World Journal of Advanced Research and Reviews

eISSN: 2581-9615 CODEN (USA): WJARAI

Cross Ref DOI: 10.30574/wjarr

Journal homepage: https://wjarr.com/

(Review Article)

Smart spirits: an integrated IoT-based liquor and health monitoring system

Nanthini S * and R. Vadivel

Department of Information Technology, Bharathiar University, Coimbatore, Tamil Nadu, India- 641046.

World Journal of Advanced Research and Reviews, 2024, 21(03), 752–763

Publication history: Received on 22 January 2024; revised on 02 March 2024; accepted on 05 March 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.21.3.0726

Abstract

This project entails the development of a comprehensive health monitoring system utilizing Arduino Uno, a range of sensors (including alcohol, pulse, and DHT11), an LCD display, and a GSM module for data transmission to the Thingspeak application. Its objective is to monitor vital health parameters such as temperature, humidity, pulse rate, and alcohol levels in real-time, accessible via the Thingspeak mobile app. Key components include an Arduino Uno microcontroller, DHT11 sensor for temperature and humidity, pulse sensor for heart rate, alcohol sensor for detecting alcohol levels, LCD display for immediate feedback, and a GSM module for remote data transmission. The user-friendly Thingspeak app serves as an interface for seamless health metric monitoring. The system operates by collecting sensor data, displaying it locally on the LCD screen, and simultaneously transmitting it to the Thingspeak app via GSM communication. Users can then access the app to visualize and monitor their health metrics in real-time, allowing for prompt interventions or medical assistance if needed. The code implementation integrates sensor readings, LCD display control, and Thingspeak functionality. Leveraging Thingspeak's cloud-based platform enhances usability and accessibility, making remote health monitoring feasible. This system offers a versatile solution for individuals looking to efficiently track and manage their well-being, thanks to the integration of Arduino Uno, sensors, Thingspeak features, and GSM communication, making it suitable for both local and remote health monitoring applications.

Keywords: Arduino Uno; IoT; GSM; LCD; Thingspeak; DHT11

1. Introduction

Health monitoring has become a pivotal aspect of modern lifestyle management, allowing individuals to track vital parameters for a proactive approach towards well-being. In response to this growing need, the development of an advanced health monitoring system is presented in this project. Leveraging the capabilities of Arduino Uno, various sensors, an LCD display, and a GSM module, the system aims to provide users with real-time health data through the integration with the Thingspeak mobile application. The contemporary emphasis on health and wellness has fuel the demand for innovative solutions that empower individuals to monitor their physiological parameters. The utilization of Arduino Uno, a versatile microcontroller, serves as the foundation for this health monitoring system. Coupled with sensors such as the DHT11 for temperature and humidity, a pulse sensor for heart rate measurement, and an alcohol sensor for detecting alcohol levels, the system offers a comprehensive suite of health metrics. The integration of an LCD display provides immediate, on-site feedback, enabling users to stay informed about their health status in real time. Moreover, the inclusion of a GSM module facilitates remote communication, allowing the system to transmit health data to the Thingspeak mobile application. Thingspeak, a popular Internet of Things (IoT) platform, acts as an interface for users to access and monitor their health parameters seamlessly. This project seeks to address the evolving needs of individuals who prioritize health and wellness by creating an accessible and user-friendly health monitoring system. By combining the capabilities of Arduino Uno, various sensors, Thingspeak integration, and GSM communication, the system aims to provide a holistic solution for both local and remote health monitoring. The subsequent sections will delve into the components, functionalities, and implementation details of the proposed health monitoring system.

* Corresponding author: Nanthini S

1.1. Problem statement

In contemporary society, there is a growing demand for effective and user-friendly health monitoring systems due to increasing awareness of health and well-being. Individuals seek accessible tools to monitor vital parameters like temperature, humidity, pulse rate, and alcohol levels in real-time. However, existing solutions often lack integration, accessibility, and immediate feedback, hindering efficient health tracking. Moreover, remote monitoring options are limited, making proactive well-being management challenging, especially in situations requiring immediate intervention. To address these challenges, a comprehensive health monitoring system is needed, seamlessly integrating various sensors, an LCD display for local feedback, and a GSM module for remote data transmission. This system should offer a user-friendly interface, enabling individuals to monitor health parameters both on-site and remotely via a mobile application. Integration with widely-used platforms such as Thingspeak would enhance accessibility and usability, facilitating informed decision-making regarding health and well-being. The development of such a system would cater to the increasing demand for personalized and integrated health solutions, empowering individuals to take a proactive approach to managing their health. By filling existing gaps in health monitoring options, this project aims to create a versatile and accessible system that meets the evolving needs of users in local and remote contexts.

