IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

LORA WIRELESS TRANSMISSION FOR HEALTH MONITORING IN ICU

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Abstract: The Internet of Things (IoT) empowers people to get a more significant level of mechanization by creating a framework, utilizing sensors, and interconnecting gadgets and the Internet. In ICU, silent checking is basic and the most significant action, as little delay in choice identified with the patient's treatment may cause perpetual inability or even passing. The Doctors and staffs need to have an all-time updateon patients' health-related parameters like their temperature, oxygen saturation, pulse rate, blood pressure, and heart rate. Doing it manually is a tedious task and for multiple patients, it becomes close to impossible. The Lora-based system can bring about automation that can keep the data updated all the time. Lora Based ICU Monitoring System is an Arduino UNO-based system that collects patient information with the help of sensors. Arranged sensors, allow for acquiring rich information collectively for our physical and mental prosperity. The goal is to use LoRa wireless system to communicate data from Sensors to a cloud or a computer. Setting up a smart and pervasive environment is one of the main challenges. Among the panoply of applications enabled by the Internet of Things (IoT), smart and connected health care is important. The sensors which are networked are worn on the patient's body. A new Iot-based health monitoring strategy in which gathered, medical sensor data is delivered to an analysis module through low-cost, low-power, and secure communication channels provided by a LoRaWAN network architecture.

***Index Terms* – LoRa, Health Monitoring, IoT, ICU.**

I. Introduction

The medical field is the backbone of any country. Medical field technology places a big role when it comes to patient care. Technology is big when it comes to giving patients the best type of quality care when they are in the hospital. In theold days, doctors or nurses would just communicate with patients manually which causes mistakes.

Now with electronic health systems, those mistakes are drastically declining. In low- and middle-income countries, an increasing number of people have chronic illnesses due to different risk factors like eating habits, inactivity, and alcohol consumption among others. According to the World Health Organization, 4.9 million people die from lung cancer through snuff use, 2.6 million obese people, 4.4 million high cholesterol, and 7.1 million high blood pressure. Chronic diseases vary greatly in their symptom evolution and their therapies. Some, if not observed and treated early, can end a patient's life. For many years the standard method for measuring blood sugar, blood pressure, and heart rate were additional tests in specialized health facilities. With the advent of technology today, there is a huge diversity of sensors that learn important signals such as a blood pressure monitor, a glucometer, and a heart rate regulator, including electrocardiograms, which allow patients to take essentials daily. Statistics have shown that using electronic health systems has lowered nursing mistakes as well as improved patient care [1, 2].

Our society has progressed throughthe years and has been introduced to electronic healthcare systems which have drastically improved our healthcare systems. Electronic healthcare systems are changing rapidly. The market is globalized, and society is concerned with medicalissues, and missing patient data from records, too [3]. The work developed in this paper focuses on the study of the development of an intelligent healthcare system. Health monitoring is a major problem in today's world.

Due to the lack of a proper health monitoring system, patients suffer from serious health issues. There are lots of IoT devices nowadays to monitor the patient over the internet. Health experts are also taking advantage of these smart devices to keep an eyeon their patients in the hospital. IoT-based ICU monitoring system which records the patient's heart beat rate, body temperature, and blood pressure. In developing an Effective healthcare monitoring system, several factors need to be considered, such as data availability, consistency, and reliability [4]. However, the most important factor is data freshness which needs to be well supported during runtime by the healthcare systems which deal with people's health.

II. Existing Method

The Intensive Care Unit, or ICU, is where severely sick patients are brought for treatment. For such urgent situations, doctors must constantly monitor patients' health-related measures such as blood pressure, heart rate, and temperature. This is very timeconsuming to execute manually, and it becomes nearly impossible with several patients [6]. For these types of scenarios, an IOT-based system can provide automation that keeps doctors up to current at all times through the internet.

ICU with IoT Patient Monitoring System is a Raspberry Pi-based system that collects patient data using a few sensors. It communicates this information to the internet via the Wi-Fi module. This blood pressure and heart rate monitor module is electrically connected to the system and physically worn by the user. The sensor detects systolic and diastolic blood pressure, as well as heart rate, and sends data to the central controller when a button is pressed. The Temperature sensor detects the temperature of its surroundings, therefore when it is close to the user, it reports the person's body temperature. Thus, the doctor may retrieve these crucial parameters relevant to the patient's health from anywhere around the world using the IOT Gecko web interface [7].

As a result, the IoT Based ICU Patient Monitoring System is an improved system that aids in the monitoring of ICU patients without the need for manual intervention.

