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Vital Health Parameters Measurement through Wireless Communication System

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In this Vital Health Parameters Measurement, there are measurements of various parameters of Patient using Wemos D1 R2 mini. In the Health monitoring system based on Wemos, the real-time parameter of a patient's health is sent to the cloud using cloud MQTT. These Parameters are sent to a remote location so that the user can view these details on their Phone and the Doctor can view these details over the computer from anywhere in the world. The MAX30102 uses a method called photoplethy smography to measure the heart rate of Patient.

Keywords: Internet of Things (IoT), Wireless Sensor Network (WSN), MQTT, Pulse SpO2, Heart Rate, Temperature, Real time monitoring, Wemos D1 mini.

1. INTRODUCTION

The sensing circuit uses one Light Emitting Diode (LED) for emitting light into human tissue and one LED for detecting the reflectance light from human tissue. A Field Programmable Gate Array (FPGA) is used to control the LEDs and determine the Heart Rate and Blood Oxygen Saturation (SpO2). N-LEDs configuration is proposed for multichannel SpO2 measurements. The approach resulted in better spectral sensitivity, increased and adjustable resolution, reduced noise, small size, low cost and low power consumption. This method shines a light on the skin and the perfusion of the blood is measured. One of the practical aspects of this approach is that it is possible to differentiate between the light reflected by the blood of an artery (produces an AC output) and other components of the body such as bones and tissues (Produces a DC output). The photo-diode in the sensor then converts the light to a current that we can use as comprehensible data. The board is based on a 32-bit processor, having 160MHz clock speed and 4 Mb flash memories. This paper aims at solving this issue by automating this process of monitoring and recording these vitals of a patient.

Key features of this system are:

- Non-intrusive and painless sensing of heart rate and blood oxygen levels of a patient through hand worn wireless sensor devices.
- Interactive centralized web page as the front end of the system showing these vitals of all the patients being monitored on a well-designed graphical user interface.
- It's easy expand ability allows adding or removing multiple patients to the system without too much hassle.
- The vitals of the patients are also recorded on a database with time stamps for further analysis and reference use.
- Ward wise or room wise grouping arrangement of patients on the interface allows easy understanding and manipulation.
- Alert system in case vitals of the patient fluctuate above or below certain values. These values can be preset into the system for every individual patient.

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2. BLOCK DIAGRAM

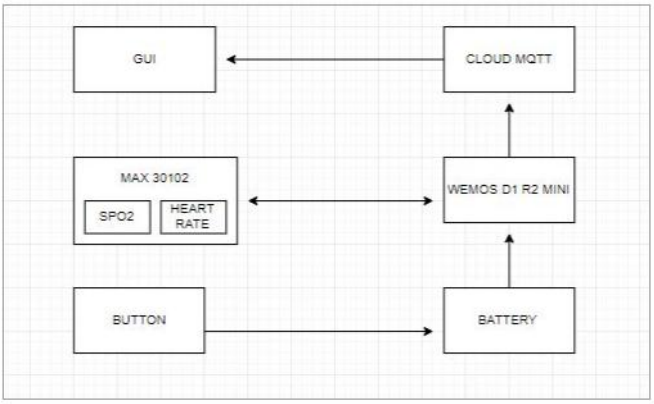

Fig -1: Connections

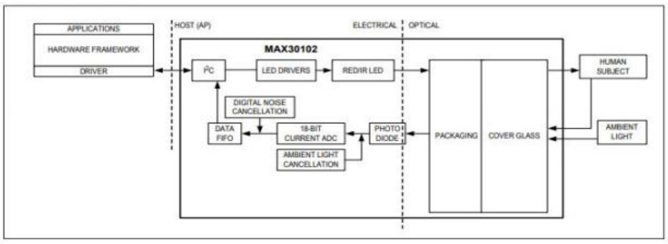

Fig -2: System Diagram

3. HOW IT WORKS.

It is a complete pulse oximetry and heart-rate sensor system solution module designed for the demanding requirements of wearable devices. The device maintains a very small solution size without sacrificing optical or electrical performance. Minimal external hardware components are required for integration into a wearable system.