2. Literature survey

The rapid expansion of sensor technologies and their impact on the Internet of Things (IoT) is examined by Swan M. in Sensor Mania, The Internet of Things, Wearable Computing, Objective Metrics, and the Quantified Self 2.0, published in the Journal of Sensor and Actuator Networks in 2012. In this context, he looks at the intersections between wearable computing, objective measurements, and the Quantified Self 2.0 movement. Swan gives a thorough review of sensor technology today, emphasizing how important they are to the advancement of the Internet of Things. The study explores how these technologies affect data-driven decision-making, tracking one's own health, and the developing idea of the Quantified Self 2.0. Swan also talks about the opportunities and problems brought about by the widespread use of sensors, providing insights into their revolutionary potential [1].

In 2013, Gómez et al. explore that utilizing the Internet of Things (IoT) in educational settings improves student academic performance. By incorporating real objects as learning resources through the IoT, educators can facilitate meaningful learning experiences by connecting specific knowledge to real-world contexts. The use of IoT systems in the experimental group has been found to enhance learning outcomes compared to control groups. Looking ahead, the future of IoT in education holds potential for further advancements, including integrating virtual objects with recommendation engines. This approach aims to personalize learning experiences, guide students towards relevant resources, and enhance engagement and comprehension in educational environments. As such, the evolving landscape of IoT in education presents a promising avenue for continued research and innovation [2].

In 2010, The Internet has fundamentally changed how we interact, shifting many aspects of life to virtual platforms across personal and professional spheres. The Internet of Things (IoT) further revolutionizes this landscape by facilitating communication among smart objects, fostering a realm of "anytime, anywhere, any media, anything" connectivity. As we place the Internet of Things inside the context of the future Internet, we acknowledge a shift from the host-to-host communication paradigm that is in use today. The current paradigm, which is focused on information publication and retrieval, requires a shift to data-centric networks, in which queries and data are self-routable and self-addressable. Although giving IPv6 addresses to Internet of Things components is consistent with the established Internet architecture, it might be worth reevaluating as the Internet develops. Additionally, the emergence of Web Squared integrates web and sensing technologies, enriching user experiences with context-aware content. In this paper, we've examined key facets of the IoT and identified areas necessitating further research. Despite current technologies enabling IoT concepts, scalability and efficiency remain formidable challenges. Addressing these issues will be instrumental for networking and communication research in academic and industrial realms, given the burgeoning interest in IoT applications [3].

In 2014, Purnima and Puneet Singh displayed a paper titled Integration of Zigbee and GSM for Persistent Wellbeing Observing at the IEEE Universal Conference on Hardware and Communication Frameworks. This paper examines the improvement and usage of a wellbeing checking framework that combines Zigbee and GSM advances. The creators investigate the utilize of Zigbee for empowering remote communication between wellbeing observing gadgets and a central framework, highlighting its significance in encouraging real-time information transmission. Also, the consolidation of GSM network permits for farther checking and convenient restorative mediations. The paper likely gives experiences into the system's design, equipment components, and communication conventions, pointing to set up viable wellbeing checking arrangement. The discoveries likely assess the system's execution, tending to viewpoints such as information exactness, transmission unwavering quality, and its generally adequacy in upgrading persistent care.

This investigate is anticipated to contribute to progressing endeavors pointed at leveraging remote advances to development persistent wellbeing checking systems [4].

In 2016, Sankar Kumar S, Gayathri N, Nivedhitha D, and Priyanka A S, titled "A Cost-effective Arduino Module for Out of commission Patient's Respiratory Screen and Control," diagrams a novel approach to address the respiratory observing and control needs of out of commission patients. The creators display the advancement of a cost-effective Arduino module outlined to screen respiratory designs and give control functionalities. Emphasizing the reasonableness of the proposed module, the paper likely talks about the integration of sensors, information preparing strategies, and the component for respiratory control. The discoveries from this consider hold potential for contributing to headways in healthcare innovation by advertising an available arrangement for observing and overseeing the respiratory wellbeing of out of commission patients [5].

In 2021, The proposed patient health monitoring system holds promise for extensive application in emergency conditions, offering daily monitoring, recording, and database storage capabilities. Looking ahead, the integration of IoT devices with computer systems could facilitate database sharing across intensive care and treatment hospitals. Particularly in the context of the ongoing pandemic, such health monitoring systems prove invaluable, enabling individuals to avoid frequent hospital visits by conducting self-checks at home. This capability aligns with current healthcare needs, emphasizing remote monitoring and self-care practices for enhanced safety and convenience [6].

