DOI: 30.0485/ijearst.10.03.3489 https://ijearst.co.in/

ENGINEERING IN ADVANCED RESEARCH SCIENCE AND TECHNOLOGY

ISSN 2386-7876
Vol.02, Issue.03
May-2026
Pages: 1017-1031

IOT-BASED MULTI-PARAMETER INTELLIGENT HEALTH MONITORING SYSTEM

[1]Kamireddy Manohar [2]K. Jayaram Kumar
[1]M. Tech, Dept. of ECE, Aditya College of Engineering & Technology, Surampalem, Andhra Pradesh, India
[2]Assistane Professor, Dept. of ECE, Aditya College of Engineering & Technology, Surampalem, Andhra Pradesh, India

ABSTRACT: The HOT Watch: IoT-Based Wearable Health Monitoring System is designed to continuously monitor the health condition of patients using wearable sensors. In this project, temperature, SpO2 and heart rate sensors are used to measure body temperature, pulse rate, and oxygen levels, while a tilt sensor is used for fall detection of the patient. An Arduino Mega collects and processes the sensor data in real time. The measured values are transmitted to a laptop through a USB connection, and Python programming is used to upload the data to the Blynk cloud server for remote monitoring. This system helps doctors and caregivers track patient health continuously and provides quick response during emergency situations.

Keywords: Internet of Things (IoT), Wearable Health Monitoring, Remote Patient Monitoring, Biomedical Sensors, Heart Rate Monitoring, SpO2 Measurement, Temperature Sensor, Fall Detection System, Arduino Mega, Wireless Health Monitoring, Real-Time Data Acquisition, Cloud-Based Healthcare

INTRODUCTION: High maintenance and management costs are the dire problems that modern healthcare systems face [1]. The healthcare system is highly complex, containing several domains, each comprising physicians, researchers, practitioners, supportive staff, management employees, and patients [2]. As a result, categorization and management of patient data becomes a daunting challenge [3,4]. This challenge is further exacerbated by dissimilar data structures and disparate workflows in different healthcare domains. For these reasons, the lack of efficient interchange of healthcare-related information among various healthcare domains poses a great hindrance [5].

To tackle health information records and exchange, a system is required to be developed, managed, and maintained. A third party develops and maintains traditional personal health record and electronic health record systems, with trust, privacy, and data security remaining important challenges [6]. However, the third-party-based existing healthcare recording systems cannot satisfy stakeholders' privacy needs [7]. As a result, the traditional electronic healthcare model lacks transparency because of privacy and data security issues. In resolving the security-related concerns and the severe problem of enormous and highly diverse data in healthcare systems, blockchain technology offers significant prospects [8]. Blockchain is a decentralized, distributed database, peer-to-peer network, and digital ledger [9]. The blockchain could link many computers via nodes, and requires no transactions to build a new block that helps send safe information from one person to another. The client may access all the allowed and verifiable medical-related information using a blockchain secured by cryptography. Anyone may choose transactions and also add a new chain to the block. The master key of a blockchain is a hash, and by using this hash function, a blockchain can generate unique identifiers for cryptocurrency to add data. Since traditional electronic health record and personal health record-based health information exchange systems have failed to cope with privacy and security-related issues, stakeholders are hesitant about collaborating and co-operating for the exchange of health information. As a result, the cost of healthcare has increased, which is a great burden on both patients and healthcare providers. To solve these trust-related problems, researchers and policymakers nowadays are turning towards blockchain technology. As per IBM, many leading healthcare organizations predict blockchain will bring a significant change to the healthcare system by upgrading healthcare management systems and by establishing a decentralized architecture for the interchange of electronic healthcare information [10]. By 2022, the blockchain technology market is anticipated to account for over USD 500 million [11]. Although several studies on blockchain in the healthcare industry have been conducted, the existing literature cannot provide a comprehensive picture of the application areas. Therefore, it becomes inevitable to conduct an extensive study to explore the applications of blockchain in the healthcare industry. Many servers are now being built to provide services to clients via mobile devices. In this current time of internet services, it is possible to create and transmit a huge amount of medical data every week or daily by using mobile devices and many applications. The current healthcare system has the potential to solve limitations in a variety of fields, such as cost limitation, tactical limitation, maintaining standardization, and individual behavioral constraint to services [12].

