IoT Based Infant Monitoring System

Aswathy R Nair[1], Eshana Mariam John[2], Lakshmi R Menon[3], Nivitha Teresa[4], Unnikrishnan L[5]

Department of Electrical and Electronics, Rajagiri School of Engineering and Technology

[1] *aswathy.rn97@gmail.com,* [2] *eshanamariamjohn@gmail.com,*
[3] *lakshmi.571997@gmail.com,* [4] *nivithateresa@gmail.com,*
[5] *unnikrishnan4u@gmail.com*

Abstract

The project proposes capable health monitoring system for infants with wireless communication which is specially designed for blind and deaf parents. In the proposed system various technological resources are being used in an integrated manner to detect the various health issues at an early stage and provide alerts in the form of vibrations to the disabled parents. The vital signs of an infant such as temperature, pulse, sound and motion are measured and recorded using various sensors and the data obtained are continuously logged into the cloud website which can be accessed by doctors anytime from the system database. IOT platforms following MQTT protocol is selected so as to develop an automated alerting system without the help of a medical assistance

Keywords: *LM 35, pulse sensor, activity sensor MPU 6050, sound sensor CZN 15E, MQTT protocol, Nodemcu, Arduino UNO*

1. Introduction

In the past decade, infant mortality rate in India has risen considerably. The main cause observed was Sudden Infant Death Syndrome. This was worse in the case of blind and deaf parents as at times many serious or vital signs of the infants left unnoticed. The primary concern was and to alert disabled parents and make it affordable for common people. Wireless technology aims to alert them even in their absence or that of a medical representative. The proposed system is a capable health monitoring system for infants with wireless communication. Sensors such as temperature sensor, pulse sensor, etc. are being used to detect various health issues of an infant at an early stage by using an IOT based wearable health monitoring system which analyses certain parameters like temperature, pulse rate, etc. IOT Based infant monitoring system serves as an effective method of monitoring infants under the age of 0-12 months. It transfers the measured values of different parameters obtained from the sensors over a wireless network to the internet cloud. Monitoring system is designed to raise an alarm in case of an emergency and for parents with disabilities, a vibration motor attached to their wrists generates a vibration in the event of an emergency. The data from the cloud are used for further analysis. The sudden fall and increase in physiological parameters may cause Sudden Infants Death Syndrome (SIDS) and may lead to apparently life threatening events. The micro controller based hardware includes integrated sensors which incorporate sensory functions in the wearable hardware making it capable of measuring the physiological parameters (temperature and heart beats) accomplishing the need of continuous health monitoring. It will notify for the potential life threatening events. The hardware will be able to output the analogue values of sensed data which in turn will be synchronized with cloud server via middle ware architecture. Wearable hardware

will communicate with middle ware architecture through wireless communication. The necessary data processing on the cloud storage will identify the critical conditions as well as will create reports. The final component of the system, i.e. mobile application is featured with real time notification, alerts in the critical situation. It will show the continuous health status. The health sensors supports for analyzing the input from the patient and the results of all the parameters are stored in the cloud database. In the cloud database both the patient details and the doctor details are stored. If any abnormality felt by the patient indications will send to the medical officials and as well the patients if they need to have any suggestions from the doctor they can have it.

