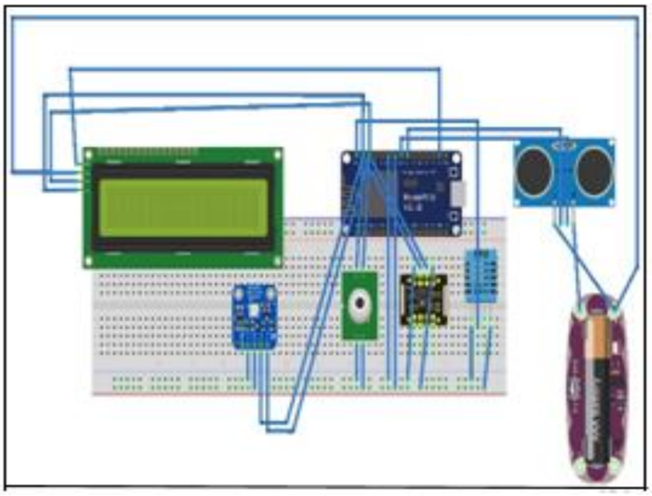

Fig 7 Bread Board Connections

The BMP180 sensor, MAX30102 heartrate sensor, MLX90614 Temperature sensor, requires 3.3 volts for operation and I2C bus line for data communication. So they are connected to 3.3v output pin of NodeMCU and the SCL,SDA pins of sensors are connected to the respective SCL(D1),SDA(D2) pins of NodeMCU.

As there are less number of Data pins in NodeMCU and LCD display requires 5v for operation, the LCD display is connected to I2c module and then connected to SCL, SDA pins of NodeMCU with 5v power supply. Similarly the Ultrasonic sensor is connected to the 5v power supply and the trigger, echo pins are connected to D6, D5 pins respectively.

The data pin of DHT11 sensor is connected to D0 pin of NodeMCU with 3.3v power supply coming from NodeMCU.

III. IMPLEMENTATION AND RESULT

All the components are soldered on a General purpose PCB. When the user waves the hand in front of the ultrasonic sensor in range of 30cm to 25cm, The system start monitoring Room temperature as shown in Figure 8.

Fig 8 Room Temperature

When the user waves the hand in front of the ultrasonic sensor in range of 25cm to 20cm, The system start monitoring Room Humidity as shown in Figure 9.

Fig 9 Room Humidity

When the user waves the hand in front of the ultrasonic sensor in range of 20cm to 15cm, The system start monitoring Room Pressure as shown in Figure10.

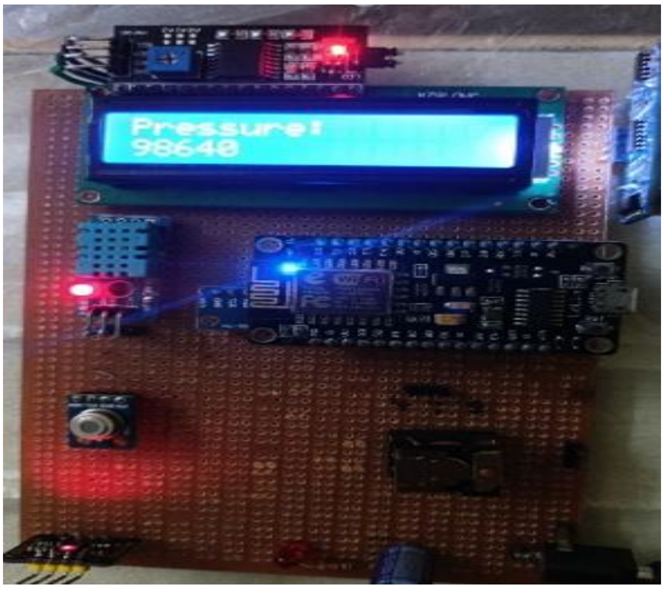

Fig 10 Room Pressure

When the user waves the hand in front of the ultrasonic sensor in range of 15cm to 7cm, The system start monitoring Heart rate of the user as shown in Figure 11.