In 2015, Bhagya Lakshmi introduced a Heart Beat Detector utilizing an Infrared Pulse Sensor to measure heart rate, a crucial parameter in cardiovascular health assessment. This computer-based monitoring system integrates an Arduino software board and a Pulse sensor, operating based on Arduino's principles. The Pulse sensor detects pulses, with data transmitted to the computer via a serial monitor. Photoplethysmography (PPG) is utilized to sense pulse signals from a fingertip, interpreted by the Arduino board and sent to the PC through a serial interface. A computer application, developed using the Processing programming language, visualizes and analyzes the received PPG signal, providing real-time feedback on the user's heart rate for effective cardiovascular health monitoring [7].

In 2014, Ch. Sandeep Kumar Subudhi initiated a project aimed at monitoring vital signs such as body temperature, blood pressure (BP), pulse rate, and ECG, alongside tracking the patient's location. Sensors in the patient's environment detect these parameters, with the data transmitted to a PIC16F877 microcontroller via a signal conditioning circuit. Each sensor value has a predefined threshold, triggering preliminary steps if exceeded, signaled by a buzzer alarm. The sensor data is then sent from the patient unit to the main controller unit via a Zigbee communication system, connected to microcontrollers in both units. From the main controller unit, the sensed data and the patient's location obtained from a GPS module are forwarded to the observer or doctor. This information is relayed via SMS by a GSM module, allowing informed decision-making. Facilitating communication between the microcontroller and the GSM modem, a MAX232 serves as a driver, enabling message transmission to a mobile phone using the Global System for Mobile (GSM) Modem [8].

In 2019, the prevalence of accidents resulting from driving under the influence of alcohol poses a significant concern, with National Crime Records Bureau (NCRB) statistics indicating that 1.5 percent of total road accidents are attributed to this cause, leading to numerous injuries. To effectively tackle this issue, a proposed system is suggested to monitor alcohol consumption levels and heart rate. In this system, if the driver is detected to be intoxicated, the vehicle's ignition system will be automatically disabled, preventing the impaired driver from operating the vehicle and potentially causing accidents. Additionally, if any abnormal changes in the driver's heart rate are detected, the system will transmit the driver's current status to their friends using IoT technology, ensuring prompt intervention if necessary. While the practical implementation of this system in automobiles is beyond the scope of this project, it is implemented using a DC motor, with Arduino Uno serving as the controller. This system offers a proactive approach to preventing accidents caused by drunken driving and prioritizes the safety of both the driver and other road users [9].

In 2020, Arwinder Dhillon introduced IoT Pulse, an innovative enterprise health information system utilizing IoT technology to predict alcohol addiction in real-time. By incorporating machine learning in a fog computing environment, IoT Pulse gathered data from 300 alcohol addicts in Punjab, India, for model training. The system showcased its effectiveness by outperforming existing methods, showing a 7% increase in accuracy, a 4% rise in sensitivity, and significant improvements of 12% in both specificity and precision. IoT Pulse underwent validation in an actual fog environment using Fog Bus-based infrastructure, resulting in further performance enhancements. Evaluation based on Quality of Service (QoS) metrics such as latency, network bandwidth, energy consumption, and response time displayed significant progress. Remarkably, IoT Pulse achieved a 19.56% reduction in latency, an 18.36% boost in network bandwidth efficiency, and enhancements of 19.53% in energy conservation and 21.56% in response time optimization. These results indicate that IoT Pulse not only enhances alcohol addiction prediction accuracy and efficiency but also demonstrates substantial performance improvements in real-world fog computing environments, showcasing its potential as a valuable tool in healthcare management and intervention [10].

In 2017, this paper proposes a smart car system utilizing IoT, GSM, and various sensors like the heartbeat, fuel level, traffic light, and alcohol sensors to enhance driver and passenger safety and prevent accidents. Inspired by the proverb "Prevention is better than cure," the concept emphasizes adherence to road rules. Challenges such as non-compliance with traffic regulations are addressed through technological interventions. Additional implementations, such as RFID tags for emergency vehicles and communication between traffic signals, are suggested to improve emergency response. The system also involves sending alerts to nearby vehicles in case of alcohol detection and displaying treatment options for drivers experiencing heart issues. By incorporating a heartbeat sensor, the system mitigates risks of accidents due to driver fatigue and stress-induced cardiac arrest. Furthermore, accurate petrol level measurement and real-time information on nearby petrol stations aid in efficient journey planning, contributing to timely arrivals. Overall, the proposed system offers comprehensive solutions to enhance road safety and travel efficiency [11].

