Intelligent Baby Monitoring System Using Blynk

Soham Talukdar and Shinjini Saha

Abstract With the significance of embedded system in conjunction with the Internet, this paper aims at designing a baby monitoring system that maintains the baby in the absence of any manual surveillance. The prototype includes an external heat supply for the baby in correspondence to the increase or decrease in temperature along with a constant notification to the admin—a fan, which starts instantly over a heat-set as the threshold. For a safety measure, firstly, a baby's cry is detected, which is indicated by a buzzer. Secondly, if the baby's surrounding is encapsulated with smoke, then a led glows. The entire data is transferred to the cloud server (here, Blynk Platform) via ESP8266 with an Internet connection. This overall system will work for monitoring a baby without any manual hindrance.

Keywords Monitoring · Intelligent · Internet · Baby · System

1 Introduction

Internet of things is a well-discussed technology or a system which mostly consists of a coordinated network of devices or things implanted with sensor modules, software, and network connectivity. IoT can be defined as a result of humanity's convenient lifestyle, which aims at reducing labour and human error. IoT is mainly used to remotely analyse the data received by the sensor modules and take appropriate action. From here, comes the idea of the Intelligent Baby Monitoring System using Blynk.

Baby monitoring has been there in history. Previously, monitoring a baby's health required a one-hundred per cent manual presence. However, over time life has become

S. Talukdar (✉) · S. Saha
School of Electronics, KIIT University, Bhubaneswar, India
e-mail: 1604389@kiit.ac.in

S. Saha
e-mail: 1604386@kiit.ac.in

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much more advanced. With the increasing birth rate, even nursing homes and hospitals have become much more congested and busy. With the advancement in technology and its application has made the life of people much more comfortable. The same has taken place in case of monitoring baby where now people do not have to be physically present as the pressure has been taken over by technology. Presently, in third world countries, the baby monitor system is not thought of mainly because of the lack of technological knowledge. People are monitoring 24×7 live for their baby. Single baby monitoring is possible, but multiple baby monitoring is not a convenience. Manual control is not practical to be implemented in hospitals and nursing homes. An automated system will make things easier and simplified; it can improve the efficiency of the administration to monitor multiple newborn. An extra level of security would be provided for transparent smoke that might not be visible to the human eye. With ever-increasing demands for automation and lack of manual intervention, advanced baby monitors could replace all the headaches and keep the baby safe and secure with remote monitoring with real-time observation and notification system.

Previously, a lot of work and models were created with advanced safety features and usability where a cradle is designed [1] such that the entire system is closed and does not require more modification. The researcher tried to integrate different modules and make it better and more efficient, however, it has become stagnant with the ideation of how to make it better.

In this paper, the aim is making the baby monitor more advance and secure in many ways and is made with the mind that it can be implemented in a hospital and nursing home. Suppose there are many babies kept in incubation. External heat is supplied to keep the baby warm. If the temperature increases over a specific limit, then a fan would turn on automatically. If the baby cries or even the surrounding of the baby is encapsulated in smoke, it would be notified. The cloud used is Blynk (in this case). It would send repeated notification via an app or even via email to inform the administration. The integration of these different modules makes it more safe and compact without increasing the cost of the model.

The detailed description of the proposed protocol is described in Sect. 3. The results have been given in Sect. 4, and the paper concludes with the future work in Sect. 5.

2 Related Work

A lot of research and articulation have taken place while designing and improving the baby monitoring system over the years. A different approach and modification lead to different results. Here, we will be looking into some of the previous research and have mentioned it below.

In one, researchers designed a baby monitoring in the following manner.

Using the Raspberry Pi B+ module which controlled working of the integrated hardware, a condenser MIC was applied which detected the baby's cry; a PIR motion

sensor was used which caught the baby's manoeuvre, and a pi camera was used to record the baby's movements, and a screen was required to receive the current condition of the infant sleeping. The entire system automatically detected the crying condition and motion of the baby [2].