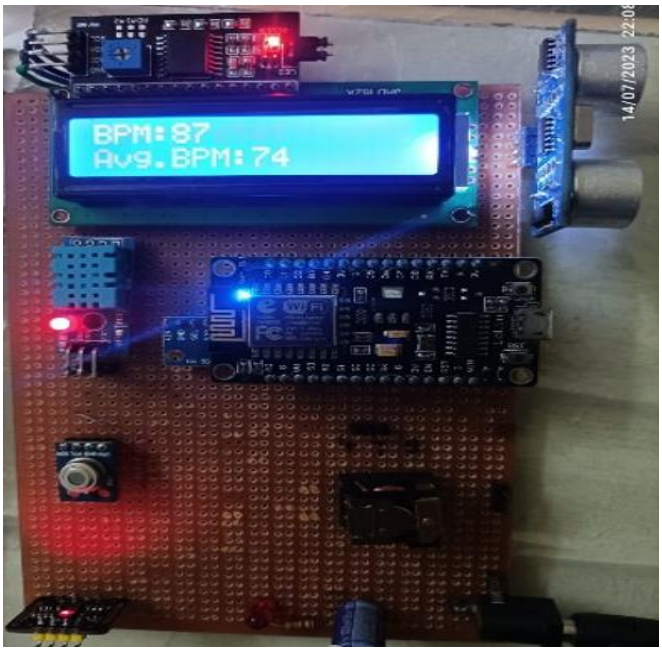

Fig 11 Heart Rate

When the user waves the hand in front of the ultrasonic sensor in range of 7cm to 0cm, The system start monitoring Body Temperature as shown in Figure12.

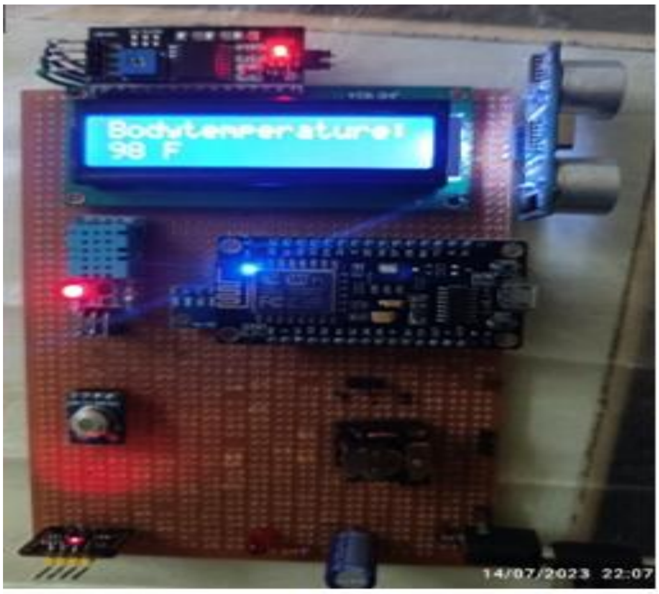

Fig 12 Body Temperature

When a particular preset is selected, the system automatically uploads the data to the Bylnk cloud so that the doctor can monitor the patient health and room conditions anywhere in the world with the help of Internet. Following figure 8 shows the Blynk cloud web Dashboard with all the parameters.

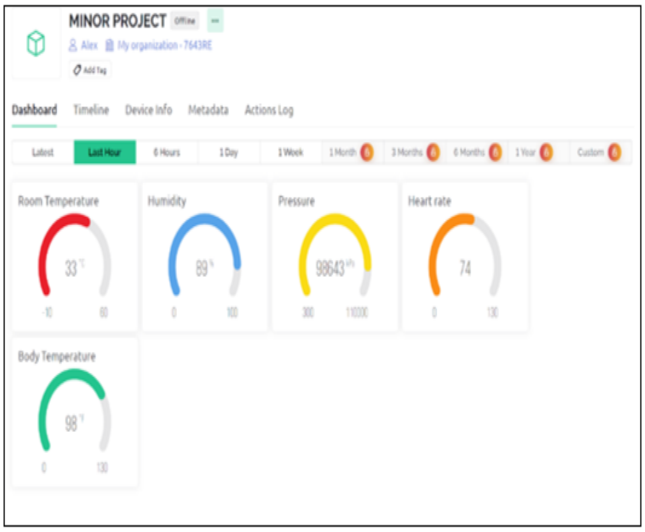

Fig 13 web Dashboard

IV. CONCLUSION

In compendious, the IoT project integrating ESP8266, ultrasonic sensor, DHT11, BMP180, MAX30102, MLX temperature sensor and LCD display shows the successful integration of multiple sensors with a powerful microcontroller to achieve comprehensive environment monitoring and health related measurements. By waving your hand within a defined range, PHES provides real-time data on temperature, humidity, heart rate, Room pressure and body temperature, all conveniently displayed on the screen. LCD screen.

