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Research Paper

REAL- TIME HEALTHCARE MONITORING AND TREATMENT SYSTEM BASED MICROCONTROLLER WITH IOT

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ABSTRACT

Health monitoring systems have achieved great popularity and great importance, especially with the presence of pandemics, large numbers of patients, and a lack of health staff. The presence of sensors on the patient's body to measure blood pressure, body temperature, and heart rate, in addition to room temperature and humidity, constantly supports the specialized medical staff in measuring these indicators. The advantage of these devices is that they are with the patient all the time, and a nurse cannot accompany a patient for this period. In this paper, a health care system is designed and implemented to measure vital signs and room environment temperature and humidity. Controller receives the vital signs data from the patient and his room. This information has been sent to the Raspberry Pi pico where the information was compared to the information provided by the doctor to ensure obtaining the alarm when the measure has a large difference. The system obtains two types of alarms; the first is a medical alarm that accrues when vital signs are high or low from the normal measurements. This alarm calls the medical staff, while the second alarm occurs during a hardware malfunction. The second type of alarm call the technical staff. Testing the system shows that the two types of alarm have been recognized on their occurrence. All these measurements and alarms have been stored in the cloud for patient health monitoring.

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1. INTRODUCTION

The term Internet of Things (IoT) was invented by Kevin Ashton in 1999 and refers to data on the Internet that are connected to evolving global service architecture [1,2]. IoT is the product of advanced research on information and communications technology. It can potentially enhance urban residents' quality of life. Since the global population is increasing at an astonishing rate, and the prevalence of chronic diseases is also on the rise, there is growing demand for designing cost-effective healthcare systems that can efficiently manage and provide a wide range of medical services while reducing overall expenses [3,4,5,6]. The IoT has become a key development area recently, enabling healthcare-monitoring system advancement. The IoT healthcare-monitoring system aims to accurately track people and connect various services and things in the world through the Internet to collect, share, monitor, store, and analyze the data generated by these things [7]. However, the IoT is a new paradigm where all connected physical objects in any intelligent application, such as smart city, smart home, and smart healthcare, are addressed and controlled remotely. Diagnosing disorders and monitoring patients is essential to providing medical care, and applying sensor networks to the human body will significantly assist in this endeavor. In addition, the information is readily accessible from any location in the world at any given time [8]. Patients with severe injuries or from certain areas may have difficulty reaching the hospital. Therefore, they can use video conferencing to communicate with their doctors to improve their health while saving money and time. Patients can use this technology to record their health conditions on their phones [9]. It is anticipated that the benefits of the IoT will be improved and result in individualized treatment, improving patient outcomes while saving healthcare management costs. IoT systems allow physicians to keep an eye on their patients remotely and schedule their appointments more efficiently. Patients also can improve their home healthcare to reduce their need for doctor visits and the likelihood of receiving unnecessary or inappropriate medical treatments in hospitals or clinics. For this reason, the quality of medical care and the overall safety of patients may improve, while the overall cost of care may decrease. The IoT holds significant potential in healthcare [7,10]. It will not be long before we have access to a health-monitoring system that can be used from the comfort of our homes and streamline hospital processes. IoT sensors should be densely deployed to monitor the body and environment continuously. This effort will enable the tracking of chronic-disease management and rehabilitation progress. In the future of virtual consultations for remote medical care, the IoT will be able to provide efficient data connections from multiple locations [11]. Most of the current implementations of the IoT and research on it are undeveloped and focus on deploying and configuring technology in various contexts and conditions. However, these practices are not widely used today. Therefore, this paper aims to evaluate related research on designing and implementing an IoT-based healthcare-monitoring system that improves quality of life. These systems rely heavily on IoT devices and sensors to connect patients with the healthcare providers best suited for their care. The main contribution of this research paper is to highlight IoT-based healthcare-monitoring systems in detail so that future researchers, academicians, and scientists can easily find a roadmap to understand the current healthcare-monitoring systems and can easily provide solutions and enhancements for such critical applications. In this research paper, we provide a general idea of IoT-based healthcare-monitoring systems in a systematic way, along with their benefits and significance, and a literature review. Moreover, we discuss the concepts of wearable things in healthcare systems from an IoT perspective. The paper also provides a classification of healthcare-monitoring sensors, addresses security and protocols for IoT healthcare-monitoring systems, and details challenges and open issues. We also suggest solutions to overcome these challenges and issues in the future.