Another researcher proposed a similar device of monitoring a baby in a crib. The AdaFruit MQTT server was used to gather and upload the data that was received by using NodeMCU using Wi-Fi. Ambient temperature, moisture, and crying are the essential variables of the baby that the model was used to detect. A prototype of the proposed baby cradle was designed. According to the system architecture, the cradle automatically swings when the baby cries. An external Web camera for monitoring the infant, the MQTT server would let the parents turn on a piece of music for the baby while tracking [3].

In another research, a baby monitoring system designed was based on a contactless approach. Using the Raspberry Pi B+ module, live monitoring of the baby was detected. The pi camera was used to take videos, for crying detection MIC was used, and image processing was used for detection of real-time movement of infants and the extreme limit of the bed. In case of any abnormal change, a notification about the present condition of the baby is sent to the particular user via email. Firstly, the system required the installation of OS Raspbian and other packages like OpenCV, Numpy, and Virtual environment. For positive face and negative non-face images, face detection algorithms were trained using the Haar classifier [4].

3 Proposed Protocol

The model that has been proposed in this paper is used to concentrate on increasing the safety measures as well as improving the usability of the user. This required the utilization of different components and their integration. The connectivity with the cloud system will track real-time data from the sensor and give instant notification to the user who would be remotely monitoring the baby. The details of the component used and its integration, along with the total workflow of the system have been described in the upcoming sections.

3.1 Components

3.1.1 Arduino UNO

The focus while designing the system was to minimize the cost and space. Raspberry Pi, as used in this paper [2], costs too much [5, 6]. To reduce the price, we opted for Arduino boards. There are many boards in the Arduino family [7]. We focussed on Arduino UNO as it served our motive the best. The best alternative that can be considered was Arduino NANO. While designing the model, we came to the point of

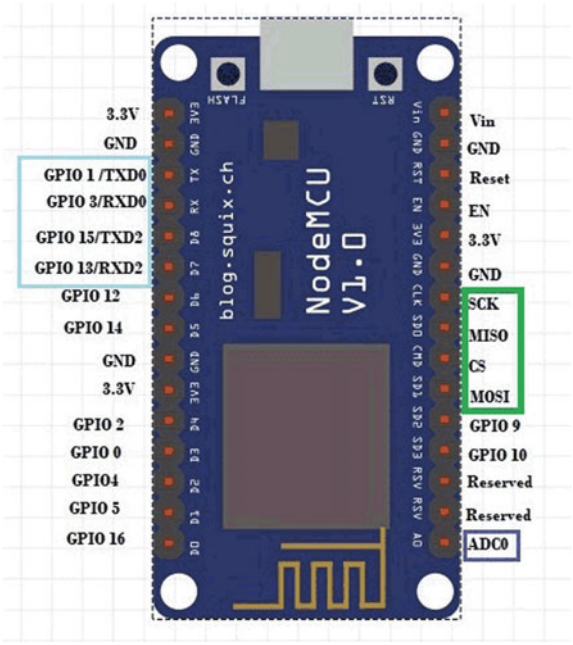


Fig. 1 ESP8266. Source: https://circuitdigest.com/microcontroller-projects/getting-started-with-nodemcu-esp12

convenience where we felt that the use of NANO while connecting the device might not be as practical as it should be as the requirement for USB mini is not readily available like the regular one. Considering the usability Arduino UNO would serve the purpose.

In the figure below, a rough schematic diagram would help to understand the layout of the module in Fig. 1.

3.1.2 NodeMCU ESP 8266

ESP 8266 is used here for connecting to the Wi-Fi. This low-cost module is used could have been replaced by raspberry Pi or even Arduino MKR1000, which would make the system more compact. However, the price would get doubled up. The second problem that we faced was the integration of the wifi, along with the different modules. While going for a trial phase with the other boards, we faced that it was becoming quite tedious with managing different components without losing the Wi-fi connectivity. Raspberry Pi was smooth enough with the working but was taken out of consideration for its pricing.