The MAX30102 is fully adjustable through software registers, and the digital output data can be stored in a 32-deep FIFO within the IC. The FIFO allows the MAX30102 to be connected to a microcontroller or processor on a shared bus, where the data is not being read continuously from the MAX30102's registers. The SpO2 subsystem of the MAX30102 contains ambient light cancellation (ALC), a continuous-time sigma-delta ADC, and a proprietary discrete-time filter. The ALC has an internal Track/Hold circuit to cancel ambient light and increase the effective dynamic range. The SpO2 ADC has programmable full-scale ranges from 2μA to 16μA.

The sampling rate is 10.24MHz. The ADC output data rate can be programmed from 50sps (samples per second) to 3200sps. Temperature Sensor the MAX30102 has an on-chip temperature sensor for calibrating the temperature dependence of the SpO2 subsystem. The temperature sensor has an inherent resolution of 0.0625°C. The device output data is relatively insensitive to the wavelength of the IR LED, where the Red LEDs wavelength is critical to correct interpretation of the data. A SpO2 algorithm used with the MAX30102 output signal can compensate for the associated

SpO2 error with ambient temperature changes. The MAX30102 works as an integrated pulse oximetry and also as a heart-rate monitor biosensor module. It has internal LEDs, photo detectors, optical elements, and low-noise electronics with ambient light rejection.

HARDWARE COMPONENTS

A. MAX30102 module:

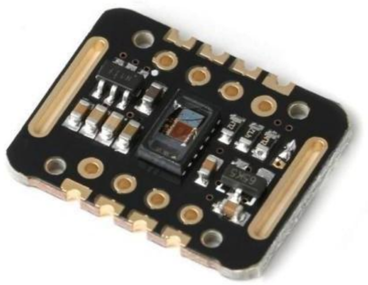

Fig- 3: MAX30102

Fig -4: MAX30102 Pin Points

The MAX30102 provides an entire system solution to ease the design-in process for mobile and wearable devices. The MAX30102 operates on one 1.8V power supply and a separate 3.3V power supply for the interior LEDs. Communication is through a standard I2C-compatible interface. The module are often pack up through software with zero standby current, allowing the facility rails to stay powered in the least times. This simple test doesn't require a blood sample and is named non-invasive. This sensor is used in making Pulse oximetry, that majorly is a test used to measure what proportion of the oxygen- carrying molecules within the blood (called hemoglobin) are literally carrying oxygen. This is known as oxygen saturation or SpO2. A pulse oximeter may be a medical device that obliquely measures the oxygen saturation of a patient's blood (as against measuring oxygen saturation directly through a blood sample) and changes in blood volume within the skin, producing a photoplethysmograph. It is often attached to a medical monitor so staff can see a patient's oxygenation in the least times. Portable battery-operated pulse oximeters also are available for home blood-oxygen monitoring. Oxygen saturation is that the fraction of oxygen-saturated hemoglobin relative to total hemoglobin

(unsaturated + saturated) within the blood. The physical body requires and regulates a really precise and specific balance of oxygen within the blood. Normal blood oxygen saturation levels in humans are 95–100 percent. If the extent is below 90 percent, it's considered low and called hypoxemia.

Arterial blood oxygen levels below 80 percent may compromise organ function, like the brain and heart; Arterial blood oxygen levels below 80 percent many compromise organ function, like the brain and heart, and will be promptly addressed. Continued low oxygen levels may cause respiratory or a systole.

B. Wemos D1 Mini:

Fig -5: Wemos D1 Mini

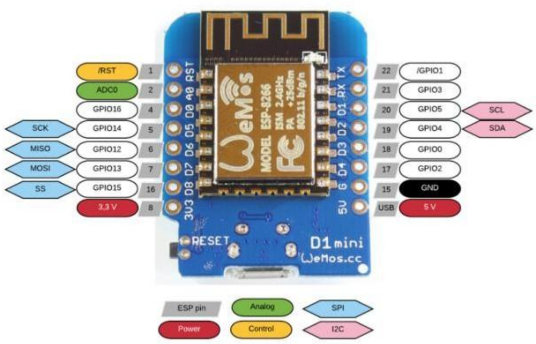

Fig -6: Wemos D1 Mini pin specification

The Wemos D1 is an ESP8266 Wi-Fi based board that uses the Arduino layout with an operating voltage of three .3V. The reason for choosing Wemos is being the Size and the cost of the microcontroller. Even in its small form factor, it provides enough computational power and Wi-Fi capabilities at reasonably cheap prices. This board also acts as the Mqtt client and connects to the server over Wi-Fi using Mqtt protocol. The temperature sensor LM35 connects to this board on its analog input pin whereas the MAX30102 module connects to this board via an I2C connection.