LITERATURE SURVEY: Dorri, et al. [2] presented a blockchain-based smart home architecture, which has been used as a core reference in the process of designing our proposed model. This BC-based smart home architecture consists of three tiers, the smart home, the overlay, and the cloud storage, in which communication within these tiers is carried out using block transactions. The smart home consists of IoT devices, local IL, and local storage; overlay is a P2P network with distributed capabilities in addition to cloud storage groups based on identical unique block numbers, where SHM has been used for authentication. A blockchain-based system runs on a P2P network of computers where each node on the network has an identical copy of the blockchain. Blockchains types can be classified as public, private, or hybrid blockchains. 1) Public blockchain: it was first implemented by Bitcoin and other cryptocurrencies, and it has contributed significantly to the distributed ledger technology (DLT) structure. Issues due to centralization are handled with DLT as it distributes data throughout a P2P network rather than storing it in a single location. Because of its decentralized nature, it forces methods of authentication. 2) Private blockchain: it is set up on a closed private network or controlled by a single entity. Functionality goes on the same basis regarding connectivity and decentralization; however, is substantially smaller. 3) Hybrid blockchain: it includes private and public blockchain characteristics. It allows the creation of a private permission-based system along with a public permissionless system, in addition to regulations for access to specific data on the blockchain [4]. A smart contract can be defined as a piece of code that lives on a blockchain and is then executed automatically when one or more conditions are met. In the case of the Ethereum blockchain, smart contracts are implemented via the "Solidity" object-oriented language, in which users can execute the smart contracts through an application binary interface [6]. This property enables entities to perform their job functionalities such as access management, request handling, and data transmission. Ethereum enhanced the communication between a patient and a physician, as sharing medical prescriptions with the patients became much faster and easier. Accordingly, patients share their historical treatment data with doctors in a fast and accurate manner [5]. Traditional legacy medical records are paper-based medical records (PMR), making it very difficult to keep track of a patient's health history. Thus, saving historical data in such a way will cause data loss in addition to increasing the potential of inaccurate historical data, which potentially may lead to maltreatment. This serious issue has been faced by utilizing electronic medical records (EMR), the digital transformation of paper-based medical records. Electronic access to historical health records significantly improved the quality of treatment in addition to better disease diagnosis and preventive care [6]. Thereby, blockchain-based systems played an important role in modern healthcare solutions. Table reviews and compares these main blockchain-based research exploited in the healthcare sector.

TABLE I REVIEW OF THE BLOCKCHAIN-BASED RESEARCH IN THE HEALTHCARE SECTOR

Research	Blockchain Characteristics	Type(s) of Data	Merits
Castaldo & Cinque [7]	A private blockchain that does not rely on proof-of-work	EMR	Sharing E-health data across the EU via audit logging
Yue, *et al.* [8]	Private blockchain	EMR & PMR	Smart App to manage and share healthcare data
Patel [9]	A private blockchain that guarantees proof-of-stake	Medical Image Records	Securely sharing medical images
Fan, *et al.* [10]	Hybrid consensus mechanism based on practical byzantine fault tolerance (PBFT)	EMR	Secure sharing of healthcare data
Ji, *et al.* [11]	Proof-of-work	Patients' Locations	Multilayer location sharing schema
Azaria, *et al.* [12]	Ethereum blockchain with proof-of-work	EMR	EMR management and sharing of healthcare data
Zhu, *et al.* [13]	Ethereum platform	EMR	Data management in the cloud environment
Genestier, *et al.* [14]	Hyperledger platform	Medical Records	Managing personal data in the e-health environment
Wang & Song [15]	Consortium blockchain	Medical Records	Coupling encryption and signature for robust security