Documentations [8–10] can give an insight into the module and its use. A rough schematic diagram would help to understand the layout of the module in Fig. 2 (Figs. 3 and 4).

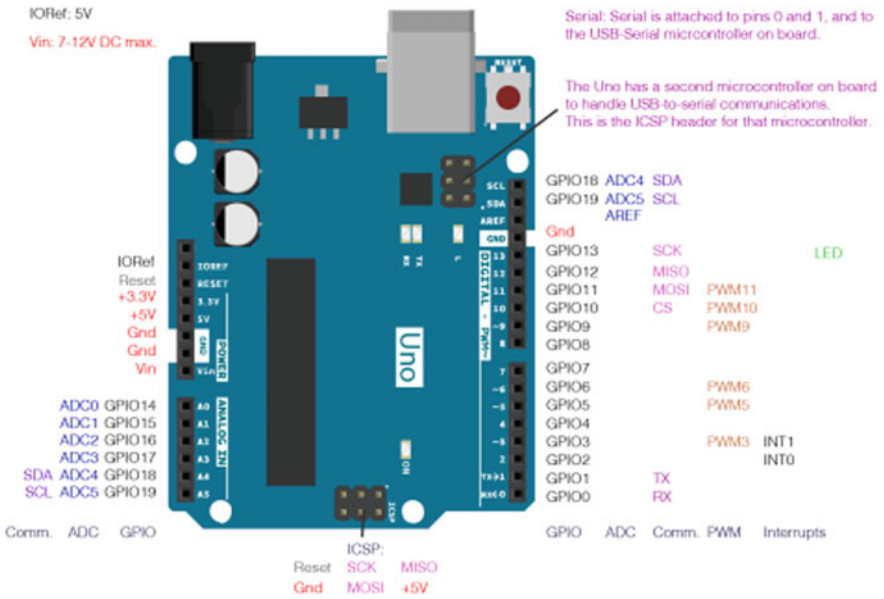


Fig. 2 Arduino UNO. Source: https://stackoverflow.com/questions/42022000/which-pins-should-i-take-for-i2c-on-arduino-uno/42022566

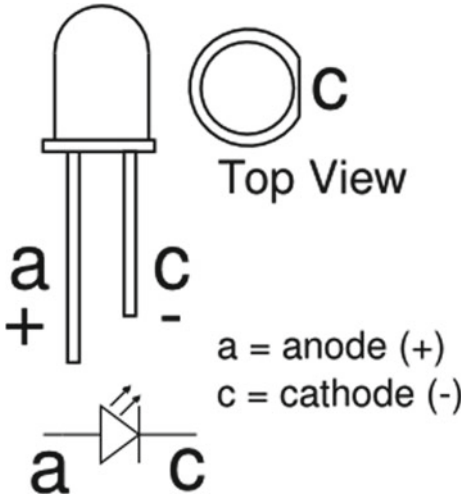


Fig. 3 LED. Source: https://startingelectronics.org/beginners/components/LED/

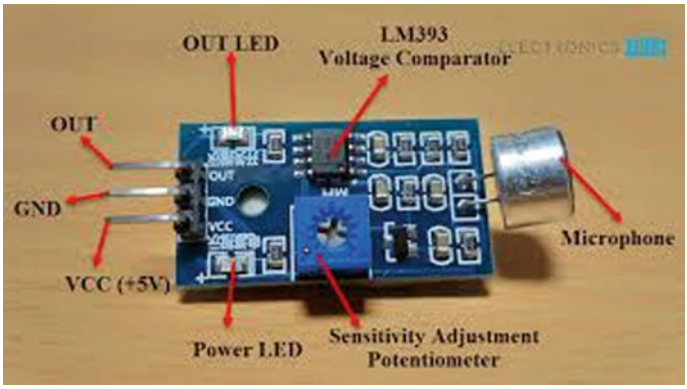
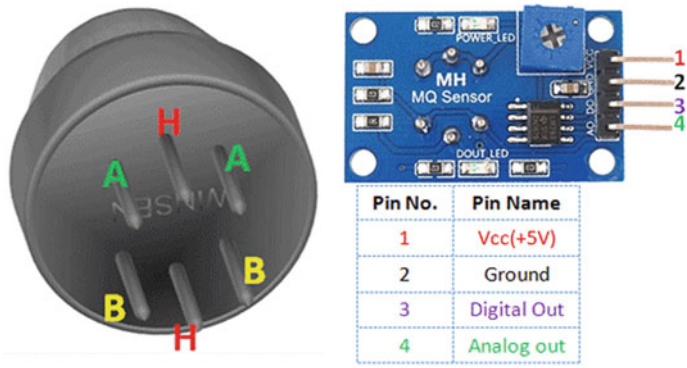