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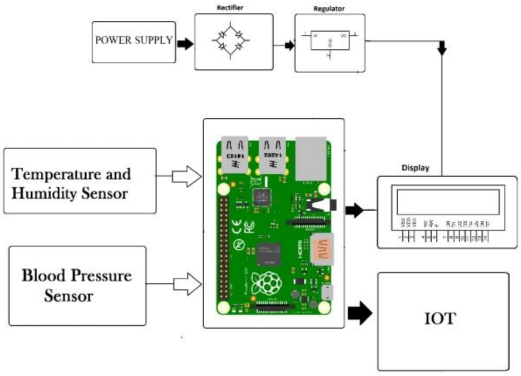

Fig. 1. Existing Method

III. Proposed Method

Lora is always different compared to other short-range sensor network technologies such as Bluetooth, ZigBee, Wi-Fi, etc. and it provides a unique set of features including wide area connectivity for low power and low data rate devices. The existing IoT-based healthcare issues including high-cost communication links with 3G/4G, data privacy, and ignorance of monitored health parameters are now a matter of concern. Many deployments and proposals about the solution to these issues have been made and it is shown that LoRa has the ability to solve all of these issues by integrating medical sensors, cloud, and gateways. Lora in mesh networking for large-area monitoring applications has been developed by Lee et.al [12]. They deployed 19 LoRa sensors in mesh networking devices to identify the Packet Delivery Ratio (PDR) by comparing it with a star-topology networking device.

The result shows that mesh networking devices achieved 88.49% whereas it is 58.7% for star-topology networking devices. A proposal has been made by Mdhaffar et. Al [13] indicating that the usage of LoRa sensors in the medical sector to monitor patients can solve the issues. Three steps are proposed including getting the patient physical metrics from medical sensors, transmitting the data through LoRa sensors and gateway, and sending the data to the cloud for further proceedings of medical records. Diabetes and arterial hypertension have been measured through this system, but it is not capable to get continuous medical data which hinders the evaluation of ECG data.

Long coverage area is one of the main characteristics of LoRa sensors. Many applications have been tested within large geographical and indoor areas. The performance of LoRa sensors in indoor areas is measured by Petjjrvi et. Al [14] where the target was to check the hypothesis of health monitoring applications. The sensor nodes are operated with various physical layer settings of LoRa sensors. The results of the experiment show that the sending data amount may differ up to 200-fold which indicates the efficiency of selecting LoRa sensors in terms of indoor health monitoring. For the large area coverage area, an aforementioned developed framework indicates that the data transmission works perfectly using LoRa sensors with a low power consumption although the security issues are not mentioned [12].

One of the core components in this project is the LoRa which is used for e-health monitoring development working in conjunction with the Arduino Uno Biomedical sensors like an ECG sensor, body temperature sensor, and oxygen saturation and pulse rate sensor are used. To transmit the measured health data wirelessly to the cloud, LoRa communication technology is used, which is a new, private, and spread-spectrum modulation technique that allows sending data at extremely low data rates to extremely long ranges.

Table. I Cost Estimation Comparison Among LPWAN Technologies [15]

	Spectrum cost	**Deployment cost**	**End-device cost**
NB-IoT	>500 M€ / MHz	>15000€ / Base Station	>20€
Sigfox	Free	>4000€ / Base Station	>2€
Lora	Free	>1000€ / Base Station	3-5€

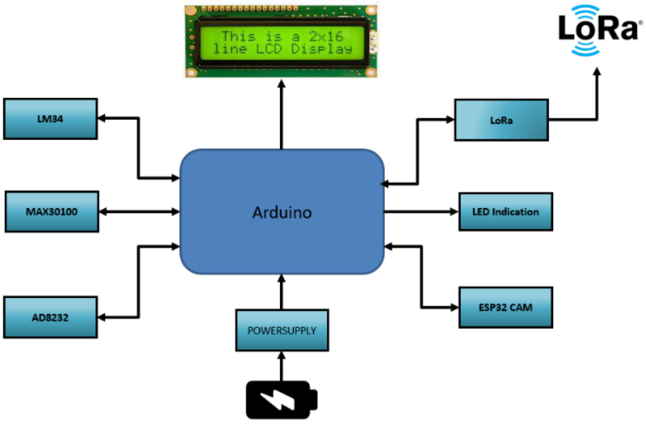

Fig. 2. Block Diagram

Fig. 3. Output

IV. HARDWARE DESCRIPTION

A. Arduino UNO:

Arduino board opensource microcontroller based on ATmega 328p microcontroller. It is one of the most popular development boards used for experimental purposes and serves as an Internet of Things (IoT) link. The board contains other items such as a serial connection, crystal oscillator, voltage regulator etc. It contains 2 kB of RAM, 1 kB of ROM, and a flash memory of 32 kB and can be easily formatted with open-source Arduino IDE software. There are many GND pins in Arduino, and any of them can be used to grind your circuit. 5V (4) & 3.3V (5): there is one 5V pin provides 5 volts of power to Arduino UNO, and the 3.3V pin provides an influence of 3.3 volts. most straightforward the components used with the Arduino vary jubilantly from five or 3.3 volts. ANALOG (6): subtitle space beneath 'Analog In' label (A0 to A5 in UNO) by Analog In pins ... DIGITAL (7): on the far side the analogue pins digital pins (0 to 13 in UNO). These pins are used for each digital input (such as telling once a button is pressed) and digital output (such as semiconductor diode power supply). PWM (8): These anchors act as standard digital pins, however also can be used with one thing referred to as Pulse Width breadth Variation.

