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# Wearable Sensor Network System for IOT-Connected Safety and Health Applications

***[1]Mr.S. MUTHUKUMAR, [2]JAYASHREE S, [3]SATHYA K, [4]SUSMITHA M, [5]THENMOZHI M***

[1]Asst.Professor, Department of ECE, Adithya Institute Of Technology, Coimbatore ,India, muthueceait@gmail.com
[2]UG Scholar, Department of ECE,Adithya Institute Of Technology, Coimbatore , India, cmcjayashree@gmail.com
[3]UG Scholar, Department of ECE,Adithya Institute Of Technology, Coimbatore , India, sathyamaha112000@gmail.com
[4]UG Scholar, Department of ECE, Adithya Institute Of Technology, Coimbatore , India, susmithamuthukalai6793@gmail.com
[5]UG Scholar, Department of ECE, Adithya Institute Of Technology, Coimbatore ,India, thenmozhimurugesanm@gmail.com

A B S T R A C T

Aiming at the disadvantage of systems to monitor the safety and health of workers are important for an industrial workplace; therefore, an IoT network system which can monitor both environmental and physiological can greatly improve the safety in the workplace. In this project a wearable sensor network system for Internet of Things (IoT) connected safety and health applications. Our proposed network system consists of two nodes (Safe Node and Health Node) to monitor en-vironmental and physiological parameters. These nodes communicate via Bluetooth transceiver. The safe node receives all data from the health node and transmits the data to a gateway via a LoRa network. After the gateway receives the data from wearable sensors, it will forward the data to an IoT cloud for further data storage, processing and visualization

***Keywords—*** IOT (*Internet of things*); PPM *(Parts per million*); GSM (*Global system for mobile communication);* LORA(*long range*); SN (Safe Node); HN (Health Node); Bluetooth; Environment and physiological;

## 1 INTRODUCTION

Wearable sensor nodes are generally deployed in wireless body area networks (WBAN) to monitor physiological parameters, such as body skin temperature photoplethysmogram (PPG), or electrocardiogram (ECG). In addition to medical signals, they can be deployed to monitor environmental conditions around the human body as well, such as in the safety application and environmental monitoring applications. Such a wearable sensor system can also provide invaluable and useful information about the environmental impact on subjects' health. People can also gain a deeper understanding of their local micro-environment. A wearable system is not only limited to personal use, it can also be installed on a bicycle, car, and animal to form a wearable or mobile wireless sensor network. For example, a mobile node is installed on bicycles for environmental monitoring. The power supply of sensor nodes is a major challenge for autonomous wearable sensor nodes, because many devices require regular battery replacement or charging. To allow long-term operation and minimize the human interaction of the wearable sensor node, the system has to be low power consumption and adopt energy harvesting. There is a need for an efficient and effective energy harvesting module, which can address this power supply issue. There are several options for energy sources, such as thermoelectric, piezo-electric, micro-magneto-electric, or photoelectric harvesting techniques. Solar energy provides the highest power density among these with high output voltages. The drawback is that the solar energy will disappear at night and this should be considered in the power management unit of a sensor node.

In this project we present a wearable IoT sensor network, named as Safe Node for safety environ-mental monitoring and a health node. Each sensor node consists of a micro-power manager, a sensing unit, and a wireless module

## 2 PROJECT OBJECTIVE

Safety and health of workers are important for industrial workplace.The wearable sensors on different subjects can communicate with each other and transmit the data to a gateway via a LoRa network which forms a heterogeneous IoT platform with Bluetooth-based medical signal sensing network.Once harmful environments are detected and, the sensor node will provide an effective notification and warning mechanism for the users.

## 3 PROPOSED SYSTEM

In our system ,IoT network system which can monitor both environmental and physiological can greatly improve the safety in the workplace.The proposed network system incorporates multiple wearable sensors to monitor environmental and physiological parameters.To transmit the data to a gateway via a LoRa network which forms a heterogeneous IoT platform with Bluetooth-based medical signal sensing network.

