American Journal of Botany and Bioengineering
https://biojournals.us/index.php/AJBB
ISSN: 2997-9331

Monitoring the Patient's Blood Pressure Based on the Internet of Things (Lot)

Saleh Jabbar Kamoun Alwan
College name / Hillah University College Department / Medical Devices Engineering Technology

Mustafa Khalil Shahwaz Fattah
Middle Technical University, College of Electrical Engineering Medical Equipment Department

Musa Jasim Hammadi Idan
Bilad ALRafidaun University Department Medical device technology Engineering

Received: 2025 19, Feb
Accepted: 2025 28, Mar
Published: 2025 18, Apr

Annotation: The growing demand for accessible and efficient healthcare services has accelerated the development of smart technologies for remote patient monitoring. Traditional blood pressure monitoring methods are limited by their reliance on manual readings and in-clinic visits, presenting challenges in continuous patient care. This study addresses this gap by designing an Internet of Things (IoT)-based system for real-time blood pressure monitoring. The system integrates Arduino-compatible sensors, ESP32 microcontrollers, and MQTT protocol for data transmission, alongside a mobile application interface for user accessibility. Alerts are automatically sent via Gmail when abnormal readings are detected. By analyzing case scenarios—normal, hypertensive, and hypotensive conditions—the system demonstrated its reliability in tracking fluctuations and enhancing early intervention. The implication of this technology lies in its potential to reduce hospitalization rates, support chronic disease management, and empower patients through continuous, home-based monitoring solutions.

Keywords: Internet of Things, blood pressure monitoring, remote healthcare, Arduino, real-time

alerts, hypertension, hypotension, patient safety.

Introduction

Monitoring a patient's blood pressure is an important part of medical care for many conditions, including hypertension, heart disease, and stroke. Traditionally, blood pressure monitoring involves manual measurement by a healthcare provider using a sphygmomanometer. However, with the increasing availability and affordability of Internet of Things (IoT) technology, it is now possible to remotely monitor a patient's blood pressure in real-time.

The IoT is a network of interconnected devices that communicate with each other to exchange data. In the context of healthcare, IoT devices can include wearable sensors, smart blood pressure cuffs, and other medical devices that can transmit data to healthcare providers or caregivers. By using IoT technology for blood pressure monitoring, healthcare providers can remotely track a patient's blood pressure over time and make adjustments to their treatment plan as needed.

The advantages of IoT-based blood pressure monitoring are numerous. Patients can be monitored in real-time, which can lead to early detection of changes in blood pressure that may require intervention. This can lead to better outcomes and a reduction in hospitalization rates. Additionally, IoT-based blood pressure monitoring can be done remotely, which can save time and reduce healthcare costs. Patients can also be more involved in their care and can take an active role in managing their blood pressure by tracking it themselves.

So, IoT-based blood pressure monitoring has the potential to revolutionize healthcare by improving patient outcomes, increasing access to care, and reducing healthcare costs.

The main goal of this project as the following:

1. Improving hypertension management: The project aims to improve hypertension management by providing patients with a tool that can monitor their blood pressure continuously, alert them of any fluctuations or changes, and help them manage their condition more effectively.
2. Facilitating remote patient monitoring: The project aims to facilitate remote patient monitoring by providing patients with a system that they can use at home, reducing the need for frequent hospital visits, and allowing healthcare providers to monitor their condition remotely.
3. Enabling early detection and intervention: The project aims to enable early detection and intervention of hypertension by providing patients and healthcare providers with real-time blood pressure data that can help identify potential issues before they become more severe.
4. Reducing expenses paid to provide health care to a patient in case of a coma.