Fig. 4 RKI-3103. Source: https://www.electronicshub.org/interfacing-sound-sensor-with-arduino/

3.1.3 Gas Sensor (MQ-6)

The gas sensor has been used as a protective measure for the baby, which is unique as there was no previous use of any gas sensor that got integrated into a baby monitoring system. The primary purpose of a gas sensor is to predict any harmful gas that might lead to the discomfort of the baby. There are different gas sensors available. The most common discomforting condition will arise with an increase in CO_2. There are occasions where too much emission of CO_2 occurs without our knowledge. In these scenarios, the gas sensor might help to identify the surrounding. The MQ-6 is particularly useful in sensing one single gas. However, it will also help in determining other gases caused due to leakage, which are highly combustible. A rough schematic diagram would help to understand the layout of the module in Fig. 5.



Pin No.	Pin Name
1	Vcc(+5V)
2	Ground
3	Digital Out
4	Analog out

Fig. 5 MQ-6. Source: https://components101.com/sensors/mq-6-gas-sensor-pinout-equivalent-datasheet

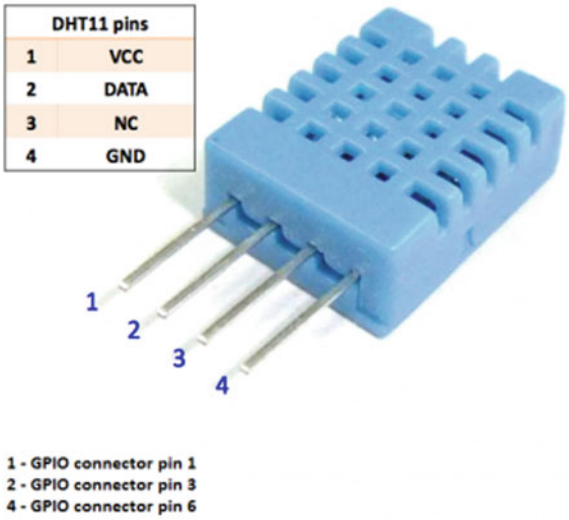


Fig. 6 DHT11. Source: https://www.programming-electronics-diy.xyz/2017/02/dht11-library-temperature-and-humidity.html

3.1.4 Temperature Sensor (DHT11)

Temperature and humidity can be a crucial factor when it comes to a baby's comfort. Maintaining a suitable temperature and humidity level is difficult. But before taking any precautions, we first need to identify the current temperature and humidity levels. To that, we have used DHT11, a prevalent temperature and humidity measuring sensor. This sensor is quite irreplaceable when it comes to both value and price. In this paper, [3] DHT22 a higher version of the one we are using is used. A minor difference is seen with such change, and due to price constraints, we used DHT11. It is widely used, and it is quite useful for our purpose. A rough schematic diagram would help to understand the layout of the module in Fig. 6.

3.1.5 Sound Sensor (RKI-3103)

A baby's discomfort can be most easily identified with a cry. A newborn baby when just born or kept in incubation has a deficient volume high-pitched sound. For this to identify, we need a sound sensor. Previously, audio sensors have been used for the same purpose. A rough schematic diagram would help to understand the layout of the module in Fig. 4.