A system for remotely monitoring patients in a Health Insurance Portability and Accountability Act (HIPAA) compliant manner is introduced in [6, 7]. However, the system does not focus on specific methods or protocols a device can use to communicate with the blockchain, forces device manufacturers to change device specifications to conform to the system's requirements, no method is described that enables medical devices to integrate into the system, or in regards to representing this data to a physician. A data transfer system between a physician and patient through the use of a blockchain system for the transfer of labs and medical charts (rather than medical device data) is described in [8]. However, unlike in our system, this transfer of data is only one-sided and does not allow any analysis of the data present, which subjects the blockchain integration to be simply another form of a database. The integration of IoT devices to mobile applications is discussed in [9]. The framework manages medical devices but is very shallow in terms of its data transfer and storage. Primarily, representing data in a mobile application that is only available to a patient severely limits the potential use of the data itself. Secondly, because the system is centralized rather than decentralized, a significant risk is present in which any breach of that system can result in the release of significant amounts of medical data. Finally, there is no method present at all that can analyze or encrypt incoming data. An EHR system that can connect various IoT devices is introduced in [10]. However, the method it uses to achieve this has severe limitations. Data is primarily stored in a centralized rather than a decentralized system, which results in a significant risk in which any breach of that system can result in the release of significant amounts of medical data. Secondly, while data can be analyzed, the system can be integrated with only specific medical devices and support a minimal scope of incoming data. On improving EHR security, a system that enhances the security of current blockchains without the use of any specific keys is described in [11].

EXISTING METHOD:

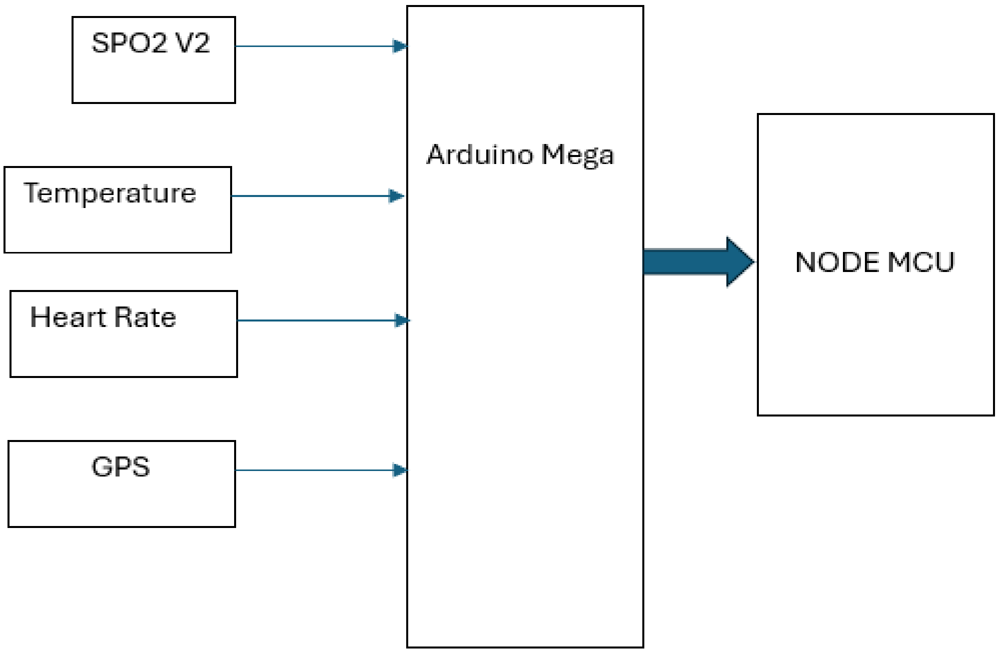


Fig 1: Existing Block diagram

NODEMCU ESP8266: The ESP8266 series, or family, of Wi-Fi chips is produced by Espressif Systems, a fabless semiconductor company operating out of Shanghai, China. The ESP8266 series presently includes the ESP8266EX and ESP8285 chips. **ESP8266EX** (simply referred to as ESP8266) is a system-on-chip (SoC) which integrates a 32-bit Tensilica microcontroller, standard digital peripheral interfaces, antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules into a small package. It provides capabilities for 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (16 GPIO), Inter-Integrated Circuit (I^2C), analog-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI), I^2S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM). The processor core, called "L106" by Espressif, is based on Tensilica's Diamond Standard 106Micro 32-bit processor controller core and runs at 80 MHz (or overclocked to 160 MHz). It has a 64 KiB boot ROM, 32 KiB instruction RAM, and 80 KiB user data RAM. (Also, 32 KiB instruction cache RAM and 16 KiB ETS system data RAM.) External flash memory can be accessed through SPI. The silicon chip itself is housed within a 5 mm × 5 mm Quad Flat No-Leads package with 33 connection pads — 8 pads along each side and one large thermal/ground pad in the center. The ESP8266 is a System on a Chip (SoC), manufactured by the Chinese company Espressif. It consists of a Tensilica L106 32-bit **micro controller** unit (MCU) and a **Wi-Fi transceiver**. It has **11 GPIO pins*** (General Purpose Input/Output pins), and an **analog input** as well. This means that you can program it like any normal Arduino or other microcontroller. And on top of that, you get Wi-Fi communication, so you can use it to connect to your Wi-Fi network, connect to the Internet, host a web server with real web pages, let your smartphone connect to it, etc ... The possibilities are endless! It's no wonder that this chip has become the most popular IOT device available. The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area.