1. Hardware:

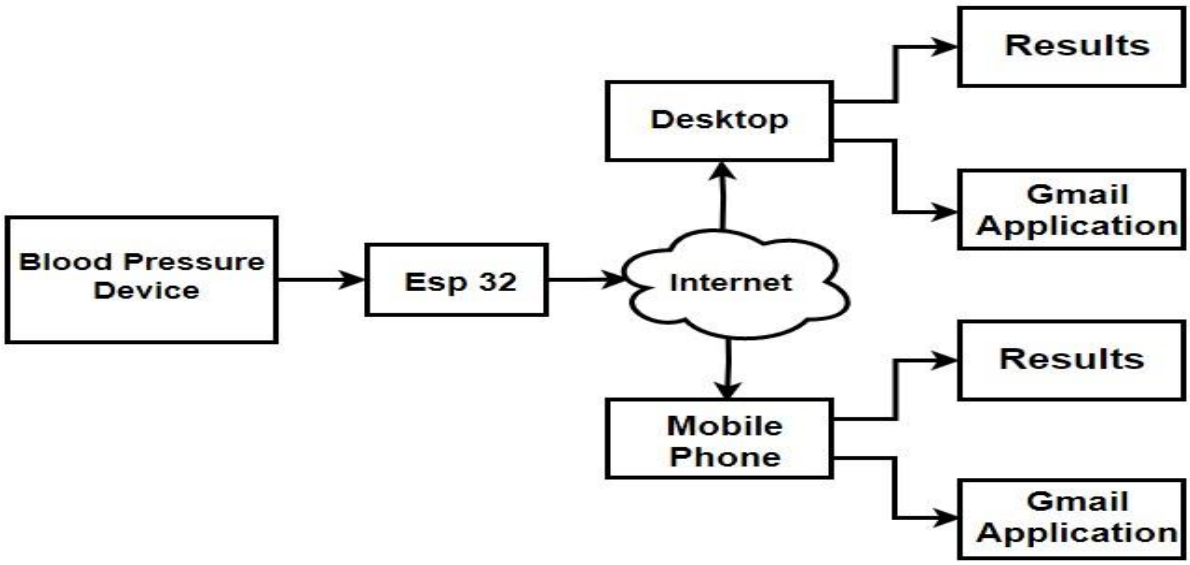
- ✓ Ardunic Blood Pressure Sensor,
- ✓ ESP32,
- ✓ Bread Board,
- ✓ Arduinc Mini Pro,
- ✓ DisPlay,
- ✓ Mother Board Processer,
- ✓ Air Motor,

- ✓ Talking head Phone,
- ✓ Start Button,
- ✓ Wire Delivery,
- ✓ Air Delivery tube,
- ✓ Battery,

Software:

- ✓ Arduino IDE
- ✓ Remote XY Arduino Control.

The designed a system for an IoT blood pressure monitoring device involves several components, including hardware, software, and communication protocols the block diagram of the system is shown below. Here is an overview of the design system:



To create a pressure measurement and monitoring system that sends Gmail alerts to a mobile phone, the following steps could be taken:

1. Hardware Setup: The system would require a blood pressure monitor with a microcontroller, sensors, and a wireless communication module. The microcontroller would need to be programmed to receive data from the sensors and send it wirelessly to a remote server. The wireless communication module could be a Wi-Fi module, which would allow the device to connect to a local Wi-Fi network.

2. Software Development: The software for the system would include firmware for the microcontroller, data processing software, and an email client. The firmware would need to be programmed to send the data from the sensors to the remote server via the Wi-Fi module. The data processing software would receive the data from the remote server and process it to determine if the blood pressure readings were within a safe range. If the readings were not within a safe range, an alert email would be sent to the user's Gmail account. The email client would be programmed to read the alert email and send it to the user's mobile phone.

3. Gmail Account Setup: The user would need to set up a Gmail account to receive the alert emails. The Gmail account would need to be configured to forward the alert emails to the user's mobile phone.

4. Mobile Phone Configuration: The user's mobile phone would need to be configured to receive the alert emails. The user would need to set up their email client on their mobile phone and configure it to receive emails from their Gmail account.

Figure 1: (a) Design of a PV system.

In summary, the pressure measurement and monitoring system would require a blood pressure monitor with a microcontroller, sensors, and a wireless communication module. The software for the system would include firmware for the microcontroller, data processing software, and an email client. The system would send alert emails to the user's Gmail account, which would then be forwarded to their mobile phone. The user's mobile phone would need to be configured to receive the alert emails. **Figure**

Discussing Three Cases to Prove Robustness the designed System

- **Case One: Normal Blood Pressure**

Even in cases of normal blood pressure, IoT-enabled blood pressure monitors can still be useful. Regular monitoring of blood pressure can help individuals maintain their blood pressure within a healthy range and identify any changes in blood pressure that may require further evaluation. In addition, IoT-enabled blood pressure monitors can provide individuals with personalized insights into their health status by tracking trends and changes in their blood pressure over time.

Furthermore, individuals with normal blood pressure can use IoT-enabled blood pressure monitors to monitor the effects of lifestyle changes, such as changes in diet and exercise, on their blood pressure. This can help them determine the effectiveness of these interventions and make informed decisions about their health.

Overall, IoT-enabled blood pressure monitors can provide individuals with a better understanding of their health status and enable them to take proactive steps to maintain their health, even in cases of normal blood pressure.

Normal blood pressure

- **Case Two: Hypertension**

In the case of hypertension, IoT-enabled blood pressure monitors can be particularly beneficial. Hypertension is a chronic condition that requires long-term monitoring and management to prevent serious health complications. With IoT-enabled blood pressure monitors, patients can monitor their blood pressure at home and share the data with their healthcare providers in real-time.

This can help healthcare providers to identify changes in blood pressure levels and adjust medication dosages or other interventions accordingly. IoT-enabled blood pressure monitors can also provide patients with personalized insights into their health status and help them to better manage their condition through regular monitoring.