## 4 BLOCK DIAGRAM

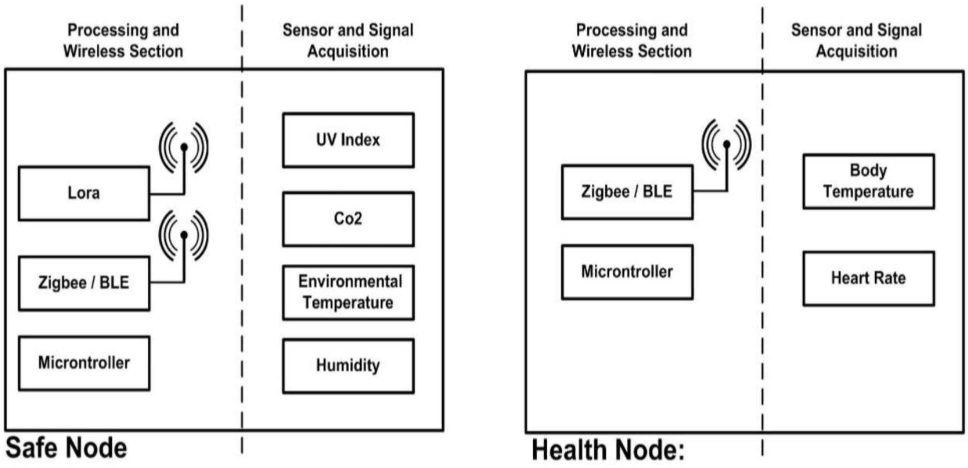
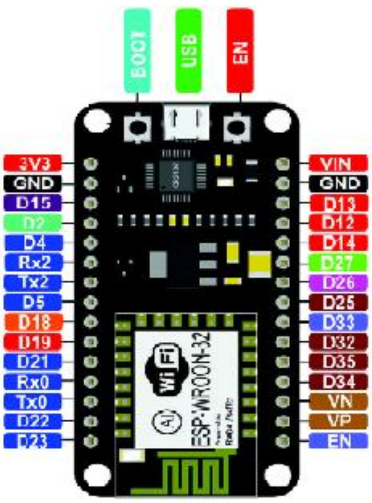



**fig : 1.1 Block Diagram**

## 5 HARDWARE IMPLEMENTATION

ESP32 is a series of low cost, low power systems on a chip microcontroller with integrated Wi-Fi & dual-mode Bluetooth. It is designed to achieve the best power and RF performance, robustness, versatility, and reliability in a wide variety of applications such as voice encoding, music streaming and MP3 decoding, etc,




*ESP32*

If you look at the ESP32 datasheet, power consumption during Active power mode, with RF working is as follows:

| Mode | Power Consumption |
|---|---|
| Wi-Fi Tx packet 13dBm~21dBm | 160~260mA |
| Wi-Fi/BT Tx packet 0dBm | 120mA |
| Wi-Fi/BT Rx and listening | 80~90mA |

For the sake of simplicity, we will make groups of pins with similar functionalities.

Power Pins There are two power pins viz. VIN pin & 3.3V pin. The VIN pin can be used to directly supply the ESP32 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pin is the output of an on-board voltage regulator. This pin can be used to supply power to external components. GND is a ground pin of ESP32 development board.

Arduino Pins are nothing but ESP32's hardware I2C and SPI pins to hook up all sorts of sensors and peripherals in your project.

The ESP32 development board has 25 GPIO pins which can be assigned to various functions programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

UART provides hardware management of the CTS and RTS signals and software flow control (XON and XOFF) as well.

SPI Pins SPI Pins ESP32 features three SPIs (SPI, HSPI and VSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- 4 timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO

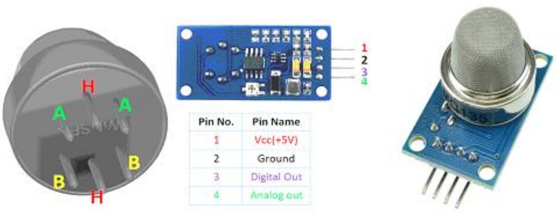
All SPIs can also be used to connect to the external Flash/SRAM and LCD.

~ PWM Pins The board has 25 channels (Nearly All GPIO pins) of PWM pins controlled by Pulse Width Modulation (PWM) controller. The PWM output can be used for driving digital motors and LEDs. The controller consists of PWM timers and the PWM operator. Each timer provides timing in synchronous or independent form, and each PWM operator generates the waveform for one PWM channel.

EN Pin is used to enable ESP32. The chip is enabled when pulled HIGH. When pulled LOW the chip works at minimum power.