2.1. Existing system

Current health monitoring systems often lack a holistic and integrated approach to individual well-being. Many existing solutions suffer from limitations in sensor integration, immediate feedback provision, and remote monitoring capabilities. Some devices focus solely on specific parameters, such as heart rate or temperature, neglecting other vital metrics. Furthermore, the disjointed communication between on-site monitoring devices and remote platforms poses challenges for real-time tracking, especially in situations necessitating urgent medical attention. The existing landscape also struggles with complex user interfaces, which hinder accessibility and usability for a broader audience. These shortcomings underscore the pressing need for an enhanced health monitoring system that addresses these limitations, providing a more inclusive, user-friendly, and integrated solution for individuals actively managing their health. In response to these challenges, there is a demand for a holistic approach that offers seamless integration of sensors, immediate feedback provision, and robust remote monitoring capabilities. Such a system would bridge the gap between on-site monitoring and remote platforms, enabling users to track their health parameters in real-time and facilitating prompt intervention when necessary. Additionally, a simplified user interface would enhance accessibility and usability, catering to a diverse user base. By addressing these shortcomings and embracing a more inclusive design philosophy, the proposed health monitoring system aims to revolutionize the way individuals manage their health. By offering a comprehensive suite of vital metrics, seamless communication between devices, and intuitive user interface, this system seeks to empower users to take control of their well-being with confidence and ease.

2.2. Proposed system

The proposed health monitoring system represents a significant advancement in the field by aiming to overcome the limitations of current solutions through a comprehensive and integrated approach to individual well-being. At its core lies the Arduino Uno, a versatile microcontroller known for its compatibility with various sensors and ease of integration. Utilizing the Arduino Uno's capabilities as the central component enables seamless communication between different sensors and modules, facilitating the collection, processing, and transmission of vital health data. An outstanding feature of this system is its integration of various sensors to capture a wide range of health metrics. For instance, the DHT11 sensor monitors temperature and humidity, providing insights into environmental conditions that may affect one's health. Additionally, a pulse sensor tracks heart rate, a critical indicator of cardiovascular health and physical exertion. Furthermore, an alcohol sensor detects alcohol levels, offering users essential information about their drinking habits and potential health risks. By incorporating these sensors, the system offers a holistic view of an individual's health status, enabling users to track multiple parameters simultaneously. To improve user experience and accessibility, the system includes an LCD display that provides immediate on-site feedback. This display allows users to visualize their health parameters in real-time, facilitating prompt decision-making regarding lifestyle choices or necessary interventions. The real-time data presentation empowers users to stay informed about their health status, fostering greater awareness and proactive management of their well-being. Moreover, the inclusion of a GSM module enables remote communication, facilitating the transmission of health data to the Thingspeak mobile application. Thingspeak serves as a user-friendly interface for remote monitoring, offering a seamless platform for users to track and analyze their health metrics from anywhere. Through the Thingspeak app, users can access their health data in real-time, receive personalized insights and recommendations, and share their data with healthcare professionals or trusted individuals for further analysis or intervention. This integration enhances the accessibility and usability of the system, catering to a diverse range of users and empowering them to take control of their health. The user-centric design further enhances the system's usability and effectiveness by prioritizing ease of use and accessibility, ensuring that individuals of all backgrounds can effectively monitor and manage their well-being. The combination of on-site feedback through the LCD display and remote monitoring via the ThingSpeak app provides users with multiple avenues to access their health data and make informed decisions about their lifestyle choices.