PROPOSED METHOD:

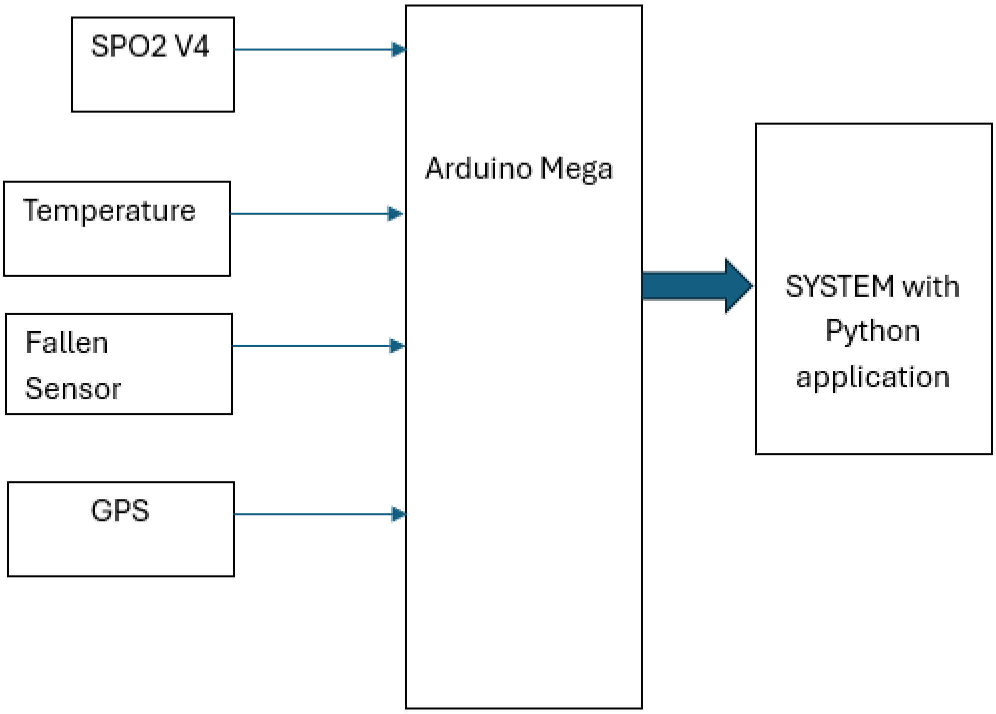


Fig 2: Proposed Block diagram

The proposed HOT Watch system consists of multiple health monitoring sensors connected to an Arduino Mega microcontroller. The temperature sensor measures the patient's body temperature, while the SpO2 sensor measures heart rate and blood oxygen level. A tilt sensor is used to detect patient falls or abnormal body movement.

All sensor outputs are continuously monitored and processed by the Arduino Mega. The processed data is sent to a laptop through USB serial communication. A Python program running on the laptop reads the sensor values and uploads them to the Blynk cloud server using Internet connectivity. Doctors or caregivers can monitor the patient's health parameters remotely through the Blynk mobile application or dashboard. If abnormal conditions or falls are detected, alert notifications can be generated for emergency assistance.

HARDWARE DESCRIPTION:

ARDUINO MEGA: The Arduino Mega is based on ATmega2560 Microcontroller. The ATmega2560 is an 8-bit microcontroller. We need a simple USB cable to connect to the computer and the AC to DC adapter or battery to get started with it. The Arduino Mega is organized using the Arduino (IDE), which can run on various platforms. Here, IDE stands for Integrated Development Environment.