Fig. 4. Arduino UNO

B. Pulse Sensor/ Heartbeat Sensor:

An alternate name of this sensor is a heartbeat sensor or heart rate sensor. Pulse Sensor is a well-designed plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart-rate data into their projects. The sensor clips onto a fingertip or earlobe and plugs right into Arduino.

Fig. 5. MAX30100

C. Temperature Sensor:

The LM35 series is a well-integrated heat-resistant heat exchanger with Centigrade temperature. The LM35 device has an advantage over Kelvin's limited direct temperature sensors, as the user does not have to emit large, uninterruptible power outages for easy Centigrade measurements. The LM35 device does not require external measurement or cutting to provide normal details of ± ¼ ° C at room temperature and ± ¾ ° C in addition to the full temperature range of −55°C to 150°C.

Fig. 6. Temperature Sensor

D. LCD Display:

LCD is a flat optical display device which uses liquid crystals' light-modulating properties combined with polarizers. Liquid crystals do not directly emit light but use a backlight or reflector to create color or monochrome images.

Fig. 7. LCD Display

E. 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. The AD8232 can implement a two-pole high-pass filter for eliminating motion artefacts and the electrode half-cell potential. This filter is tightly coupled with the instrumentation architecture of the amplifier to allow both large gain and high-pass filtering in a single stage, thereby saving space and cost. An uncommitted operational amplifier enables the AD8232 to create a three-pole low-pass filter to remove additional noise. The user can select the frequency cut-off of all filters to suit different types of applications.

Fig. 8. AD8232

F. ESP32 CAM:

The ESP32-CAM is a small-size, low-power consumption camera module based on ESP32. It comes with an OV2640 camera and provides an onboard TF card slot. The ESP32-CAM can be widely used in intelligent IoT applications such as wireless video monitoring, Wi-Fi image upload, QR identification, and so on.

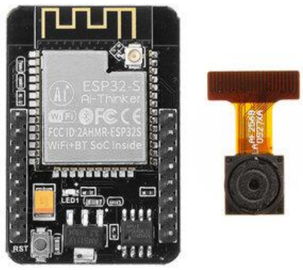

Fig. 9. ESP32 CAM

G. LORA:

LoRa 433MHz module designed by AI-THINKER, which is based on the chip SX1278. The SX1278 RF module is mainly used for long-range spread spectrum communication. It can resist Minimizing current consumption. Thanks to SEMTECH's patented LoRa ™ modulation technology, the SX1278 has a high sensitivity of -148 dBm with a power output of +20 dBm, a long transmission distance and high reliability. At the same time, compared with the traditional modulation technology, LoRa™ Modulation technology in anti-blocking and selection also has obvious advantages, to solve the traditional design cannot take into account the distance, interference and power consumption. Lora Modules are long-range low-power RF Modules. Great for IoT applications to send sensor data to the cloud over long ranges.

Fig. 10. LoRa Module

V. RESULT AND CONCLUSION

In our work, we have used three senses. First, the LM35 temperature sensor that we used to measure the patient's temperature. The best accuracy is achieved when the temperature sensor is placed on the armpit or tongue. Another sensor that was used in this project was the heartbeat sensor, it measures the heart rate by measuring the backlight LED hitting the back of the light sensor on the front side. Better accuracy is achieved when the person places this sensor on the fingernails and ear. All sensors were connected to the analog pins of the Arduino board. All of these sensors provided a power difference based on the input parameter and these power variables were converted to output, the output of the LM35 sensor was converted to a temperature by degrees Celsius and the output of the DIY pulse sensor was converted to a heart rate in BPM (beats per minute) on the Arduino system. The image was taken from the serial architect of Arduino IDE software. As a result, the heartbeat was marked in the form of spikes. For analog input, Arduino offers digital output from 0 to 1023 levels as the Atmega328 small controller on board has 10 bits in built-in ADC.

Set a limit of 520 to estimate the number of pulses. Therefore, the output rate that was higher than the limit was considered to calculate and measure the heart rate in BPM (Beats per Minute). These results are displayed on the LCD screen.

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