**MQ-135 Sensor**

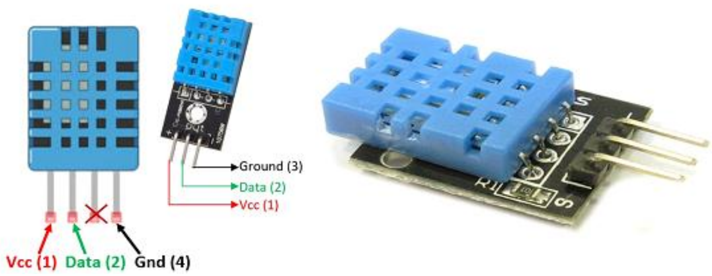
Air quality sensor for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2. Ideal for use in the office or factory. The MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benze steam, also sensitive to smoke and other harmful gases. It is low cost and particularly suitable for Air quality monitoring application.




**MQ-135 Sensor**

**DHT-11 Sensor**

DHT11 is a humidity and digital temperature sensor. It comes under the classification of weather sensors. The sensor gives out a digital signal based on temperature and humidity output. DHT11 consists of an NTC, 8 bit microcontroller and a resistive sense of wet components.




**DHT-11 Sensor**

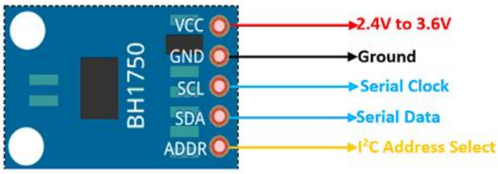
**Photo Max30100 (Pulse Oximeter and Heart-Rate Sensor) Module**

MAX30100 is an integrated pulse oximeter and heart-rate monitor sensor solution. It's an optical sensor that derives its readings from emitting two wavelengths of light from two LEDs – a red and an infrared one – then measuring the absorbance of pulsing blood through a photodetector. This particular LED colour combination is optimized for reading the data through the tip of one's finger. It is fully configurable through software registers and the digital output data is stored in a 16-deep FIFO within the device.It has an I2C digital interface to communicate with a host microcontroller.


**Photo Max30100 (Pulse Oximeter and Heart-Rate Sensor) Module**

**BH1750 Sensor**

This is a BH1750 light intensity sensor breakout board from rhydoLABZ. BH1750 is a digital Ambient Light Sensor IC with IIC bus interface. This IC is most suitable to obtain the ambient light data for adjusting LCD, Keypad backlight etc. Photodiode on BH1750 detects the light intensity, which is converted as voltage output with the help of an integration-OPAMP. The built in AD converter finally gives out the 16bit digital data. Internal logic of BH1750 avoids the need for any complicated calculations, as it directly outputs meaningful digital data in Lux (Lx).




## 6 SOFTWARE IMPLEMENTATION

ESP32 Development Platforms

There are a variety of development platforms that can be equipped to program the ESP32. You can go with Espruino – JavaScript SDK and firmware closely emulating Node.js, or use Mongoose OS – An operating system for IoT devices (recommended platform by Espressif Systems and Google Cloud IoT) or use a software development kit (SDK) provided by Espressif or one of the platforms listed on WiKiPedia.If you're just getting started programming the ESP32, this is the environment we recommend beginning with, and the one we'll document in this tutorial. Check out the ESP32 Arduino GitHub repository for more information.

Installing the ESP32 Core On – Windows OS

Once you are done, try the example sketch below.

```
intledPin = 2;
voidsetup()
{
        pinMode(ledPin, OUTPUT);
}
voidloop()
{
        digitalWrite(ledPin, HIGH);
        delay(500);
        digitalWrite(ledPin, LOW);
        delay(500);
}
```

Once the code is uploaded, the LED will start blinking. You may need to tap the EN button to get your ESP32 to begin running the sketch.

We are going to create two tables to store the real time data of the Electronic Mask

Accounts Table Creation

User Table consists of user credentials to authentication.Three columns are created in this table.

- username - Data type – Var Char – maximum size 100 char
- password -Datatype – Var Char – Maximum Size 100 char
- email -Datatype – Var Char – Maximum Size 100 char

- mobile_number -Datatype – Var Char – Maximum Size 12 char
- name -Datatype – Var Char – Maximum Size 100 char
- age -Datatype – Var Char – Maximum Size 10 char
- blood_group -Datatype – Var Char – Maximum Size 10 char
- Id –Data Type – int


## 7 CONCLUSION

The system is able to monitor both physiological and environmental data forming a network from wearable sensors attached to the worker's body and provide invaluable information to the system operator and workers for safety and health monitoring.
Aspects such as sensor node hardware and software design, gateway and cloud implementation are discussed.

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