2. System Architecture

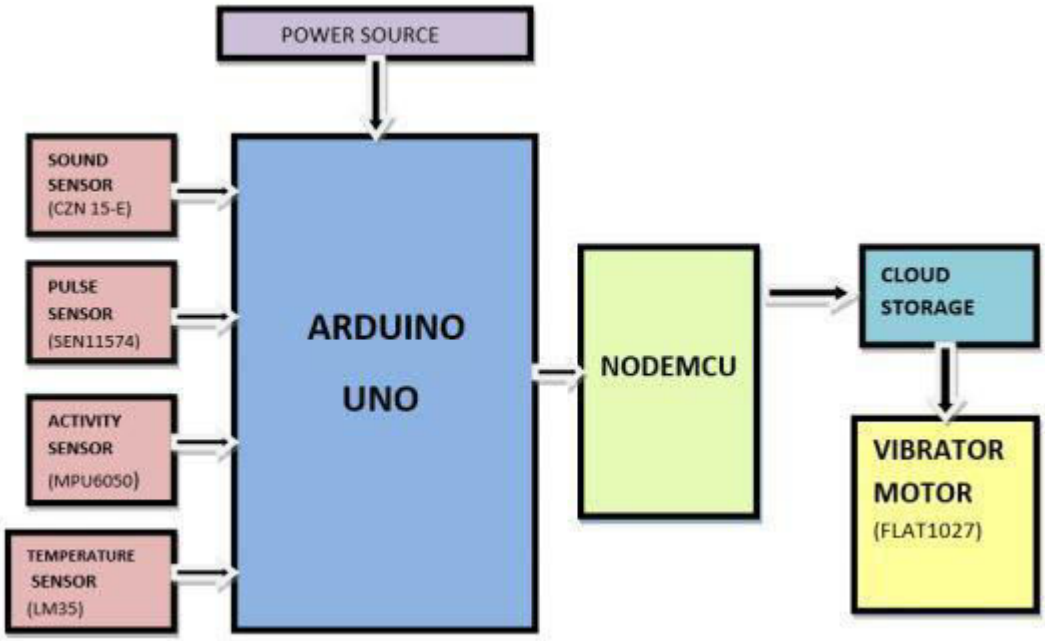

Figure 1. Block Diagram

3. Hardware Implementation

3.1. Sound Sensor

The sound sensor module provides an easy way to detect sound and is generally used for detecting sound intensity. This module can be used for security, switch, and monitoring applications. Its accuracy can be easily adjusted for the convenience of usage. It uses a microphone which supplies the input to an amplifier, peak detector and buffer. When the sensor detects a sound, it processes an output signal voltage which is sent to a microcontroller then performs necessary processing.

3.2. LM35

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of 0.25 degree Celsius at room temperature and 0.75 degree Celsius over a full -55 degree Celsius to 150 degree Celsius temperature range. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 micro amperes from the supply, it has very low self-heating of less than 0.1C in still air. The LM35 device is rated to operate over a 55C to 150C temperature range, while the LM35C device is rated for a -40 degree Celsius to 110 degree Celsius range (-10 degree Celsius with improved accuracy).

3.3. Pulse Sensor

The Pulse Sensor Amped is a 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. It essentially combines a simple optical heart rate sens or with amplification and noise cancellation circuitry making it fast and easy to get reliable pulse readings. Also, it sips power with just 4mA current draw at 5V so it's great for mobile applications.

3.4. Activity Sensor

For detecting the motion of the baby, an activity sensor is used.MPU6050 sensor module is a complete 6-axis Motion Tracking Device. It combines 3-axis Gyroscope, 3-axis Accelerometer and Digital Motion Processor all in small package. Also, it has additional feature of on -chip Temperature sensor. It has I2C bus interface to communicate with the microcontrollers. It has Auxiliary I2C bus to communicate with other sensor devices like 3 -axis Magnetometer, Pressure sensor etc. If 3-axis Magnetometer is connected to auxiliary I2C bus, then MPU6050 can provide complete 9-axis Motion Fusion output.

3.5. Vibration Motor

Vibration motor is a compact size coreless DC motor used to informs the users of receiving the signal by vibrating, no sound. Vibration motors are widely used in a variety of applications including cell phones, handsets, pagers, and so on. The main features of vibration motor is the magnet coreless DC motor are permanent, which means it will always have its magnetic properties (unlike an electromagnet, which only behaves like a magnet when an electric current runs through it); another main feature is the size of the motor itself is small, and thus light weight. Moreover, the noise and the power consumption that the motor produce while using are low. Based on those features, the performance of the motor is highly reliable. The vibration motors are configured in two basic varieties: coin (or flat) and cylinder (or bar).

4. Software Implementation

4.1. MQTT

A method of employing modern technology involving Internet of Things (IOT) modules based on MQTT protocol to collect and assess valuable data with minimal overhead to remotely monitor infant health and uniquely identify each new-born in the hospital inventory. Monitoring of certain fundamental vitals such as heart rate, temperature, precipitation and perspiration levels of the infant, additionally identifying and tracking the child to instantly alert the concerned pediatrician as well as the parent, in case of any abnormality with an automated notification system, has been proposed and prototyped , which makes child health monitoring easier and more efficient for doctors. It is a lightweight publish and subscribe system where you can publish and receive messages as a client.