4. THE MQTT PROTOCOL

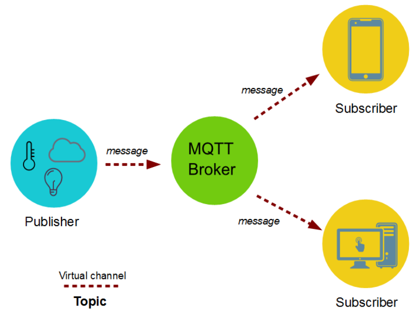

Fig -7: MQTT Protocol

MQTT also known as the Message Queuing Telemetry Transport is one among the most commonly and widely used protocols in IoT projects. It's designed as a very light messaging protocol that uses publish/subscribe services to exchange data between clients and the server. Its small size, low power usage, minimized data packets and simple implementation make the protocol ideal of the "M2M" or "Internet of Things" applications. Like many other protocols used over internet, MQTT is also based on clients and a server.

MQTT has 5 main components, which are as follows:

- Broker, also known as the MQTT server, is a tool that manages all the messages being sent to or from devices.
- A topic, which is a series of string, can be thought of as a place where clients can send their messages or can receive them.
- The message, it is the complete frame of data being sent to or from clients. It contains the payload which is the actual useful data along with message id, topic and quality of service.
- Publish is a service through which a client can send a message on a particular topic.
- Subscribe is a service through which a client can retrieve any messages which are send to any particular topic

5. RESULT

Fig -8: Result of three Patients

As a result of this system we were able to design the web interface for the monitoring and display of patient vitals in real time. The above screen shows the demo user interface for 3 patients only. The readings shown in the above image are only dummy readings and are not real. Same interfaces can be readily replicated for as much number of patients as required. Due to cost constraints we only could implement one properly functioning node measuring the actual vitals of the patient.

The real reading of the vitals of that node displayed on one section of the user interface which is opened on a Smart phone is shown in the images below.

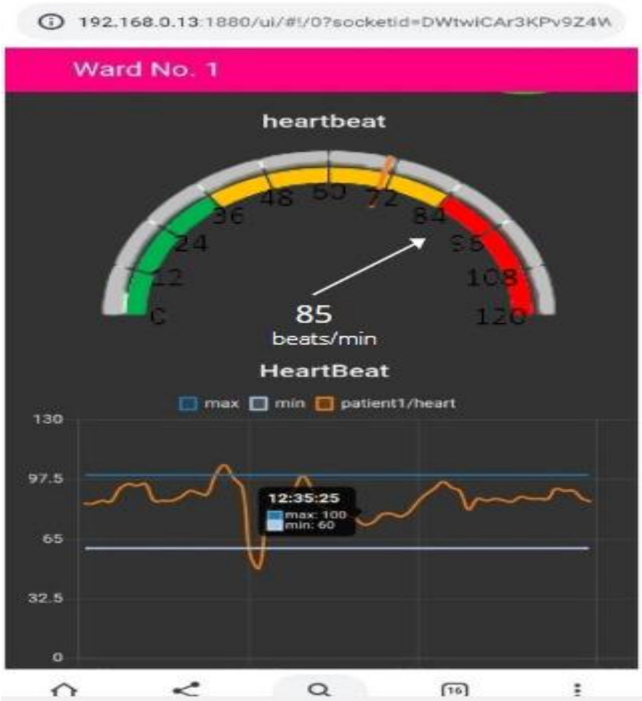

Fig -9: Heart beat of Patient1

CONCLUSION

Our project currently, works for patient monitoring using Internet of things technology it with further advancement in the Technology; it can be joined with hospitals and medical facilities for emergency services. This project can be extended for use by hospitals to monitor people in hard to reach areas for providing uninterrupted medical services. It is cost effective setup and is also accurate and efficient. The future operation of this project can be to store each patient data and easily checking their health with respect to their medical history and proper medication could be provided with respect to it. The only constraint we might face in the project is network connection with raspberry pi. The working prototype can successfully monitor few patients and display their real time health parameters on the screen, and if any anomaly is detected alarm for the patient can be raised

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