3.1.6 Notifiers

After gathering data and processing in real time, there need to be specific ways by which it gives a signal or alarm to the surrounding or gives immediate back-up. For

these, we have used a few components which will be very useful in combating the stressful times by giving out appropriate notification.

Fan
Fan acts as a back-up when the temperature increases and there is no immediate external support. In this case, Fan would help in bringing down the temperature and give relief to the baby's discomfort.

Led
Led is an excellent indicator from a distance which gives the surrounding a notification that something might be wrong. A rough schematic diagram would help to understand the layout of the module in Fig. 3.

Buzzer
Buzzer gives an immediate alarm in case the monitor or the person who is in-charge accidentally dozed off.

3.2 Architecture

3.2.1 Circuit Design

The entire set-up could be embedded by only using the ESP8266. Still, due to the presence of only one analog pin, Arduino UNO has been used in a master-slave configuration with ESP8266 where the former is the slave while the latter is the master. Communication between Arduino UNO and ESP8266 is initiated with Tx of former to Rx of latter and similarly with Rx of former to Tx of latter. The Arduino UNO is responsible for the processing of all the data and its transmission to the ESP8266 while the ESP8266 is only responsible for the network connectivity. A PCB board is used to short the GND and Vcc pins of the sensor modules with the same pins in Arduino UNO and ESP8266. DHT-11 is connected to the analog pins of the Arduino Uno, GND, and Vcc as mentioned above. MQ-6 which is connected to one of the digital pins and has the same GND and Vcc connection as DHT-11. Now RK-3103 also has the same link as that of the MQ-6. This entire set-up is connected to the PC, and the code is dumped to the Arduino UNO. A schematic diagram has been shown in Fig. 7. And a working model is represented in Fig. 8.

3.2.2 Connection Between Circuit and Blynk Server

Once the code has been dumped into the Arduino UNO, the working of the entire system starts with the temperature sensor DHT-11, which detects the temperature of the area concerned. If the sensed temperature goes beyond the desired temperature, the cooling fan automatically starts along with notification alert and email. The same