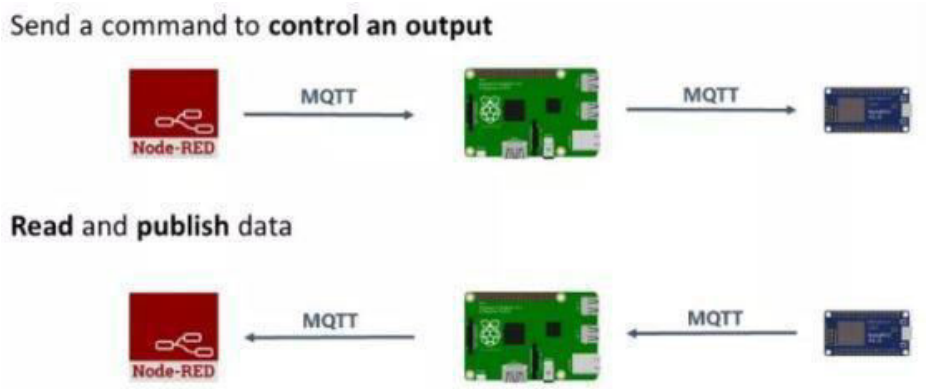

Figure 2. Overview of MQTT

MQTT is a simple messaging protocol, designed for constrained devices with low bandwidth. So, it's the perfect solution for Internet of Things applications. MQTT allows you to send commands to control outputs, read and publish data from sensor nodes and much more. Therefore, it makes it really easy to establish a communication between multiple devices.

4.2. BLYNK

Blynk is a Platform with IOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets.

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5. Methodology

IOT based infant monitoring system consists of mainly two PCB boards and an IOT platform. The first PCB board is attached to the infants body while the other PCB Board is attached to the blind and deaf parents wrist with a vibrator module in it. The infant PCB board consists of 4 sensors, Arduino Uno and a NodeMCU module. All the sensor values are collected by the Arduino board and is send over to NodeMCU module. The NodeMCU is calibrated with threshold of temperature, pulse, sound and axis of motion. All these values are send to the Blynk platform where the medical surveillance monitors the values and sends an alert signal to the parent in case of emergency. There is a virtual switch in the Blynk monitor which on pressed sends a signal to parent when any abnormality is observed in the sensor readings. In the parent PCB board there is vibrator motor which is connected to another NodeMCU module which receives the signal from Blynk and sets the motor to vibration.

6. Mechanical Design

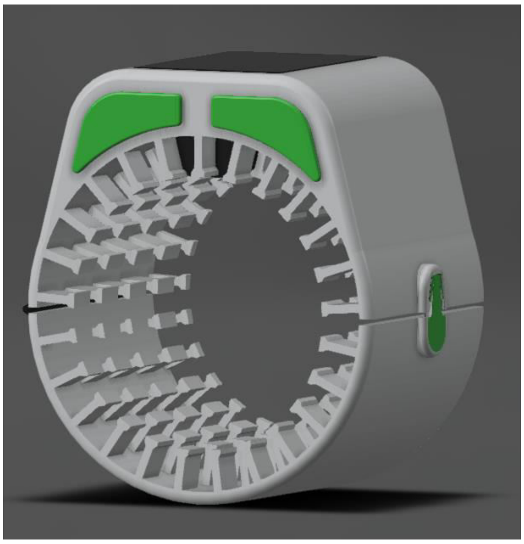

Figure 2. Overview of MQTT

This is a model of hardware in which the the vibrator module is placed using AutoCAD.

7. Circuit Design

7.1 Power Supply Circuit

Usage of 12V/500mA transformer for the supply
Rectifier output = 12V/1A
A capacitor is used to reduce the ripples. Equation for determining the capacitor value is:

$$C = \frac{I}{2 F \delta V} = 1000\mu F \quad (1)$$

F→ Frequency (varies for each circuit), **δV**→ Ripple voltage

Regulator is used to regulate the voltage. It has reduced 12V to 5V. Another capacitor of 10µF is used to regulate the regulator ripples. It is designed using the same capacitor equation as given above.

Arduino and Node MCU works in two different voltages 5V and 3.3V respectively and hence to reduce the current two 1k resistors are connected in series which serves the purpose of level shifter

7.2 Level Shifter Circuit

Arduino and Node MCU works in two different voltages 5V and 3.3V respectively and hence to reduce the current, two current limiting resistors are kept in series between the RX and TX pins of Arduino uno and NodeMCU.
R = (5-3.3)/10mA R = 1k

7.3 LED Circuit

Maximum permissible current and voltage of LED:

Voltage = 1.25V

Current = 10Ma

R = 1.25V/10mA = 1k

8. Results

During the execution of system snapshots of Blynk was taken. The system being a complete hardware design and the data available on laptop and Blynk monitor have been captured. Test results of the system are given below, shows successful implementation of the system.