2. RELATED WORK

2.1. IOT Based Healthcare systems and their applications

IoT-based healthcare systems and their applications facilitates people's lives in different ways, such as:

1. Remote healthcare: Wireless IoT-driven solutions bring healthcare to patients rather than the patient to healthcare. Data are collected securely through IoT-based sensors, and the data are analyzed by a small algorithm before being shared with health professionals for appropriate recommendations.
2. Real-time monitoring: IoT-driven non-invasive-monitoring sensors collect comprehensive psychological information. Gateways and cloud-based analysis manage the storage of data.
3. Preventive care: IoT healthcare systems use sensor data, which help with the early detection of emergencies and alerts family members. Machine learning for health-trend tracking and early anomaly detection is achieved through the IoT approach [12].

2.2. The Significance of IoT-Based Healthcare-Monitoring Systems

The development of monitoring systems for healthcare is receiving a great deal of attention from researchers and leaders in the medical field. Several successful research projects have been conducted in this area, and many more are currently underway [13]. The number of gaps in care provided by healthcare providers is increasing significantly, directly resulting from the rapidly growing number of older adults and patients with chronic illnesses. The major shortcoming is that healthcare is only provided in hospitals; therefore, it is unsuitable for seniors and people with disabilities and cannot always meet their needs [14]. The IoT, with the help of sensor values and telecommunications, provides an effective and practical solution to the issue of real-time monitoring of the health status of the elderly. It has been shown that the IoT, in conjunction with smart technologies, can provide various improved and enhanced services. Using sensors, researchers have developed various emergency systems using technologies that enable intelligent and remote wireless communication. These technologies have been used for various medical purposes, particularly in monitoring the health of the elderly. This way, data can be collected on general health and dangerous situations by capturing important vital signs [15].

2.3. Benefits of Using IoT in Healthcare

The IoT will reshape healthcare as we know it, with profound implications. In terms of how apps, devices, and people communicate with each other to deliver healthcare solutions, we have reached a whole new level of evolution. The IoT has given us a new perspective and tools for an integrated healthcare network, greatly improving healthcare quality. The IoT has made it possible to automate healthcare procedures that previously required a significant amount of time and left room for error due to human involvement. For example, to control airflow and temperature in operating rooms, many hospitals now use networked devices. There are almost endless ways the IoT can improve medical care; however, the following are some of the key benefits:

- Reduced cost of care.
- Human errors are reduced.
- Elimination of the limitations of distance.
- Reduced amounts of paperwork and record keeping.
- Chronic diseases are detected early.
- Improvements in medication management.
- The need for prompt medical care.
- Better treatment outcomes.

3. METHODOLOGS

3.1 EXISTING SYSTEM

Existing system presents a health care monitoring system. In particular, COVID-19 patients, high blood pressure patients, diabetic patients, etc., in a rural area in a developing country, such as Bangladesh, do not have instant access to health or emergency clinics for testing. Buying individual instruments or continuous visitation to hospitals is also expensive for the regular

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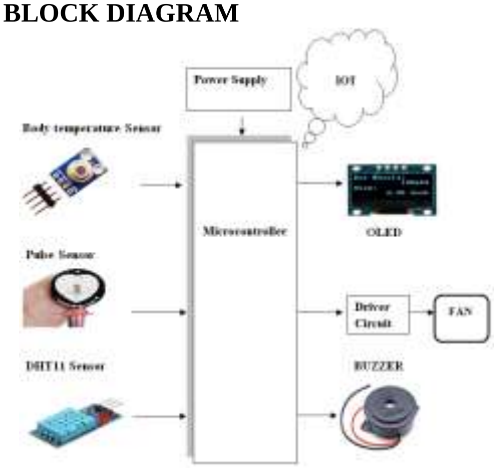
population. The system will measure a patient's body temperature, heartbeat, and send the data to a mobile application using Bluetooth. The mobile application was created via the Massachusetts Institute of Technology (MIT) inventor app and will receive the data from the device over Bluetooth.

3.2 PROPOSED SYSTEM

The proposed system is a real-time healthcare monitoring and treatment solution that leverages microcontroller-based hardware integrated with IoT technology. It continuously tracks vital signs such as heart rate, body temperature and DHT11 using biomedical sensors. The collected data is processed by a microcontroller and transmitted wirelessly to a cloud platform or mobile application for real-time access. This enables healthcare professionals or caregivers to monitor patient conditions remotely and make timely decisions. The system can also trigger alerts via SMS or app notifications if any health parameter crosses critical thresholds. Additionally, it can be programmed to activate emergency treatments or medication reminders based on sensor inputs. The device is designed to be compact, portable, and energy-efficient for use in homes, hospitals, or ambulances. IoT integration ensures seamless data logging, analytics, and remote diagnostics. This solution aims to reduce response time, improve patient outcomes, and support continuous health management, especially for elderly or chronically ill individuals.