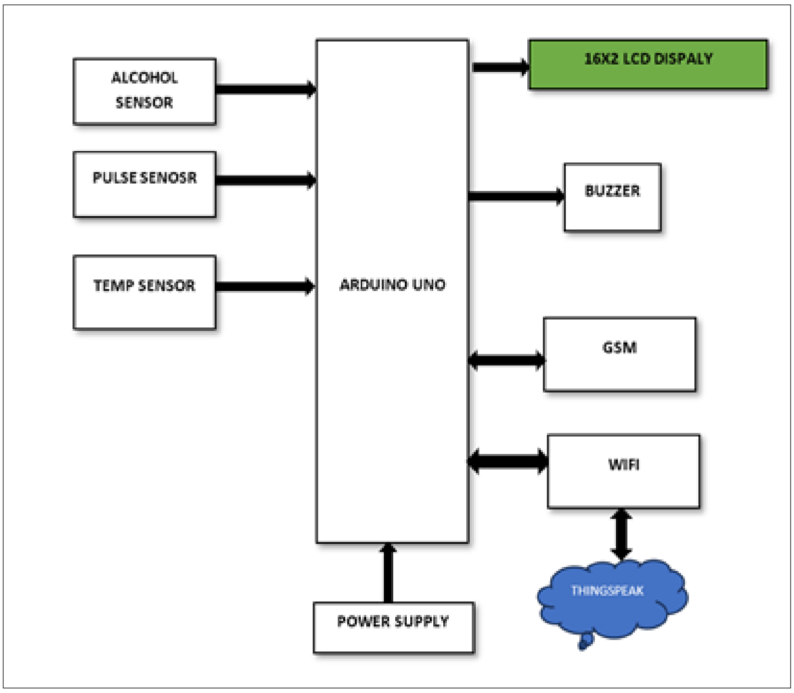

Figure 1 Architecture for Liquor and Health monitoring system

3. Methodology

3.1. Components used

3.1.1. Arduino Uno

One well-known microcontroller board that contains the ATmega328P chip is the Arduino Uno. It incorporates a 16 MHz ATmega328P microprocessor and provides 6 analog inputs and 14 digital input/output pins, 6 of which allow PWM output. It has 32 KB of flash memory, of which 0.5 KB is reserved for the bootloader; it also has 2 KB of SRAM and 1 KB of EEPROM, so there's plenty of room for code and data. Communication features include an ICSP header for SPI communication and USB for programming. There are two ways to power the device: via USB or an external 7–12V DC source. An integrated voltage regulator maintains a constant 5V supply to the microprocessor. The Uno can run at 5V and is compatible with a variety of shields.

Figure 2 Arduino Uno

3.1.2. Alcohol Sensor MQ3

The MQ-3 alcohol sensor is widely used for detecting alcohol vapor concentrations in the atmosphere. It operates based on the principle of resistance variation triggered by alcohol molecules' presence, featuring a tin dioxide (SnO2) sensing element. This element exhibits higher electrical resistance in clean air but decreases when exposed to alcohol vapor. The sensor requires heating for optimal performance, typically achieved through an integrated heating element. Once heated, it can swiftly and sensitively detect alcohol concentrations ranging from 0.05 to 0.3 mg/L. Applications include breath analyzers, alcohol detection systems in vehicles, and personal safety devices. Cost-effective and reliable, the MQ-3 sensor is valuable for enhancing safety and preventing alcohol-related incidents.

Figure 3 Alcohol sensor (MQ-3)

3.1.3. Pulse Sensor

The pulse sensor is integral to IoT health monitoring systems, facilitating non-invasive and continuous heart rate measurement in real-time using photoplethysmography (PPG) technology. It detects blood volume fluctuations in peripheral blood vessels, such as the fingertip or earlobe, by illuminating the skin with an infrared LED and capturing reflected light with a photodetector. This data forms a waveform reflective of the heartbeat, which is analyzed to derive heart rate information. Integrated with platforms like Arduino Uno or Arduino and utilizing wireless protocols like Wi-Fi or Bluetooth, the sensor enables remote monitoring of cardiovascular health, aiding in early anomaly detection and prompt intervention. Its compact size, minimal power consumption, and seamless integration make it suitable for wearable devices like smartwatches and fitness trackers, providing users with valuable insights into heart health metrics. Remote monitoring allows for personalized health interventions and timely medical assistance, making the pulse sensor a crucial component in promoting proactive cardiovascular health maintenance and overall well-being in diverse demographics.

Figure 4 Pulse sensor

3.1.4. Temperature Sensor (DHT11)

A simple, inexpensive digital temperature and humidity sensor is the DHT11. It's frequently used in do-it-yourself electronics projects and other applications where humidity and temperature readings are required. The sensor has a capacitive humidity sensor to detect humidity and a thermistor to monitor temperature. With the use of its digital signal output, microcontrollers such as the Arduino, Raspberry Pi, and other embedded systems may be readily interfaced with. For many automation applications and hobbyists, the DHT11 sensor offers good accuracy and ease of use.

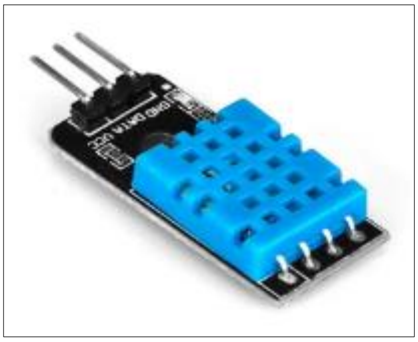

Figure 5 Temperature sensor (DHT11)

3.1.5. Liquid Crystal Display (LCD)

With 16 columns and 2 rows, the 16x2 LCD (Liquid Crystal Display) is a widely used display module that can display up to 32 characters at once. It has a backlight for low-light visibility, a glass display with liquid crystal cells, and an operating controller chip. To send and receive alphanumeric data and control display functionalities, microcontrollers interface with the LCD module. To interface with a microcontroller, pins for power, data, and control must be connected. The 16x2 LCD is a solid display option for electronic projects because of its price, simplicity, and variety. It may be found in digital clocks, thermometers, weather stations, and other electronic devices hardware. Because it's an open-source platform, the Arduino IDE makes programming easier, and its design files are publicly available.

