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A Review on IoT Based Smart Healthcare Monitoring System for ICU Patients

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Abstract: *In recent pandemic situation due to coronavirus healthcare institutions have been experiencing tremendous strain. It is becoming very difficult to monitor each and every patient who requires intensive care. Keeping track of your patient's health status is a difficult task due to huge of patients and limited medical staff. Especially, critical and elderly patients should be monitored periodically. So, we propose an innovative and revolutionary and cost-effective system which automates the monitoring of all the vital parameters of health like Blood Pressure, Blood oxygen level, body temperature, heart rate, room temperature, room humidity, level measurement in urine bag, ECG. Our equipment uses a smart webserver to track patient health using this tracking system. So, using all these parameters patients can be monitored remotely for the all the health parameters listed above. In this project, an IoT-based patient health monitoring system using Node MCU ESP32 is presented. We can measure Heart Rate/Pulse (BPM) as well as Blood Oxygen Level (SpO2) using the MAX30100 /102 pulse oximeter sensor. We use the DS18B20 temperature sensor to measure body temperature. Similarly, the patient needs to be kept in a room having a certain temperature and humidity level. Hence, the patient does not feel uncomfortable in the room. To do this we also need to monitor the room temperature and humidity. So, we use DHT11 Humidity and Temperature sensor.*

Keywords: IoT (Internet of Things), Smart Healthcare, Healthcare Monitoring Systems, Wireless Sensor Network (WSN), Medical Services.

I. INTRODUCTION

Corona pandemic has changed the world. Medical healthcare experienced unprecedented growth which broke medical infrastructure of many developed nations. In developing countries like India Medical infrastructure collapsed because of this enormous number of patients in hospitals. Most of the Covid cases needed extensive care but because of huge number of patients and a smaller number of medical staff lots of people lost their lives. There were around 500 million cases of covid and around 6.2 million people lost their lives. Healthcare monitoring system has been present for last few decades. But it is mostly manual and offline and requires a medical person to perform the monitoring. It is also very costly to setup and difficult to manage. In the recent times there has been revolutionary changes in the way healthcare technologies are progressing. There has been a lot work in the field IoT based technologies. World is connected online with all the tools and devices using IoT. These devices can provide real time data which can be stored in cloud and using machine learning and AI we can process this data to achieve desired results.

The Internet of Things (IoT) is described as the network of physical objects— "things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial, scientific and medical tools. With more than 7 billion connected IoT devices today, experts are expecting this number to grow 22 billion by 2025. But actual definition of IOT is creating a brilliant, invisible network which can be sensed, controlled and programmed. Since these devices connect through internet, they should provide a better life style, create safer and more engaged communities and transform healthcare. IOT mostly consists of sensors, gateway devices and wireless sensor network which enable us to access and communicate the application/information. As they say "Health is wealth", it is extraordinarily crucial to make use of the innovation for better wellbeing. Consequently, it is obliged to add to an IOT framework which gives secure health awareness checking. So, outlining a modern medical services framework where patient information is received by the sensor

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and sent to the cloud through wireless networks. These advancements can help us in creating a healthcare monitoring system using these new technologies and devices.

II. Literature Review

Imran khan et.el. [1] has proposed IoT-based, intelligent HMS which continuously monitors patient's health parameters like blood pressure, heart beat and ECG. Data from blood pressure sensor, heart rate sensor and ECG sensor automatically monitored by Arduino UNO and Pi-camera attached to raspberry pi for video. Arduino UNO sends sensor data to raspberry pi which fed data to server's database using Wi-Fi, finally server sent data to webpage, which updates every 2 minutes. Doctor access data anywhere using internet and give feedback accordingly using text.

R. Alekya et.el. [2] has presented as system on how IoT can be incorporated into complex health care procedures. The "Mobile Healthcare Management System (HMS)" is one of the main IoT apps that link the Internet to mobile sensors, people, clinicians, networks and other connected devices. The failed method, the IoT-based smart HMS, has made it possible for clinicians to monitor their patients in remote areas on an ongoing basis. The Internet of Things cooperates with numerous technologies, such as the Wireless Sensor Network (WSN), which communicates with each other through Coap, 6LoWPAN, REST and other protocols, such as radio frequency data, smart mobile inventions and wireless sensor networks.