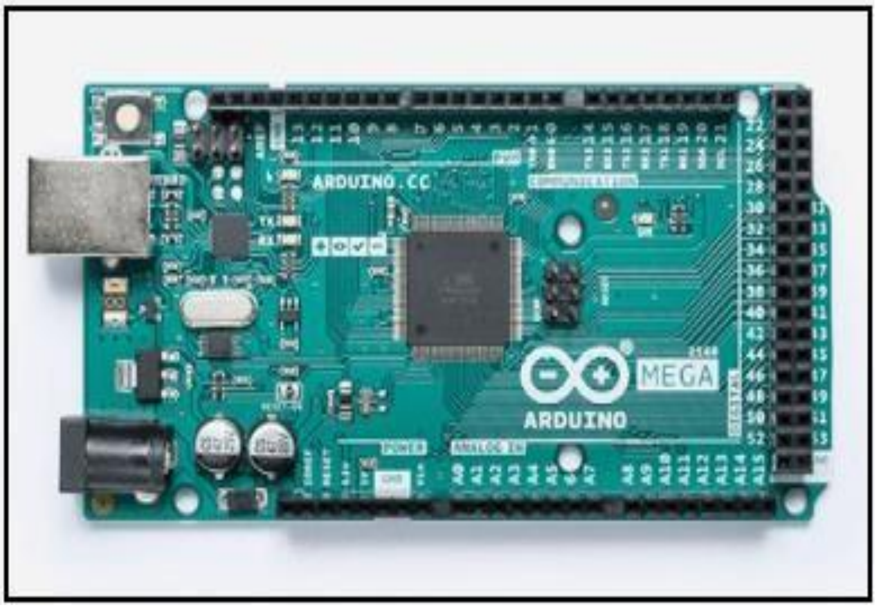


Figure 3: Arduino Mega board

The functioning of the Arduino Mega is similar to other Arduino Boards. We need not require extra components for its working.

Arduino Mega use The advantage of using the Arduino Mega board over other boards is that it gives the advantageof working with more memory space. It has higher processing power, which can help us to work with the number of sensors at a time.

Difference between Arduino-UNO and Arduino-Mega

- The Arduino UNO is based on the ATmega328 Microcontroller, while Arduino Mega is based on ATmega2560 Microcontroller.
- Arduino Mega (8Kb SRAM) acquires more SRAM space than Arduino UNO (2Kb SRAM). The greater the SRAM space, the more space would the Arduino have to manipulate and create a variable when it runs.
- The Arduino UNO includes 6 analogy pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. The Arduino Mega includes 54 I/O digital pins and 16 Analog Input/output (I/O), ICSP header, a reset button, 4 UART (Universal Asynchronous Receiver/Transmitter) ports, USB connection, and a power jack. PINS of Arduino Mega 2560 Board & Uses
- In digital side 54 pins for I/O (input output pins)
- 15 pins out of this are useful for PWM (pulse width modulation)
- In analog side 16 input pins
- Ground pins : 5

- One pin for 3.3 volts
- One reset button
- USART pins : 4 (These are hardware serial ports which produces maximum speed to setup communication)
- ISP programming pins : 6
- Crystal oscillator is added on the board having frequency of 16 MHz
- USB cable port (It is used to transfer and connect code from computer the board)
- ICSP header (Used to program the board and to upload code from computer. Indeed aremarkable addition in Arduino Mega 2560)
- Power Jack

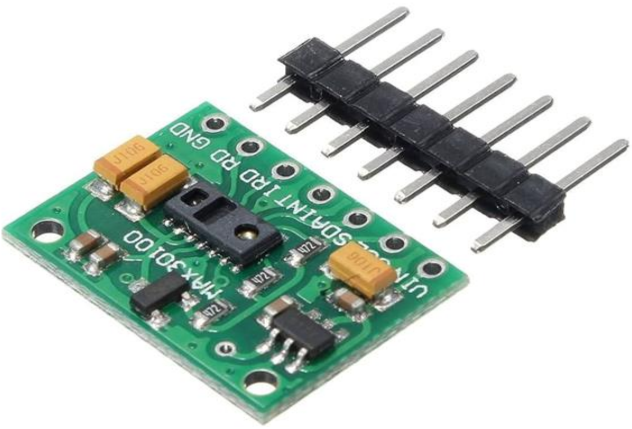
Resettable Polyfuse : (to provide extra layer of protection. It prevents USB port of the computer from overheating in case of high current flowing through microcontroller board)

