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IOT BASED REMOTE MEDICAL DIAGNOSIS SYSTEM USING NODE MCU

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ABSTRACT: - Internet of things (IoT) can help us better our lives in many ways by rendering real time Information over the internet collected from a smart network of devices. In this paper, we have discussed about Remote Medical Diagnosis System (RMDS), which can come to aid for humans in many life-threatening situations. Often, people fall sick in locations where there are no hospitals or healthcare facility nearby, in such cases people sometimes even die due to lack of proper treatment and diagnosis. In rural areas of third-world countries, this problem is even more intense. For demonstration purpose, heartrate and body temperature of a person is determined and rendered over the internet. Health data is uploaded in real-time and can be viewed through a web browser. The aim of RMDS is to remotely provide health information of a patient to a healthcare professional in life-threatening situations. It can also be used for remote patient monitoring of regular patients of a doctor.
KEY WORDS: - IoT, Heart Beat Sensor, Temperature Sensor, Microcontroller, Photoplethysmography.

1. INTRODUCTION

Internet of Things (IoT) has a very close relationship with embedded systems, where a smart system consisting of various sensors and modules is connected to each other through the internet or they can be inter-connected through a local network and the local network can further be connected to the internet. IoT opens doors to numerous possibilities and smart solutions to complicated problems. From agriculture to home automation to smart cities to healthcare, application of IoT is beyond limits. The research in this field has gained a lot of popularity recently. Utilizing IoT in healthcare gives us a lot of benefits. Firstly, it reduces the cost of treatment as diagnosis is performed remotely. Also, it saves valuable time of both doctors and patients while, maintaining descent accuracy. It also has the potential of reducing the burden of manual data collection. In life-threatening situations, it can provide image of the patient's health in real-time so that the doctor can make an informed and reasonably quick decision from a remote location. Keeping these facilities in mind, we proposed an intelligent system consisting of a microcontroller, A Wi-Fi module, a button, two sensors (heartbeat and temperature), a Wi-Fi router and a website. The raw sensor data is first collected and processed by the microcontroller and then it is passed on to the Wi-Fi module. The Wi-Fi module then pushes the data to a remote webserver through a Wi-Fi router. The server stores the data and displays it through the website. A doctor can easily view all the health information by visiting this website and logging in with his/her credentials, which will be provided by the system administrators.

2. METHODOLOGY

Remote Medical Diagnosis System (RMDS) has the ability to measure two types of health data, one is heartrate (Heartbeats per minute) or BPM and the other one is body temperature in Celsius. The most important and Sophisticated part of this system is the correct measurement of heartrate. For the calculation and determination of heartrate, accurate detection of heartbeats is crucial. In RDMS, photoplethysmography (PPG) has been used to detect heartbeats.

Photoplethysmography is a low-cost, non-invasive heartbeat and oxygen level determining mechanism which is based on the reflection, refraction and scattering of light. In this mechanism, a diagnosis device monitors the perfusion of blood to the dermis and subcutaneoustissue of the skin by

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passing Infrared Ray (IR) through the skin. IR is a kind of light with wavelength greater than 800nm, which is located right after red light in the electromagnetic spectrum and is invisible to the naked eye. A portion of the emitted IR is absorbed by blood and the rest is reflected, refracted and scattered. By monitoring the amount of reflection or refraction and scattering, heartbeats can be detected. Thus, there are two modes of PPG: transmissive and reflective. IR of wavelength close to 940nm is best suited for the deepest penetration and yielding the best deep tissue blood flow measurement.

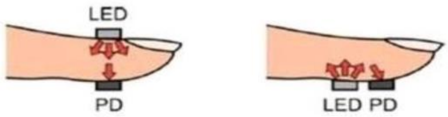

Fig. 1: Transmissive and Reflective PPG Modes.

At the beginning of the heartbeat, the capillaries beneath our skin fills with blood. At that moment, the volume of blood is the highest. With time, blood volume decreases and the amount of reflection, refraction and scattering increases accordingly, as less IR is observed by the blood. The reflected/ refracted/scattered IR is caught by an IR receiver (photo diode). Based on the amount of reflected/refracted/scattered IR, the voltage across the photodiode fluctuates and using these voltage levels, an Operational Amplifier (Op-Amp) generates different analog values which are then fed to a micro controller for further processing.