Md. Milon Islam et.el [3] proposed a smart healthcare system in IoT environment that can monitor a patient's basic health signs as well as the room condition where the patients are now in real-time. In this system, five sensors are used to capture the data from hospital environment named heart beat sensor, body temperature sensor, room temperature sensor, CO sensor, and CO2 sensor. The error percentage of the developed scheme is within a certain limit (5%) for each case. The condition of the patients is conveyed via a portal to medical staff, where they can process and analyse the current situation of the patients. The developed prototype is well suited for healthcare monitoring that is proved by the effectiveness of the system Mohammad Monirujjaman Khan et.el. [4] presented a study on an IoT-based system that is a real-time health monitoring system utilizing the measured values of body temperature, pulse rate, and oxygen saturation of the patients, which are the most important measurements required for critical care. This system has a liquid crystal display (LCD) that shows the measured temperature, pulse rate, and oxygen saturation level and can be easily synchronized with a mobile application for instant access. The proposed IoT-based method uses an Arduino Uno-based system, and it was tested and verified for five human test subjects. The results obtained from the system were promising: the data acquired from the system are stored very quickly. The results obtained from the system were found to be accurate when compared to other commercially available devices. IoT-based tools may potentially be valuable during the COVID-19 pandemic for saving people's lives.

S. M. Riazul Islam et.el. [5] surveyed advances in IoT-based health care technologies and reviews the state-of-the-art network architectures/platforms, applications, and industrial trends in IoT-based health care solutions. In addition, this paper analyses distinct IoT security and privacy features, including security requirements, threat models, and attack taxonomies from the health care perspective. Further, this paper proposes an intelligent collaborative security model to minimize security risk; discusses how different innovations such as big data, ambient intelligence, and wearables can be leveraged in a health care context; addresses various IoT and eHealth policies and regulations across the world to determine how they can facilitate economies and societies in terms of sustainable development; and provides some avenues for future research on IoT-based health care based on a set of open issues and challenges

Pavani Lakshmi Penmatsa et.el. [6] explained about detection of abnormalities in heart through specially designed ECG circuit and transmission of data to smart phone via Bluetooth. Hence provides real time monitoring of the health care parameters for doctors and care takers where data can be accessed anytime. This system is efficient with low power consumption capability, easy setup, high performance and time to time response. This paper explains in brief how IoT functions and how it is used in conjunction with wireless and sensing techniques to implement the desired healthcare applications.

Chanchal Raj et,el. [7] presented a low cost Health sensor platform for rural health monitoring with a well-structured and secure interface between medical experts and Remote centers for sharing of important medical parameters. In our proposed and implemented model we developed separate interface for medical experts and remote Centre's and introduced a new algorithm for implementation. Features like live video streaming, chat boxes, automatic prescription generation and push notification are included. The prototype is used for trial under the supervision of medical experts and the data are compared with standard test done in pathological laboratory. The result is satisfactory with good level of acceptance.

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III. Proposed Work

The System architecture includes two main sections.

- Hardware architecture
- Software architecture

3.1 Hardware Architecture

Health monitoring system consisting of sensors along with peripheries for valuable operation. Here we have discussed prototype of hardware used:

1. **ESP 32:** The ESP32 is a very versatile System On a Chip (SoC) that can be used as a general purpose microcontroller with quite an extensive set of peripherals including Wi-Fi and Bluetooth wireless capabilities.
2. **MAX30100:** Pulse Oximeter is integrated Pulse Oximetry and Heart Rate monitor sensor solutions. It operates with 1.8V to 3.3V power supply. Also, it can be powered down using software with negligible standby current, allowing the power supply to be connected all the time. The sensor combines two LEDs, a photodetector, optimized optics, and low- noise-analog signal processing to detect pulse and heart-rate signals.
3. **DS18B20:** This is a pre-wired and waterproof version of the DS18B20 sensor. Useful when you need to measure something far away, or in wet conditions. The sensor can measure temperatures from -55 to 125°C (-67°F to +257°F). Actually, the cable of this sensor is jacketed in PVC. DS18B20 is a digital sensor, hence there is no signal degradation over long distances. It is fairly precise, i.e ±0.5°C over much of the range. It provides up to 12 bits of precision from the onboard digital-to-analog converter. This sensor works great with any microcontroller using a single digital pin.
4. **DHT 11:** The DHT11 is a simple, ultra-low-cost digital temperature & humidity sensor. DHT11 uses a capacitive humidity sensor and a thermistor to measure the surrounding temperature and humidity. It sends data in digital signal form so no analog input pin is required.
5. **BPR 10012018:** Bloop pressure reader: This user-friendly upper arm cuff-based blood pressure monitor measures systolic & diastolic blood pressure levels (in mmHg) with ± 3mmHg accuracy. The built-in colour LCD display displays all measured blood pressure values and additional heart rate information (bpm) and allows this sensor to be used both as standalone device or as biosignalsplux sensor within OpenSignals (r) evolution software.
6. **AD8232:** The AD8232 is an integrated signal conditioning block for ECG and other biopotential measurement applications. It is designed to extract, amplify, and filter small biopotential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. This design allows for an ultralow power analog-to-digital converter (ADC) or an embedded microcontroller to acquire the output signal easily.
7. **Water Level Sensor:** This is a simple low cost sensor which can be used to check the urine bag level measurement.