Figure 6 LCD display

3.1.6. Buzzer

In IoT applications, a buzzer is an electromechanical device that creates audible alerts based on specific conditions or events. It's a small component that produces sound when electricity flows through it. Buzzers are used in various scenarios such as indicating alarm conditions like high temperatures or gas leaks in smart security systems, providing notifications in smart home devices, and giving feedback in industrial settings. They play a vital role in emergencies by alerting people to fire alarms or evacuation notices in smart buildings or public safety systems. Controlled by a microcontroller or CPU, buzzers activate according to preset logic or sensor-detected conditions, improving safety, security, and user experience in IoT applications.

Figure 7 Buzzer

3.1.7. Global System for Mobile Communications (GSM)

Introduced by the European Telecommunications Standards Institute (ETSI) in 1991, the Global System for Mobile Communications (GSM) completely changed 2G digital cellular networks. Using the 900 MHz and 1800 MHz frequency bands, GSM allowed for extensive data transmission, text messaging, and voice conversations. By splitting frequency channels into time slots and utilizing Time Division Multiple Access (TDMA), GSM effectively distributed spectrum resources while increasing network capacity. For call routing, handovers, and user authentication, its intricate architecture includes Mobile Stations (MS), Base Transceiver Stations (BTS), Base Station Controllers (BSC), Mobile Switching Centers (MSC), and Home Location Registers (HLR). By storing user data and using encryption techniques like A5, mutual authentication, and temporary IDs, SIM cards improved device mobility and security. GSM added SMS to its list of services in addition to voice calls.

Figure 8 GSM module

3.2. Working principle

3.2.1. Alcohol Sensor (MQ3)

Alcohol sensors just like the work by chemical responses between liquor vapors and touchy materials, regularly tin dioxide ($SnO2$). When liquor atoms associated with $SnO2$, it changes the semiconductor's electrical conductivity. The sensor incorporates a radiator to raise $SnO2$'s temperature, making it touchier to liquor vapors. As liquor vapors are retained, the sensor's electrical resistance changes. This alter is measured and changed over into an electrical flag, interpretable by a microcontroller. Observing this flag permits precise discovery of liquor levels, valuable in breath analyzers, vehicle liquor location frameworks, and security observing. This instrument guarantees dependable liquor discovery for educated decision-making on security and compliance.

3.2.2. Pulse Sensor

The Pulse sensor works by recognizing changes in blood volume beneath the skin, such as on the fingertip or ear cartilage, caused by the heart pumping blood through the body. It employments a light-emitting diode (Driven) to sparkle light into the skin and a photodetector to degree the sum of light ingested or reflected back. When blood volume increments amid a pulse, more light is ingested, decreasing the identified light. On the other hand, when blood volume diminishes between heartbeats, less light is ingested, expanding the recognized light concentrated. By checking these variances in light concentrated, the sensor precisely measures the user's beat rate, which is the number of heart beats per diminutive. This data is prepared by the sensor's gadgets to calculate and yield the beat rate in real-time. In general, the beat sensor identifies changes in blood volume utilizing light retention or reflection to degree beat rate accurately.

3.2.3. Temperature Sensor (DHT11)

The DHT11 temperature sensor works by carefully detecting temperature changes employing a semiconductor fabric, ordinarily silicon. Its electrical resistance shifts with temperature, and an inside analog-to-digital converter (ADC) changes over this resistance into a advanced flag. Utilizing the 1-Wire communication convention from Proverb Coordinates, the sensor permits different associations to a single microcontroller stick, simplifying wiring. Each sensor encompasses a special 64-bit serial code put away in its Read-Only Memory (ROM) for person distinguishing proof in multi-sensor setups. Encased in a little, waterproof bundle, the DHT11 sensor is appropriate for different situations, securing against dampness and clean. Generally, it gives exact and solid temperature estimation, making it reasonable for applications extending from indoor climate control to mechanical forms, much appreciated to its advanced yield and strong design.