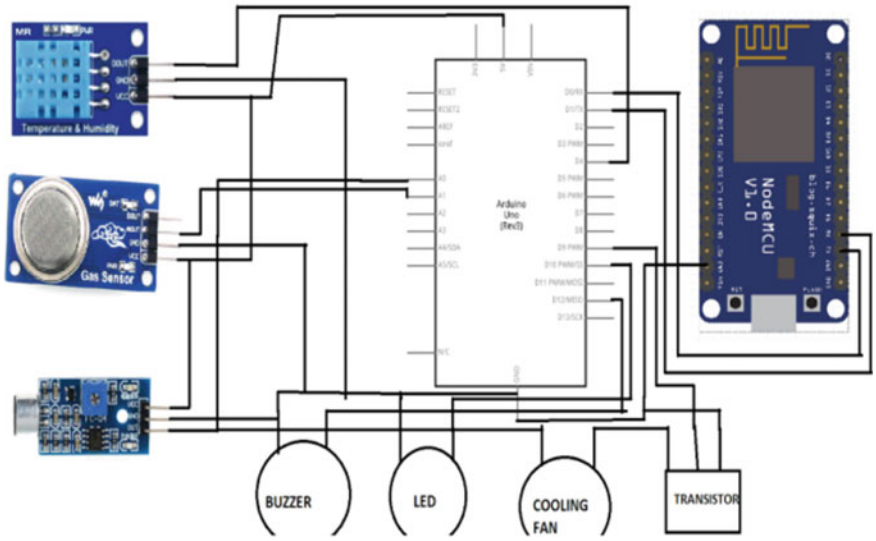


Fig. 7 Schematic

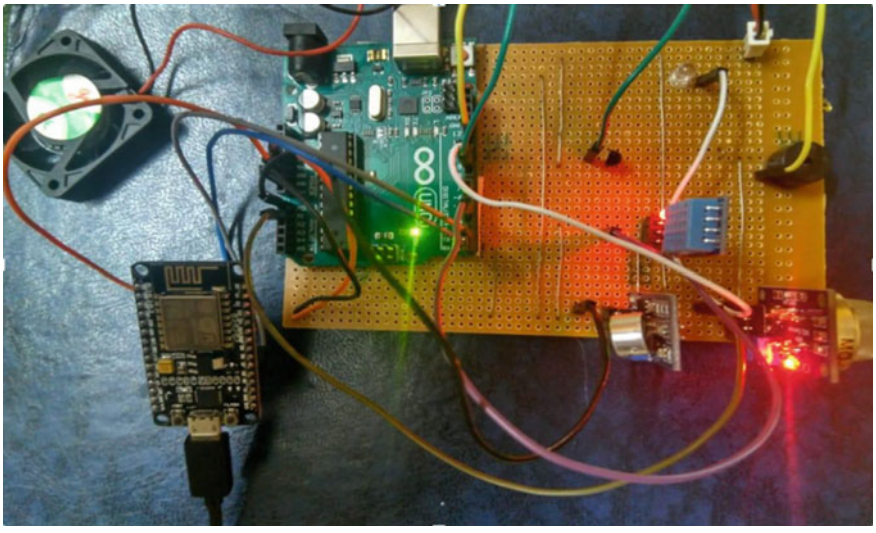


Fig. 8 Working model

stops when the required temperature has been reached. MQ-6 detects the presence of smoke or colourless gases such as LPG. An absolute threshold has been set using an incense stick. If the identified gas content goes beyond the limit, the buzzer or LED used goes off and does not switch off till the issue is resolved. Last but not

least comes the sound sensor RK-3103, which helps to detect the baby's cry and the buzzer goes off is this case [1, 11].

3.3 Working

3.3.1 Communication Between ESP8266 and Arduino UNO

- Both the micro-controllers are connected in a master and slave configuration where ESP8266 is the master, while Arduino UNO is the slave [12, 13].
- Both the micro-controllers are connected via their Tx and Rx pins, where the Tx of one is connected to the Rx of the other and vice-versa [14].

3.3.2 Temperature Detection

- The temperature is detected by the temperature sensor module DHT11. The sensed data is sent to the micro-controller via the data pin in the DHT 11 module.
- On receiving the data, the condition for the temperature being at optimum temperature is checked.
- If the temperature is above the optimum temperature, the cooling fan goes off, bringing down the temperature to the required optimal one. Also, a mail is sent to the administrator e-mail id regarding the high temperature and is sent continuously till the heat goes to the optimal temperature.

3.3.3 Smoke Detection

- The smoke or colourless gases, if any is detected by the gas sensor module MQ-6. The sensed data is sent to the micro-controller via the analog out pin in the MQ-6 module.
- On receiving the data, the condition for the presence of smoke or gases being within the permissible range is checked.
- If the value or values are above the optimal, the buzzer goes off alarming the administration regarding the high level of unwanted smoke or gases.

3.3.4 Sound Detection

In events of a baby crying, the decibel of the sound detected is sent to the micro-controller via the analog pin. A notification is sent to the administrator until the baby is not attended.

4 Result and Validation

The system is designed for these main purposes:

1. Providing utmost care to the infants
2. Reduction of workforce.

The above purposes are implemented by the automatic action taken by the sensors.

Whenever the temperature goes beyond the optimal range, the cooling fan automatically turns on and again automatically turns off when the optimal temperature is received. Also, an email and notification are sent continuously. If the email and notification continues for a long time, then the equipment requires servicing.

Whenever the concentration of gas goes beyond the safe value, the buzzer turns on, and it turns off only when the level of gas decreases.

A detailed explanation for all the components has been shown and how it provides output is explained below in Tables 1, 2, and 3.

- *For DHT-11*

  A representation of how it looks in Blynk while working is shown in Fig. 9.

- *For MQ-6*

- *For RKI-3103*

When an infant cries, another buzzer goes on till it is attended. In the case of temperature issues, the care is taken by the temperature sensor.