VOLTAGE AND CURRENT SPECIFICATIONS

- Operating voltage : 5 V
- Input Voltage 7-12 V (recommended)
- Input Voltage 6-20 V (limit for this board)
- DC Current per input/output pin : 20mA
- DC Current for 3.3

MAX30100

MAX30100 sensor is a device that is used to monitor the heart rate and it is also used as a pulse oximeter.



The Pulse oximeter consists of Light-emitting diodes and an IR sensor. And signal processing unit to improve the quality of the output signal.

It works on the input voltage of 1.8V to 3.3V.

Working of MAX30100 pulse oximeter sensor:

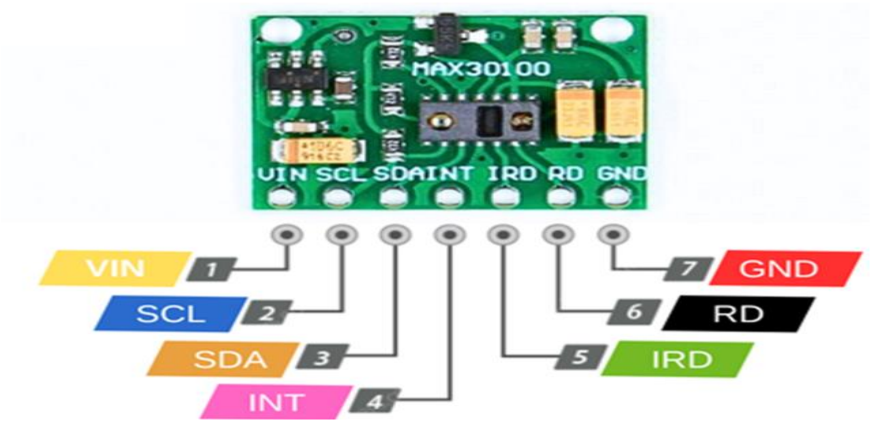
Whenever we breathe in oxygen, the oxygen enters our lungs and passes into our blood. The blood carries oxygen to various organs of our body.

Blood carries oxygen to our body, using hemoglobin. During a pulse oximetry reading, a small clam-like device is attached to our finger, earlobe, or toe.

A small beam of light is passed through the finger. This light passes the finger and is used to measure the content of oxygenated or deoxygenated blood.

The sensor has two light-emitting diodes and one photodiode. The LEDs are used to emit the light and the photodiode is used to detect and measure the intensity of the received light.

MAX30100 Pulse oximeter Pin Diagram



1. **VIN:** This pin is used to turn on the sensor. You may supply either 3.3V or 5V from your Arduino.
2. **SCL:** This is the I2C clock line. Make sure it is connected to the right clock pin on the Arduino.
3. **SDA:** This is where the I2C data pin is situated. It is critical to ensure that the Arduino's I2C data pin and data line are properly connected.
4. **INT:** If the sensor detects a pulse, the INT pin may be activated. It remains high most of the time, but in the event of an interruption, it is dragged down low and remains there until it is cleared.
5. **IRD:** This pin activates the IR LED for heart rate and SpO2 monitoring. If you don't want to operate the IR LED yourself, simply leave it disconnected.
6. **RD:** This pin is identical to the IRD pin, but it controls the red LED. Again, if you are not directly controlling the red LED, you may leave it unattached.
7. **GND:** This is your ground pin; connect it to the Arduino's ground.