3.2.4. Global System for Mobile Communication (GSM)

To distribute recurrence groups among clients in an efficient manner, GSM uses Time Division Differential Access (TDMA) and Recurrence Division Multiple Access (FDMA). In order to manage calls and data transmission, its framework consists of Versatile Stations (MS), Base Handset Stations (BTS), Base Station Controllers (BSC), Portable Exchanging Centers (MSC), and Domestic Area Registers (HLR). In order to ensure a stable network, communication starts with the client and moves through BTS, BSC, and MSC with assistance from HLR. Client protection is ensured by security methods like encryption and confirmation. Generally speaking, GSM provides strong security, efficient recurring band assignment, and organized coordination to ensure dependable portable Communication Centers (MSC), as well as Home Location Registers (HLR), for user authentication, handovers, and call routing. SIM cards were used to store user data, improve device security and mobility, and provide mutual authentication and A5 encryption.

3.2.5. Arduino Uno

The operational principle of the Arduino Uno revolves around the sequence of input acquisition, processing, and output generation. Initially, it acquires input from sensors or switches connected to its digital or analog pins. Subsequently, the ATmega328P microcontroller executes instructions encoded in the Arduino sketch to process this input. Based on this processing, the board generates output signals to govern actuators such as motors or LEDs. Optionally, it can provide feedback through connected output devices or communication channels to facilitate monitoring or debugging tasks. This iterative process enables the Arduino Uno to interact with the physical environment, enabling a diverse array of applications ranging from straightforward projects to intricate automation systems.

4. Result and discussion

The successful deployment of the health monitoring system has demonstrated its effectiveness in delivering real-time access to crucial health metrics, both locally and remotely. Through the integration of various sensors like the DHT11, pulse sensor, and alcohol sensor, the system ensured precise and comprehensive health data collection. Incorporating an LCD display enabled immediate feedback, empowering users to monitor their health parameters seamlessly and stay informed about their well-being. Additionally, the integration of a GSM module facilitated remote communication, enabling the transmission of health data to the Thingspeak mobile application. This feature provided users with convenient access to their health metrics from any location, offering enhanced flexibility and accessibility. The user-friendly interface of the Thingspeak app further improved the user experience, allowing intuitive navigation and easy tracking of temperature, humidity, pulse rate, and alcohol levels. The system's versatility was evident in its ability to cater to both local and remote health monitoring requirements effectively.

The synchronized operation of the Arduino Uno, sensors, LCD display, and GSM module demonstrated successful integration of hardware components and software functionalities. Throughout testing, the system consistently delivered accurate and reliable readings, offering users a comprehensive overview of their health status. Discussions surrounding the system highlighted its capability to bridge the gap between on-site and remote health monitoring, serving as a significant advantage. The seamless communication between the Arduino Uno and the Thingspeak app not only improved accessibility and usability but also aligned closely with the project's goal of providing individuals with proactive health management tools. However, there are opportunities for further refinement, including exploring additional sensors to expand the range of monitored health parameters and incorporating continuous user feedback mechanisms for iterative improvements. Overall, the implementation results underscore the promising potential of the proposed health monitoring system, offering a comprehensive and accessible solution for proactive health management and improved well-being.