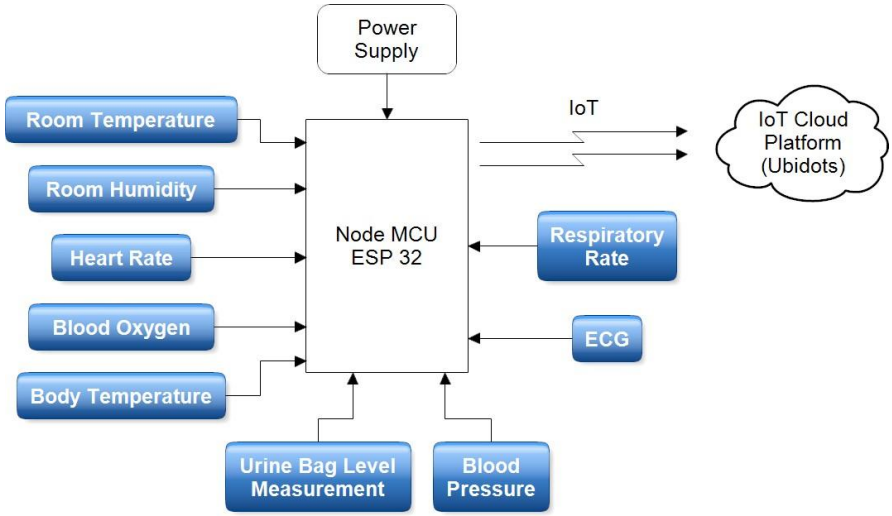

Figure: Block diagram

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3.2 Software Architecture

It consists of MQTT protocol, IoT Cloud Platform and Integrated Development Environment (IDE).

1. **Integrated Development Environment**: IDE plays a key role in Arduino hardware although it's independent on any specific platform. Different programming languages can be used to implement Arduino code or algorithms. IDE is an effective platform for researcher to develop sensors related project, Programmers and project development professionals. Arduino IDE is openly accessed, introduced from Integrated Development Environment for widely used in wiring projects and Programming languages Processing.
2. **MQTT Protocol:** Message Queuing Telemetry Transport (MQTT) is lightweight, low bandwidth protocol for communicating different equipment and applications together particularly for Machine to Machine(M2M) communication. MQTT base on publish/subscribe architecture in comparison to HTTP protocol flows request/response architecture. It's a client friendly by providing opportunity to communicate as a subscriber, owner or both. This protocol makes the Connection of user to MQTT broker which entirely regulate reception and transmission of messages.
3. **IoT Cloud Platform (Ubidots):** Ubidots is an Internet of Things (IoT) data analytics and visualization company. We turn sensor data into information that matters for business-decisions, machine-to-machine interactions, educational research, and increase economization of global resources.