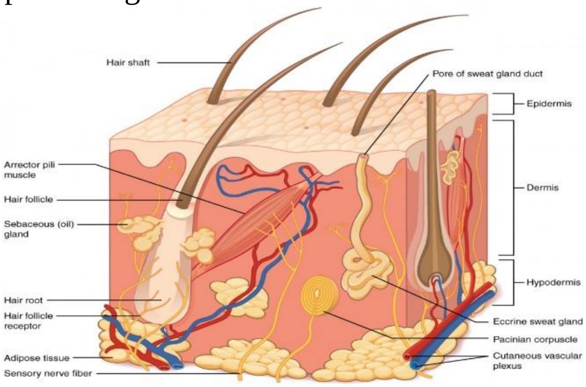

Fig. 2: Layers of human skin

A PPG waveform comprises two main components; ‘AC’ arterial pulsatile changes in blood flow synchronized to heartbeat and ‘DC’ elements attributed to venous blood, tissue, respiration, sympathetic nervous system activity and thermoregulation. It is the AC changes which are used to extract heartbeats. The signal is generally mixed with a lot of noise so a descent amount of filtering is needed for obtaining acceptable data.

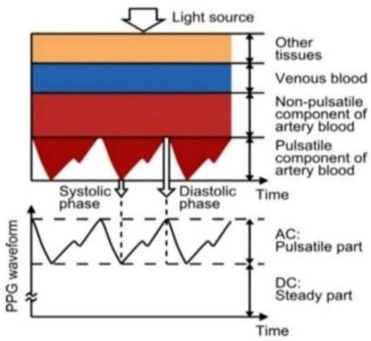

Fig. 3: Variation in light attenuation by tissue

3. ELECTRONIC COMPONENTS

We need a few hardware components to materialize the proposed system. First, we need a processor

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for data collection and processing. In other words, we need a brain for the system. The brain of RMDS is the microcontroller Atmel Atmega328P. An Arduino Nano has been used for utilizing this microcontroller and programming it easily.

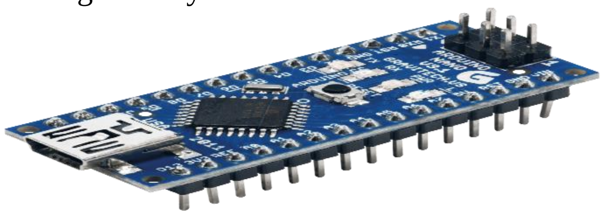

Fig. 4: Arduino Nano

Two sensors are attached to the Arduino Nano. One of them is the Heartbeat Sensor. The other one is the temperature sensor LM35.

The custom built Heartbeat sensor is a small device that utilizes PPG in reflective mode. It needs to be placed under the fingertip of a patient. It has an Infrared Ray (IR) emitter-receiver pair and an Operational Amplifier (Op-Amp) onboard. IR is emitted from the emitter (IR LED) and reflected onto the receiver. Depending on the amount of reflected light, the voltage level across the IR receiver fluctuates. Output of the photo diode is connected to an Op-Amp for amplification as voltage levels across the photodiode are too delicate to be detected by a microcontroller. The Op-Amp acts as a non-inverting amplifier with an amplification factor of 1001. The output of the first Op-Amp is fed to the second Op-Amp, which acts as a voltage comparator. The output of the second Op-Amp triggers a N-P-N transistor and from there the signal is sent to the microcontroller. The Op-Amp used in this circuit is LM358, which has two Op-Amps on the same chip.

Fig. 5. Heartbeat Sensor.