Tilt Sensor

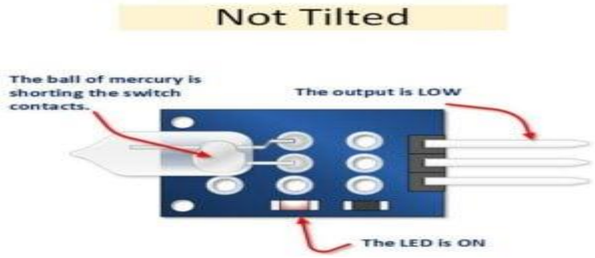
Specifications

- Tilt sensor consists of 3 pins : GND, VCC, DO (Output Signal)
- Operating Voltage : 3.3 V to 5 V
- Maximum output current : 15mA

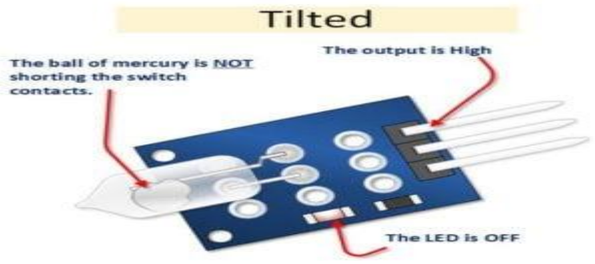
Working

Not Tilted

When the sensor is in "Not Tilted" position, the mercury ball will be at the bottom and shorting the contacts as shown in the image below. This will turn ON the LED and the output will be LOW.

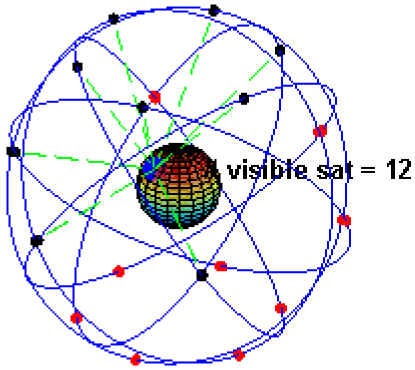


Tilted When the sensor is in "Tilted" position, the mercury ball will move away from the contacts as shown in the image below. This will turn OFF the LED and the output will be HIGH.



GLOBAL POSITIONING SYSTEM

GPS receivers use a constellation of satellites and ground stations to compute position and time almost anywhere on earth.



Notice the moving point on the globe and the number of visible satellites.

At any given time, there are at least 24 active satellites orbiting over 12,000 miles above earth. The positions of the satellites are constructed in a way that the sky above your location will always contain at most 12 satellites. The primary purpose of the 12 visible satellites is to *transmit* information back to earth over radio frequency (ranging from 1.1 to 1.5 GHz). With this information and some math, a ground based *receiver* or GPS module can calculate its position and time.

How Does a GPS Receiver Calculate Its Position and Time?

The data sent down to earth from each satellite contains a few different pieces of information that allows your GPS receiver to accurately calculate its position and time. An important piece of equipment on each GPS satellite is an extremely accurate atomic clock. The time on the atomic clock is sent down to earth along with the satellite's orbital position and arrival times at different points in the sky. In other words, the GPS module receives a timestamp from each of the visible satellites, along with data on where in the sky each one is located (among other pieces of data). From this information, the GPS receiver now knows the distance to each satellite in view.

Advantages

1. Continuous real-time health monitoring.
2. Remote access to patient health data through IoT technology.
3. Early detection of abnormal health conditions and fall incidents.
4. Reduces the need for frequent hospital visits.
5. Portable, compact, and easy-to-use wearable system.
6. Cost-effective healthcare monitoring solution.
7. Helpful for elderly people, chronic patients, and home healthcare.

Applications

1. Remote patient health monitoring systems.
2. Elderly and bedridden patient care.
3. Smart hospitals and healthcare centers.
4. Fitness and wellness monitoring devices.

5. Emergency and fall detection systems.
6. Home-based healthcare applications.
7. Wearable IoT healthcare products.

Conclusion

The HOT Watch: IoT-Based Wearable Health Monitoring System provides an efficient and reliable solution for continuous patient monitoring. The system measures important health parameters such as body temperature, heart rate, oxygen level, and fall detection using wearable sensors. Arduino Mega processes the sensor data and transfers it to the cloud through Python and the Blynk platform for remote access. The proposed system improves patient safety, enables quick medical response during emergencies, and supports modern smart healthcare technology

Future Scope

1. Integration of additional sensors such as ECG and blood pressure monitoring.
2. Development of a fully wireless wearable device using Wi-Fi or Bluetooth modules.
3. Implementation of AI and machine learning for disease prediction and health analysis.
4. Addition of GPS tracking for patient location monitoring during emergencies.
5. Direct cloud uploading without requiring a laptop intermediary.
6. Mobile app enhancement with real-time alerts and health history analysis.
7. Miniaturization of the system for improved comfort and portability.