Furthermore, IoT-enabled blood pressure monitors can be used to track the effectiveness of different treatments and lifestyle modifications on blood pressure levels. For example, patients can track the effects of exercise, diet, and stress reduction on their blood pressure over time and make informed decisions about their health based on the data.

Overall, IoT-enabled blood pressure monitors can provide a more comprehensive approach to managing hypertension, allowing patients to monitor their blood pressure at home and receive timely interventions from their healthcare providers. This can lead to better outcomes, fewer hospitalizations, and a higher quality of life for patients with hypertension.

Hypertension

- **Case Three: Hypotension**

IoT-enabled blood pressure monitors can also be useful in cases of hypotension, which is a condition characterized by abnormally low blood pressure. Hypotension can cause symptoms such as dizziness, lightheadedness, and fainting, and can be caused by various underlying conditions such as dehydration, heart problems, or hormonal imbalances.

In cases of hypotension, IoT-enabled blood pressure monitors can help individuals monitor their blood pressure levels and identify any sudden drops or changes that may require medical attention. For example, individuals with chronic hypotension can use IoT-enabled blood pressure monitors to track their blood pressure over time and monitor any changes in response to medications or other interventions.

- **Case Three: Hypotension**

IoT-enabled blood pressure monitors can also be useful in cases of hypotension, which is a condition characterized by abnormally low blood pressure. Hypotension can cause symptoms such as dizziness, lightheadedness, and fainting, and can be caused by various underlying conditions such as dehydration, heart problems, or hormonal imbalances.

In cases of hypotension, IoT-enabled blood pressure monitors can help individuals monitor their blood pressure levels and identify any sudden drops or changes that may require medical attention. For example, individuals with chronic hypotension can use IoT-enabled blood pressure monitors to track their blood pressure over time and monitor any changes in response to medications or other interventions.

Furthermore, IoT-enabled blood pressure monitors can be used to monitor the blood pressure of individuals who are at risk of developing hypotension, such as those who are dehydrated or those who have certain medical conditions. This can help these individuals to take proactive steps to prevent hypotensive episodes and maintain their blood pressure within a healthy range.

Overall, IoT-enabled blood pressure monitors can provide individuals with a better understanding of their blood pressure levels and enable them to take proactive steps to maintain their health, even in cases of hypotension. Regular monitoring of blood pressure can help individuals identify any changes in blood pressure that may require medical attention, and enable them to take timely interventions to prevent any serious complications.

Hypotension

In conclusion, IoT-enabled blood pressure monitors have the potential to revolutionize the management of blood pressure-related conditions such as hypertension and hypotension. These devices offer several advantages over traditional blood pressure monitors, including the ability to monitor blood pressure in real-time, track changes in blood pressure over time, and share data with healthcare providers.

In the case of hypertension, IoT-enabled blood pressure monitors can provide patients with a cost-effective and convenient solution for monitoring their blood pressure at home. This can help healthcare providers to identify changes in blood pressure levels and adjust medication dosages or other interventions accordingly, leading to better outcomes for patients.

In the case of hypotension, IoT-enabled blood pressure monitors can help individuals to monitor their blood pressure levels and identify any sudden drops or changes that may require medical attention. Additionally, individuals at risk of developing hypotension can use these devices to take proactive steps to prevent hypotensive episodes and maintain their blood pressure within a healthy range.

Overall, IoT-enabled blood pressure monitors hold great promise for improving the management of blood pressure-related conditions and enabling individuals to take a more proactive approach to their health. With continued innovation and development in this field, we can expect to see even more advanced and effective blood pressure monitoring solutions in the future.

Resources

1. M.S. Bogner, Human Error in Medicine (Human Error and Safety), CRC Press, Boca Raton, FL, 2018.
2. P.A. Palmieri, P.R. DeLucia, L.T. Peterson, T.E. Ott, A. Green, The anatomy and physiology of error in adverse health care events, in: G.T. Savage, E.W. Ford (Eds.), Patient Safety and Health Care Management, vol. 7, Emerald Group Publishing Limited, Bingley, 2008, pp. 33–68.
3. Australian Institute of Health and Welfare, Australia's Health 2018, AIHW, Canberra, 2018.
4. D.S. Tawfik, et al., Physician burnout, well-being, and work unit safety grades in relationship to reported medical errors, Mayo Clin. Proc. 93 (11) (2018) 1571–1580.
5. A.W. Stimpfe, J. Fletcher, C.T. Kovner, A comparison of scheduling, work hours, overtime and work preferences across four cohorts of newly licensed registered nurses, J. Adv. Nurs. 75 (9) (2019) 1902–1910. N.S. Weingart, R.M. Wilson, R.W. Gibberd,