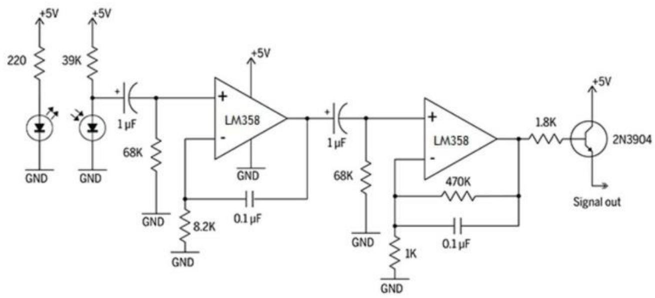

Fig. 6: Heartbeat Sensor Schematic.

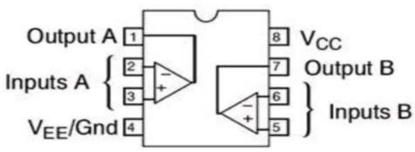

Fig. 7: LM358 Pinout.

4. SOFTWARE AND COMMUNICATION

The Arduino Nano has been programmed in the Arduino language for ease of programming. The

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microcontroller code filters the raw sensor data and converts it into Beats Per Minute (BPM). The temperature values are also processed by this code.
The NodeMCU was programmed in C++ using the PlatformIO IDE.

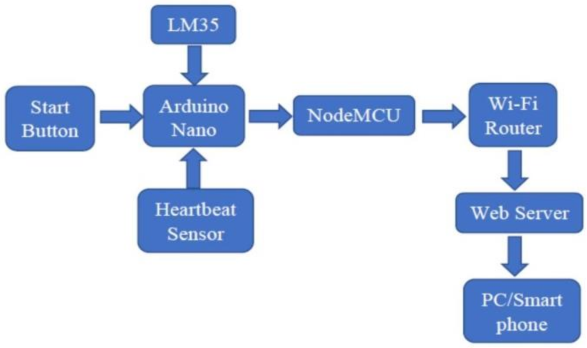

Fig. 8: Data Flow Path of RMDS

5. EXPERIMENTS AND OBSERVATONS

Several experiments were conducted to ensure proper functionality of the system. This helps to accurately determine the future complications that may occur in actual field. RMDS showed success scenarios when tested. Temperature andBPM values were being uploaded and displayed on the website in real time. Below are some results obtained, which are seen on the serial monitor on PC, 16x2 LCD and the RMDS website. All the health information and data are marked by unique ID numbers. If anyone needs to find information of a particular patient, then he/she just needs to remember ID number of the data of the concerned patient.

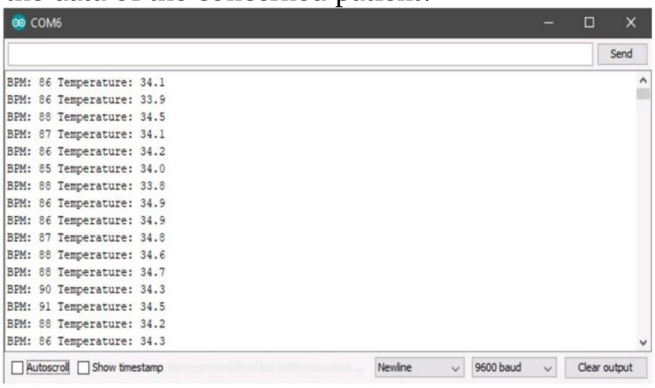

Fig. 9: Results on the serial monitor

6. CONCLUSION

In this modern era, IoT has become one of the brightest fields by which human life has become easier, safe and efficient through variety of its applications. In every sector of our daily life, we realize the impact of this particular field. However, our effort was to develop a life saver. Heartrate (BPM) and temperature of a person was determined on-device and rendered over the internet through a Wi-Fi network. Uploaded data was stored in a remote webserver and displayed through the RMDS website. Comparison with another device was conducted in order to ensure precision and accuracy. Finally, advantages and areas of further development were discussed. Remote health diagnosis systems, particularly those equipped with IoT technology, offer access to increased frequency of patients' health data, help reduce hospital stays and enable patient monitoring even after release. They can save lives through real-time interventions and support while reducing cost and diagnosis time. These systems have the potential of radically improving healthcare facilities around the globe. However, challenges in sensing, analytics, and visualization of health data requires further research and

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discussion. They need to be addressed before these systems can be designed for seamless integration into clinical practice.

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