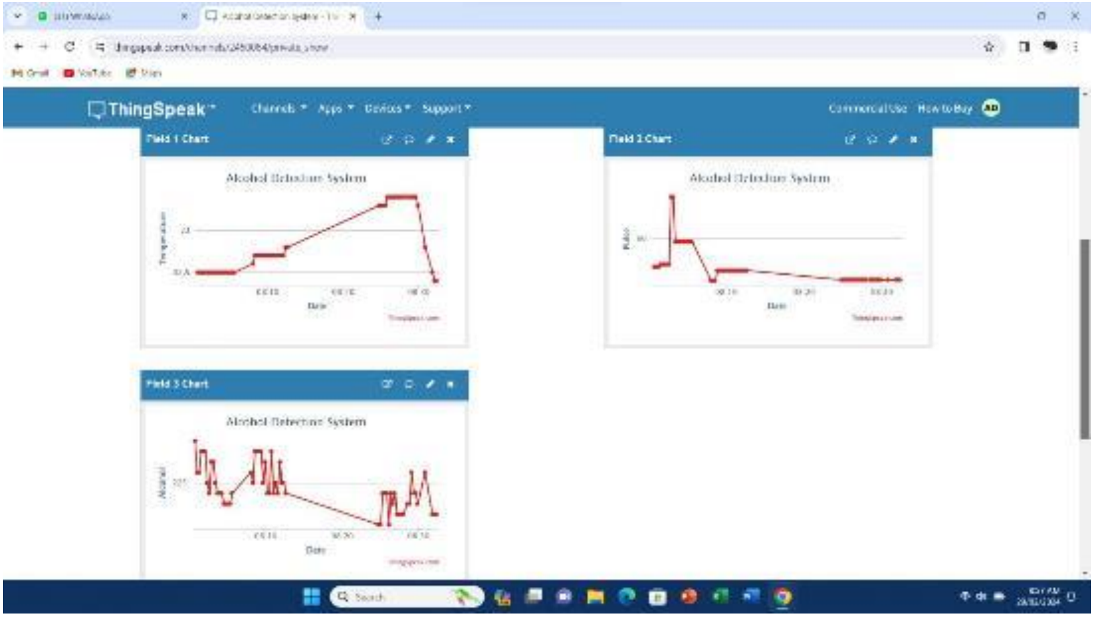

Figure 9 Thingspeak cloud values

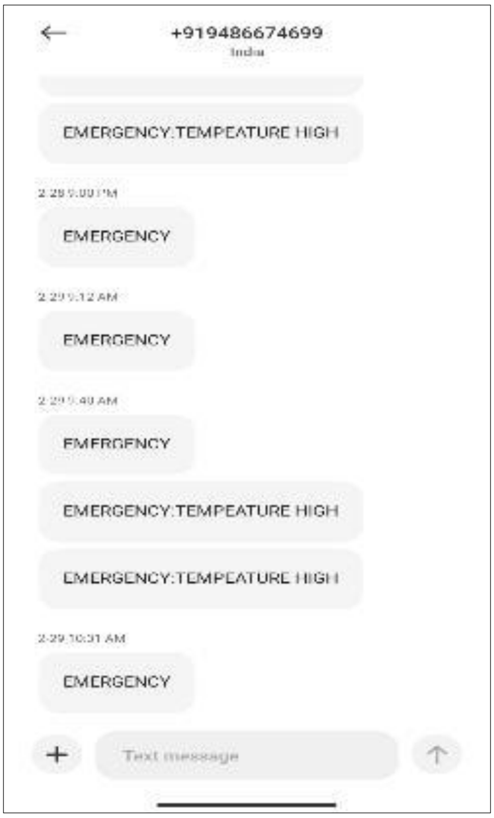

Figure 10 Alert message

5. Conclusion and Future Scope

The development and implementation of the health monitoring system have effectively tackled the shortcomings of existing solutions, providing a robust platform for tracking vital health parameters. By integrating Arduino Uno, various sensors, an LCD display, and a GSM module alongside the user-friendly Thingspeak app, a versatile tool has been created, offering comprehensive health monitoring capabilities both locally and remotely. Looking forward, several avenues for future improvement and expansion are evident. Incorporating additional sensors to capture a wider array of health data would enrich the system's insights, empowering users with a more holistic understanding of their well-being. Moreover, integrating machine learning algorithms could leverage historical health data to offer predictive insights and personalized recommendations, enhancing the system's utility and value to users. Exploring wearable devices or miniaturized components could enhance user comfort and promote continuous health monitoring, fostering greater engagement with the system. Collaborating with healthcare professionals to validate the accuracy and reliability of the system's readings would bolster its credibility for clinical and preventive healthcare applications. Optimizing power consumption for prolonged device operation and exploring scalability options to support diverse health sensors and parameters are also vital considerations for future enhancements. In essence, the health monitoring system presented lays a strong foundation for proactive and user-centric health management. As technology advances, there is considerable potential for further refinement, making health monitoring systems increasingly sophisticated, user-friendly, and indispensable tools for promoting overall well-being.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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Authors short Biography

	**S Nanthini** graduated with a bachelor's degree in information technology from Bon Secours College for Women, Bharathidasan University, Thanjavur, Tamil Nadu in the academic year of 2019–2022. She will be attending Bharathiar University in Coimbatore, Tamil Nadu, from 2022 to 2024 to pursue a master's degree in information technology. The Internet of Things is her area of interest.
	**Dr. R. Vadivel** holds the position of Associate Professor in the Department of Information Technology at Bharathiar University in Tamil Nadu, India. 2013 saw him graduate from Manonmaniam Sundaranar University with a Ph.D. in computer science. He received his B.E. in computer science and engineering from Periyar University in 2002, his M.E. in computer science and engineering from Annamalai University in 2007, and his diploma in electronics and communication engineering from the State Board of Technical Education in 1999. He had over 40 conference papers and over 96 journal articles published in both national and international journals. Digital signal processing, data mining, and information security are some of his interests.