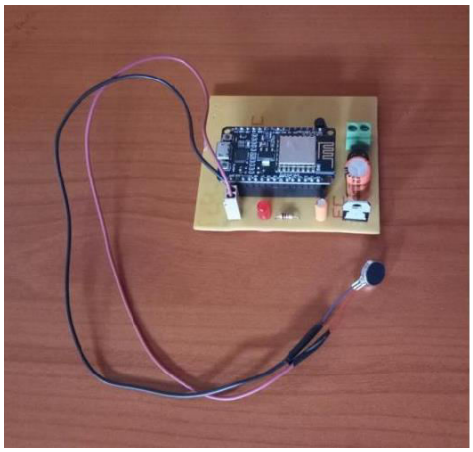

Figure 3: Parent PCB (vibrator)

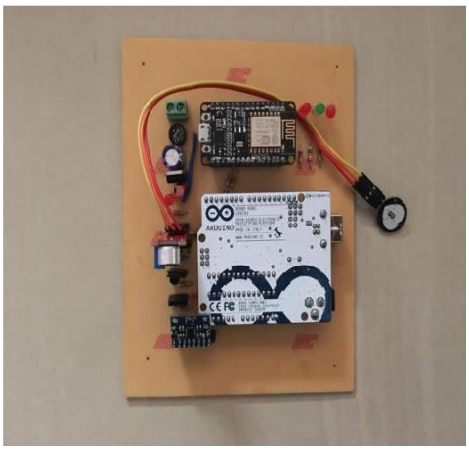

Figure 4: Infant PCB

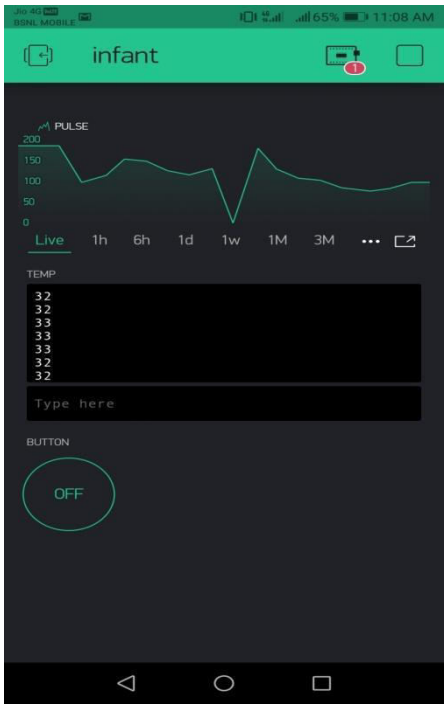

Figure 5: Blynk Monitor

9. Conclusion

The baby monitoring system is capable of detecting unexpected events and registering several physiological parameters, making it a powerful medical tool to track health of baby and a reliable real time monitor of infants. There is a provision for initializing and calibrating the system according to a childs body and activity patterns, e.g. the normal pulse rate, pulse rates during eating and sleeping, time of the day when the child usually takes his/her meal (after which he/she is supposed to wash hands properly) can be registered before usage or in a periodic manner during a short. Based on this calibration step, the tunable parameters of the algorithm for event detection and alert notification are set. Periodic calibration over the lifetime of the device can help to adjust for sensor drift due to aging and environmental variations.

10. Future Scope

Sound sensor(CZN-15E) can be replaced with high end sound sensors with voice recognition technology for the detection of crying or any other disturbed noises caused. By using this technology, it makes the design more precise and accurate as the noise detection is further classified and compared and then predicted. Since the alert is only triggered if the baby cries or if there is any huge disturbances in the surrounding ,it eliminates the possibility of false alarms and thus ensures proper monitoring. Temperature sensor at an advanced stage can be used to record the rate of variation in temperature to detect conditions like febrile seizure which occurs in children, where seizures tend to happen when the body temperature becomes high. Thus with a faster and accurate monitoring system, it helps the parents in assisting their children at such conditions without fail. The introduction of heart rate variability measurement (HRV) includes various advantages other than intrinsic heart rate measurement. Overall cardiovascular and autonomous nervous system can be monitored. Vibration pattern production

for various sensor outputs. This improves the alert system, as each sensor output has a different vibrating pattern which helps the deaf and blind parents in distinguishing and recognizing the parameter.

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