REFERENCES:

[1] A. Pantelopoulos and N. G. Bourbakis, "A Survey on Wearable Sensor-Based Systems for Health Monitoring and Prognosis," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 40, no. 1, pp. 1–12, Jan. 2010.

[2] H. Alemdar and C. Ersoy, "Wireless Sensor Networks for Healthcare: A Survey," *Computer Networks*, vol. 54, no. 15, pp. 2688–2710, Oct. 2010.

[3] S. M. Riazul Islam et al., "The Internet of Things for Health Care: A Comprehensive Survey," *IEEE Access*, vol. 3, pp. 678–708, 2015.

[4] D. Singh, G. Tripathi, and A. J. Jara, "A Survey of Internet-of-Things: Future Vision, Architecture, Challenges and Services," in *Proc. IEEE World Forum on Internet of Things*, 2014, pp. 287–292.

[5] M. Chen, Y. Ma, J. Song, C. F. 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.

[6] P. Gope and T. Hwang, "BSN-Care: A Secure IoT-Based Modern Healthcare System Using Body Sensor Network," *IEEE Sensors Journal*, vol. 16, no. 5, pp. 1368–1376, Mar. 2016.

[7] A. Rahmani et al., "Smart e-Health Gateway: Bringing Intelligence to Internet-of-Things Based Ubiquitous Healthcare Systems," in *Proc. IEEE Healthcom*, 2015, pp. 826–834.

[8] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions," *Future Generation Computer Systems*, vol. 29, no. 7, pp. 1645–1660, 2013.

[9] L. Catarinucci et al., "An IoT-Aware Architecture for Smart Healthcare Systems," *IEEE Internet of Things Journal*, vol. 2, no. 6, pp. 515–526, Dec. 2015.

[10] A. Darwish and A. E. Hassanien, "Wearable and Implantable Wireless Sensor Network Solutions for Healthcare Monitoring," *Sensors*, vol. 11, no. 6, pp. 5561–5595, 2011.

[11] M. S. Hossain and G. Muhammad, "Cloud-Assisted Industrial Internet of Things (IIoT) – Enabled Framework for Health Monitoring," *Computer Networks*, vol. 101, pp. 192–202, 2016.

[12] K. Ashton, "That 'Internet of Things' Thing," *RFID Journal*, vol. 22, no. 7, pp. 97–114, 2009.

[13] S. Li, L. D. Xu, and S. Zhao, "The Internet of Things: A Survey," *Information Systems Frontiers*, vol. 17, no. 2, pp. 243–259, 2015.

[14] A. Milenkovic, C. Otto, and E. Jovanov, "Wireless Sensor Networks for Personal Health Monitoring: Issues and an Implementation," *Computer Communications*, vol. 29, no. 13, pp. 2521–2533, 2006.

[15] J. Yick, B. Mukherjee, and D. Ghosal, "Wireless Sensor Network Survey," *Computer Networks*, vol. 52, no. 12, pp. 2292–2330, 2008.

[16] V. Kumar and S. Malhotra, "Health Monitoring System Using IoT," in *Proc. International Conference on Computing, Communication and Automation*, 2017, pp. 617–621.

[17] M. Patel and J. Wang, "Applications, Challenges, and Prospective in Emerging Body Area Networking Technologies," *IEEE Wireless Communications*, vol. 17, no. 1, pp. 80–88, Feb. 2010.

[18] A. Rayes and S. Salam, *Internet of Things from Hype to Reality*, Cham, Switzerland: Springer, 2017.

[19] B. Latré et al., "A Survey on Wireless Body Area Networks," *Wireless Networks*, vol. 17, no. 1, pp. 1–18, Jan. 2011.

[20] T. Gao et al., "The Advanced Health and Disaster Aid Network: A Light-Weight Wireless Medical System for Triage," *IEEE Transactions on Biomedical Circuits and Systems*, vol. 1, no. 3, pp. 203–216, 2007.