3.3 BLOCK DIAGRAM



3.4 HARDWARE REQURIMENTS

3.4.1 RASPBERRY PI PICO W

Raspberry Pi Pico W is **Raspberry Pi**'s first wireless microcontroller board, designed especially for physical computing. It is the successor of the popular **Raspberry Pi Pico** board. Similar to the Pico board, which we discussed earlier, the **Pico W** board is also built around the **Raspberry Foundation** in-house ARM chip RP2040. The main improvement is the addition .of Wi-Fi and Bluetooth functionality. **Raspberry Pi Pico W** incorporates an Infineon **CYW43439** wireless chip that supports IEEE 802.11 b/g/n wireless LAN, and Bluetooth 5.2.

Raspberry Pi Pico Vs Raspberry Pi Pico W

The main difference between the **Pico** and **Pico W** is the inclusion of Infineon's CYW43439 2.4-GHz Wi-Fi chip, which is responsible for WiFi and Bluetooth. Another major change is with the power section. The new Pico W uses the **RT6154A** from **Richtek** as the power regulator instead of the **RT6150B** in the original Pico design. The debug port also moved near the SoC to make space for the Wi-Fi antenna.

Raspberry Pi Pico W Specifications:

The key features of Raspberry Pi Pico W are the following:

- **RP2040** microcontroller chip designed by Raspberry Pi in
- **Dual-core ARM Cortex M0+** processor, flexible clock running up to 133 MHz
- 264kB of **SRAM**, and 2MB of onboard Flash memory
- On-board single-band 2.4GHz wireless interfaces (802.11n)
- Castellated module allows soldering directly to carrier boards
- USB 1.1 Host and Device support
- Low-power sleep and dormant modes
- Drag & drop programming using mass storage over USB
- 26 multi-function GPIO pins
- 2×SPI, 2×I2C, 2×UART, 3×12-bit ADC, 16×controllable PWM channels
- Accurate clock and timer on-chip
- Temperature sensor
- Accelerated floating point libraries on-chip
- 8×Programmable IO (PIO) state machines for custom peripheral support

3.4.3 OLED (Organic Light Emitting Diodes)

OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight).

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OLED displays are not just thin and efficient - they provide the best image quality ever and they can also be made transparent, flexible, foldable and even rollable and stretchable in the future. OLEDs represent the future of display technology!

Specifications

- ✓ Use CHIP No.SH1106
- ✓ Use 3.3V-5V POWER SUPPLY
- ✓ Graphic LCD 1.3" in width with 128x64 Dot Resolution
- ✓ White Display is used for the model OLED 1.3 I2C WHITE and blue Display is used for the model OLED 1.3 I2C BLUE
- ✓ Use I2C Interface
- ✓ Directly connect signal to Microcontroller 3.3V and 5V without connecting through Voltage Regulator Circuit
- ✓ Total Current when running together is 8 mA - PCB Size: 33.7 mm x 35.5 mm

3.4.4 DHT11 – TEMPERATURE AND HUMIDITY SENSOR

DHT11 Specifications:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%

3.4.5 BODY TEMPERATURE SENSOR

FEATURES

- High Accuracy and Low-Voltage Operation Aids Designers in Meeting Error and Power Budgets
  - 0.1°C Accuracy (37°C to 39°C)
  - 16-Bit (0.00390625°C) Temperature Resolution
  - 2.7V to 3.3V Supply Voltage Range
- One-Shot and Shutdown Modes Help Reduce Power Usage
- 600μA (typ) Operating Supply Current
- Digital Functions Make Integration Easier into Any System
  - Selectable Timeout Prevents Bus Lockup
  - Separate Open-Drain OS Output Operates as Interrupt or Comparator/Thermostat Output

Benefits and Features

- High Accuracy and Low-Voltage Operation Aids Designers in Meeting Error and Power Budgets
  - 0.1°C Accuracy (37°C to 39°C)
  - 16-Bit (0.00390625°C) Temperature Resolution
  - 2.7V to 3.3V Supply Voltage Range
- One-Shot and Shutdown Modes Help Reduce Power Usage
- 600μA (typ) Operating Supply Current
- Digital Functions Make Integration Easier into Any System
  - Selectable Timeout Prevents Bus Lockup
  - Separate Open-Drain OS Output Operates as Interrupt or Comparator/Thermostat Output

3.4.6 HEART RATE USING PULSE SENSOR

S (Signal) is the signal output.Connects to analog input of an Arduino.
+ (VCC) is the VCC pin. Connects to 3.3 or 5V.
– (GND) is the Ground pin.

Technical Specifications

Here are the technical specifications:

Maximum Ratings	VCC	3.0 – 5.5V
	IMax (Maximum Current Draw)	< 4mA
	VOut (Output Voltage Range)	0.3V to Vcc
Wavelength	LED Output	565nm
	Sensor Input	525nm
Dimensions	L x W (PCB)	15.8mm (0.625″)
	Lead Length	20cm (7.8″)

.4.7 RELAY

INTRODUCTION

A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Fig. Relay

Advantage of relay:

A relay takes small power to turn ON, but it can control high power devices to switch ON and OFF. Consider an example; a relay is used to control the ceiling FAN at our home. The ceiling FAN may runs at 230V AC and draws a current maximum of 4A. Therefore the power required is 4X230 = 920 watts. Off course we can control AC, lights, etc., depend up on the relay ratings. Relays can be used to control DC motors in ROBOTICs.