Comparative Analysis

The result of this model is different as it has taken into account various modules. This baby monitoring system would be very much beneficial in hospitals where the care of multiple babies has to be made. Security camera would of not much use and hence has been replaced by buzzer such that it gives immediate sense from where it is used. The facility of emailing, it can find a pattern as to which time for which reasons a baby's discomfort is being aggravated according to which the supervisors can take precautions beforehand.

The notification is shown in Fig. 10.

This model has used many different modules for ensuring security and efficiency. The best part of it is quite portable and can be fixed anytime anywhere, and due to its low price, it is quite affordable. Previously, the work that has been mentioned here

Table 1 Output of DHT-11

Temperature value	Action taken
Greater than 28 °C	Fan turns on, E-mail and notification alert
Less than or equal to 28 °C	Fan turns off

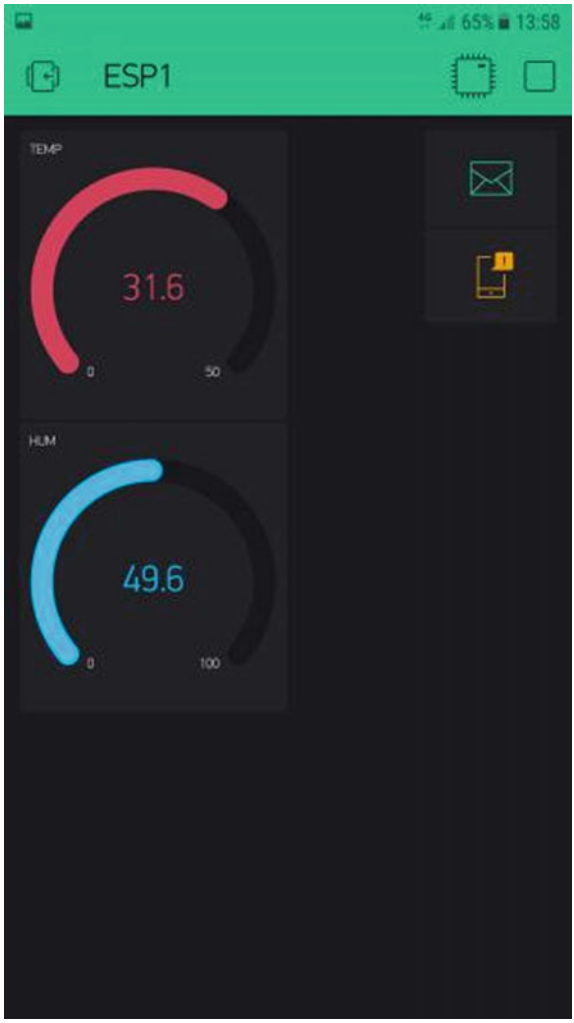


Fig. 9 Blynk interface

Table 2 Output of MQ-6

Concentration of gas	Action taken
Greater than or equal to 250	Buzzer/LED goes on
Less than 250	Buzzer/LED goes off

Table 3 Output of RKI-3103

Decibel value of sound	Action taken
Greater than or equal to 950	Buzzer/LED goes on
Less than 950	Buzzer/LED goes off

Fig. 10 Output

is quite good, but it either lacked the portability or was too pricey. With this model, we hope to overcome the problems and make the model better for real-time use.

5 Conclusion

Helping to keep an eye on any discomfort faced by the newborn infants, this system helps to maintain the required temperature and humidity; also the addition of a camera module would help the parents to see their baby without being physically present to avoid the presence of any germs and would allow the staff in-charge to monitor them and take necessary action as and when required.

On the one hand, monitoring the baby with the help of video streaming, the temperature, and humidity sensors informing about the conditions around the baby, the PIR sensor to detect the movement and graphical representation of the data helps the parents to analyse them carefully. Notifications, on the other hand, notifications received alert the parents and caretakers regarding the infants' discomfort, vaccination schedule, and also their feeding time helping to maintain a proper plan.

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