The project offers numerous advantages, including contactless sensing, wireless connectivity, flexibility, and IoT capabilities. The use of a contactless sensing through ultrasonic sensor ensures convenience, hygiene and eliminates discomfort when using a physical contact sensor. Wireless connectivity enables remote access to sensor data, expanding usability and accessibility. The project's flexibility allows for applications in a variety of fields, including home automation, health monitoring, and environmental monitoring etc. Additionally, the integration of IoT capabilities opens up additional possibilities for data storage, analytics, and intelligent functionality.

In addition, the project holds educational value, providing a foundation to learn IoT concepts, sensor integration, data transmission, and microcontroller programming. It improves your knowledge and understanding in the field of embedded systems and IoT development.

Overall, the PHES represents a successful implementation of a sensor-based system that provides real-time monitoring, wireless connectivity, and versatile applications. It showcases the potential of IoT technologies to provide effective solutions for environmental monitoring and health-related measurement. With a combination of several sensors and LCD displays, PHES represents a valuable contribution to the field of IoT development and serves as a springboard for future innovations in the field.

REFERENCES

[1]. Ananth S, Sathya P and Madhan Mohan P, “Smart Health Monitoring System through IOT”, International Conference on Communication and Signal Processing, India, 2019.

[2]. S Pradeep Kumar, Vemuri Richard Ranjan Samson, U Bharath Sai,P L S D Malleswara Rao, K Kedar Eswar , “Smart Health Monitoring System of Patient through IOT”, International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud),India,2017.

[3]. Stephanie Baker, Wei Xiang, Senior Member, IEEE, and Ian Atkinson,“Internet of Things for Smart Healthcare:Technologies, Challenges, and Opportunities”, IEEE Access,vol.5,pp.26521-26544, November 2017.

[4]. Fahim Faisal and Syed Akhter Hossain,” IoT Based Remote Medical Diagnosis System Using NodeMCU”, 13th International Conference on Software, Knowledge, Information Management and Applications (SKIMA), Island of Ulkulhas, Maldives, 2019.

[5]. Pavankumar Kulkarni, Hamjad Ali Umachagi and Mariya sultana Bakshi,” IOT Based Temperature and Oxygen Pulse Scan Entry System”, 3rd International Conference on Communication, Computing and Industry 4.0 (C2I4), India,2022.

[6]. Segundo Enrique Dobbertin-Sanchez and Hector A. Chinchay-Espino,“Low-Cost IoT-Based Oximeter Controlled by NodeMCU and MAX30102 Targeting Peru's Non-Specialized Population in 2022”, Universidad Privada del Norte,2023.

[7]. Aravind R, Yadikiumarani, Meghna K, R Divyashree and Harshitha Naregowda,” IOT based Real Time Data Monitoring for Industry”, International Journal of Engineering Research & Technology (IJERT),NCCDS - 2021 Conference Proceedings,2021.

[8]. M. N. Bhuiyan, M. M. Billah, F. Bhuiyan, M. A. R. Bhuiyan, N. Hasan, M. M. Rahman, M. S. Miah, M. A. Alibakhshikenari, F. Arpanaei, F. Falcone, and M. Niu, "Design and Implementation of a Feasible Model for the IoT Based Ubiquitous Healthcare Monitoring System for Rural and Urban Areas," IEEE Access, vol. 10, pp. 91984-91997, 29 August 2022.

[9]. S. N. R. Vonteddu, P. Nunna, S. Jain, Samson Isaac. J, Nitya S and G. Diwakar, "Smart Wearable Wristband for Patients' Health Monitoring System through IoT," in 2022 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), India, 2022.

[10]. Vaneeta Bhardwaj, Rajat Joshi and Anshu Mli Gaur,” IoT-Based Smart Health Monitoring System for COVID-19”,National Library of Medicine, Springer Nature Singapore Pte Ltd,2022.

[11]. V.Baby Shalini,” Smart Health Care Monitoring System based on Internet of Things (IOT)”, 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS),2021.

[12]. Ali I. Siam, Atef Abou Elazm, Nirmeen A. El-Bahnasawy, Ghada El Banby and Fathi E. Abd El-Samie,” Smart Health Monitoring System based on IoT and Cloud Computing”, 1st International Conference on Electronic Engineering, Menoufia University, Egypt,2019