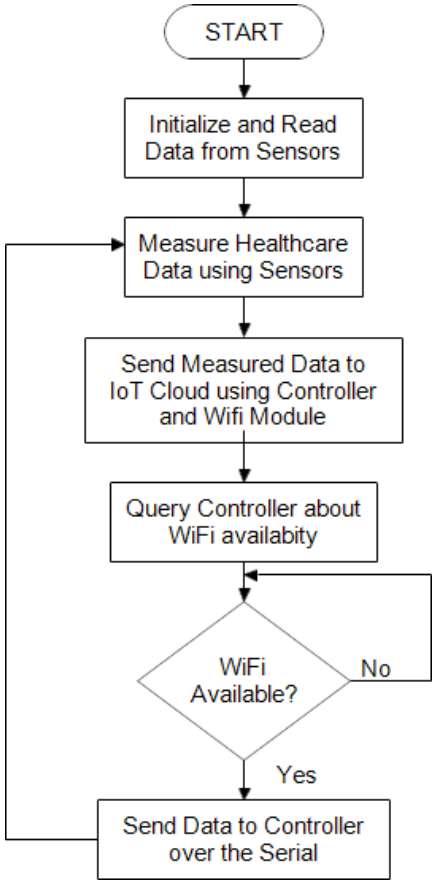

Figure: Flow Chart

IV. Conclusion

The system introduced smart healthcare to monitor the basic important signs of patients like heart rate, body temperature, blood pressure and some measures of hospital room's condition such as room humidity, temperature. Authentic medical staff can view and track the data in real-time even though the patients perform the tests outside of the hospital. The system

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can also benefit nurses and doctors in situations of epidemics or crises as raw medical data can be analysed in a short time. The developed prototype is very simple to design and use. The system can be very useful in the case of infectious disease like a novel coronavirus (COVID-19) treatment. The developed system will improve the current healthcare system that may protect lots of lives from death. Although the system looks somewhat bulky, it will be a tiny device by proper manufacturing in the near future. The video feature can be added for face-to-face consultation between the doctors and patients. Some more measures which are very significant to determine a patient's condition like the level of diabetes, respiration monitoring, etc. can be addressed as future work.

REFERENCES

[1]. Imran khan , Kamran Zeb, Asif Mahmood, Waqar Uddin Muhammad Adil Khan, Saif-ul-Islam, Hee Je Kim, "Healthcare Monitoring System and transforming Monitored data into Real time Clinical Feedback based on IoT using Raspberry Pi" in International Conference on Computing, Mathematics and Engineering Technologies – iCoMET 2019

[2]. R. Alekya , Neelima Devi Boddeti , K. Salomi Monica , Dr.R. Prabha, Dr.V. Venkatesh, "IoT based Smart Healthcare Monitoring Systems" in European Journal of Molecular & Clinical Medicine Dec 2020

[3]. Md. Milon Islam, Ashikur Rahaman, Md. Rashedul Islam, "Development of Smart Healthcare Monitoring System in IoT Environment" in SN Computer Science (2020)

[4]. Mohammad Monirujjaman Khan , Safia Mehnaz , Antu Shaha , Mohammed Nayem , and Sami Bourouis, "IoT-Based Smart Health Monitoring System for COVID-19 Patients" in Computational and Mathematical Methods in Medicine 2021

[5]. S. M. Riazul Islam, Daehan Kwak , Md. Humaun Kabir , Mahmud Hossain, And Kyung-Sup Kwak, "The Internet of Things for Health Care: A Comprehensive Survey" in IEEE 2015.

[6]. Pavani Lakshmi Penmatsa, D. V. Rama Kkoti Reddy, "Smart Detection and Transmission of Abnormalities in ECG via Bluetooth" in IEEE 2016.

[7]. Chanchal Raj, Chaman Jain, Wasim Arif, "HEMAN: Health monitoring and nous: An IoT based e-health care system for remote telemedicine" in IEEE 2017.

[8]. AD8232 Heart Rate Monitor Hookup Guide." [Online]. Available: https://learn.sparkfun.com/tutorials/ad8232-heart- ratemonitor-hookup-guide

[9]. OMS, Overview – Preventing chronic diseases: a vital investment. http://www.who.int/chp/ chronic_disease _report/part1/en/ visited November 2015.

[10]. Covid-19 Coronavirus Pandemic https://www.worldometers.info/coronavirus/

[11]. Zanella A, Bui N, Castellani A, Vangelista L, Zorzi M. Internet of Things for smart cities. IEEE Internet Things J. 2014;1:22–32. https://doi.org/10.1109/JIOT.2014.2306328.

[12]. Banerjee S, Roy S. Design of a photo plethysmography based pulse rate detector. Int J Rec Trends Eng Res. 2016;2:302– 6.

[13]. Acharya AD, Patil SN. IoT based health care monitoring kit. In: 2020 Fourth international conference on computing methodologies and communication (ICCMC). IEEE; 2020. p. 363–8

[14]. J. IoT based health monitoring system. In: 2020 6th International conference on advanced computing and communication systems (ICACCS). IEEE; 2020. p. 386–9.

[15]. Marques G, Pitarma R. An indoor monitoring system for ambient assisted living based on Internet of Things architecture. Int J Environ Res Public Health. 2016;13:1152. https://doi.org/10.3390/ ijerph13111152.