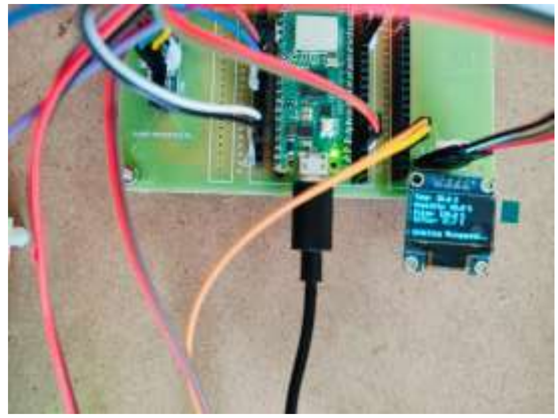
3.4.8 BUZZER

USES

- Annunciator panels
- Electronic metronomes
- Game shows
- Microwave ovens and other household appliances
- Sporting events such as basketball games
- Electrical alarms

Fig. Buzzer

4. IMPLEMENTATION & RESULTS



5. CONCLUSION

In this review, the use of iot in health monitoring systems has been summarized. Although iot is being used in all sectors of medical science, there is room for further improvement and research. The early identification of any health problem can help the patient to take necessary emergency measures, which can potentially save the patient's life. Iot can help in this regard. Iot based health monitoring systems can monitor the patients in real-time and warn the patient of any abnormalities. However, the iot architecture must have the facilities to ensure the proper security of sensitive data. Also, the used sensors must be small in size so that they can be easily incorporated into various systems.

REFERENCES

[1] Riazul Islam, S.M., Kwak, D., Kabir, H., Hossain, M., Kwak, K.S. (2015). The internet of things for health care: a comprehensive survey. IEEE Access, 3: 678-708. http://dx.doi.org/10.1109/ACCESS.2015.2437951

[2] Agu, E., Pedersen, P., Strong, D., Tulu, B., He, Q., Wang, L., Li, Y. (2013). The smartphone as a medical device: Assessing enablers, benefits and challenges. 2013 IEEE International Workshop of Internet-of-Things Networking and Control (IoT-NC), pp. 48-52. http://dx.doi.org/10.1109/IoT-NC.2013.6694053

[3] Lloyd-Jones, D., Adams, R., Carnethon, M., De Simone, G., Ferguson, T.B., Flegal, K., Ford, E., Furie, K., Go, A., Greenlund, K., Haase, N., Hailpern, S., Ho, M., Howard, V., Kissela, B., Kittner, S., Lackland, D., Lisabeth, L., Marelli, A., McDermott, M., Meigs, J., Mozaffarian, D., Nichol, G., O'Donnell, C., Roger, V., Rosamond, W., Sacco, R., Sorlie, P., Stafford, R., Steinberger, J., Thom, T., Wasserthiel-Smoller, S., Wong, N., Wylie-Rosett, J., Hong, Y.L. (2009). Heart disease and stroke statistics2009 update: A report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Circulation, 119(3): 480-486. https://doi.org/10.1161/CIRCULATIONAHA.108.191261

[4] Moser, L.E., Melliar-Smith, P.M. (2015). Personal health monitoring using a smartphone. 2015 IEEE International Conference on Mobile Services, pp. 344-351. http://dx.doi.org/10.1109/MobServ.2015.54

[5] Kong, X., Fan, B., Nie, W., Ding, Y. (2016). Design on mobile health service system based on Android platform. 2016 IEEE Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC), pp. 1683-1687. http://dx.doi.org/10.1109/IMCEC.2016.7867504

[6] Turner, J., Zellner, C., Khan, T., Yelamarthi, K. (2017). Continuous heart rate monitoring using smartphone. 2017 IEEE International Conference on Electro Information Technology (EIT), pp. 324-326. http://dx.doi.org/10.1109/EIT.2017.8053379

[7] Reddy, G.K., Achari, K.L. (2015). A non invasive method for calculating calories burned during exercise using heartbeat. 2015 IEEE 9th International Conference on Intelligent Systems and Control (ISCO), pp. 1-5. http://dx.doi.org/10.1109/ISCO.2015.7282249

[8] World Health Day 2016: Beat diabetes. World Health Organization, 2016. Available: http://www.who.int/campaigns/worldhealthday/2016/en/, accessed on 01- Oct- 2019.