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IoT-based smart infant baby cradle using IR IP-camera

Ibrar Ahmad [1,*], Syed Jabir Hussain [1], Safeer Ullah [1], Waqas Ali Shah [1], Hamid Ali [1], Umar Waqar [1] and Shah Fahad [2]

[1] *Center of Excellence in IT, Institute of Management Sciences, Peshawar, Pakistan.*
[2] *Center of Excellence in IT, University of Agriculture, Peshawar, Pakistan.*

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Abstract

With the evolution of the internet of things and headway technologies like android phones and sensors every single thing got coupled and get controlled through the internet distantly, but at the same time the number of family member workers is also incremented. infant baby needs parental aid 24/7 to monitor different actions and check different parameters distantly but it is impractical, especially for those Parents/Caretakers who work outside of the home. So, there is a need for a system through which Parents/Caretaker can aid their infant baby and see infant babies' activities distantly in real time about different parameters and conditions of the infant baby. The proposed system is a smart infant Baby Cradle using IoT Technology that sends an alert notification to the Parent/Caretaker. In the proposed system IR IP-Camera is used to seize an infant baby in the real environment even at night. The proposed system is able to sense an infant baby's scream using a Microphone Module for 10 seconds, the temperature of the infant's environment, sense urine in meters ultrasonic sensor, automate the opening and closing of mosquitoes' net to sense mosquitoes and other harmful parasites using PIR sensor, infant baby Mass using weighting Scale, automatic fan, toys and music to entertain infant baby. The power bank is used to aid infant baby's in case of lack of electricity. Finally, all these sensors and components are physically connected through Arduino AT Mega 2560. When sensors sense then it updates data onto the database server and notifies her/his Parent/Caretaker using HC-05 Blue-tooth and GSM SIM900A-D57 Module. The proposed system is able to keep all recorded history for one month.

Keywords: IR IP-Camera; Mosquito-Net; Ultrasonic Sensor; PIR-Sensor; Automatic Fan; Power Bank; Arduino AT MEGA 2560; HC-05 Blue-tooth Module; GSM SIM900A-D57 Module; Record history

1. Introduction

Since the cost of living and expenditure are incrementing on regular basis to keep balance with expenditure females also stands with man and work outside their home [1][2], but on the other hand, they also have to aid their infant baby. The evolution of the internet and headway technology plays an important role to keeps balance in daily life activities with smart technology every single thing is coupled with the internet and we can control and monitor our activities distantly from our android phone. More than 80.

- The proposed system is able to swing automatically when an infant screech is detected using the Microphone Module for 10 seconds, if the screech is detected continuously for more than 10 seconds then an alert is sent to their caretaker to take the mandatory action, at the same time the other parameters are also checked like urine and temperature of the infant baby.
- The proposed system is able to talk with infant on her mother or caretaker voice which already recorded and at same time toys starts rotating, music plays on for consideration.
- After every hour automatic air freshener is on to avoid bad smells in the room.

* Corresponding author: Ibrar Ahmad

- The proposed system is able to check the infant and environment temperature and take mandatory action. If the environment temperature is rises from 30 ^{o}C then the mini-fan automatically ON and if the infant's temperature is rises from normal temperature, then Alert-Notification is sent to the Parent/Caretaker for physical help.
- The proposed system is able to check urination in an infant mattress if the mattress is wet then an alert notification is sent to the caretaker and parent to change the mattress and keeps the baby in comfort and healthy environment.
- Weighting Scale is used to check the Mass of the infant on regular basis and store the record for 30 days if there is any increment or decrement in infant mass then an alert-Notification is sent to the Parent/Caretaker.
- To keep infant safe from harmful mosquitoes the PIR sensor is placed above the cradle and the mosquito net is closed automatically when mosquitoes or other harmful parasites are detected.
- IR IP-Camera is used to see and talk with an infant baby in real time environment distantly. This camera is specially installed for night vision, it is competent to work at night.
- Finally, the proposed system is able to keep all the records of infant babies for 30 days, and upload data to the server on regular basis.

The proposed system is divided into several portions, the first portion of the paper is comprised of the previous and present research-related information and their comparison, the second portion comprises the methodology mechanism of the project, the next portion comprised the design and components used in the project, then onward it comprised of results and discussion, second last portion is comprised of conclusion and future work recommendations and the last portion is comprised of references

2. Literature review

This portion of the proposed system discusses variegated systems that were carried out at one time.

2.1. IoT Based Healthy Baby Cradle System

Sagar S Bachhav in 2018 proposed [1] a healthy baby cradle. The design system entertains babies on-line through music and recorded voices of their parent. The implemented system uses a temperature sensor that accurately measures temperature and results in an alarm output to save applications from damage, an accelerometer sensor for the detection of motion heartbeat sensor to record the baby's pulse rate. The author designed AWS cloud technology for the communication of different devices and DURACRIB android application to control the system online. The proposed system is beneficial and has some useful features. But it needs some improvement with technology.

2.2. IoT Based Smart Cradle System with an Android App for Baby Monitoring

Madhuri P.Joshi in [2] proposed a baby monitoring system. The author of the proposed system designed an automated smart cradle that seizure different activities of babies online using a video monitoring system. The proposed system swings automatically when it detects the crying voice and then sent an alert to the parent for attention. The advantage of the design system is that the parent can monitor the baby's status through video monitoring also, the cradle is controlled by the user. The proposed system sends an alert when the cradle is wet and for reducing the crying possibility baby is entertained with rotating toys.

2.3. Automatic cradle system with measurement of baby's vital biological parameters

Vijayamahantesh Hiremath in 2017 [3] proposed a low-cost cradle for the measurement of a baby's biological parameters. The author proposed an electronic cradle to aid the infant baby 's microcontroller base automated swing is designed which swings when the baby's cry is sense and then starts swinging until the baby is mute and the of cradle speed can be controlled by the user. Also, the design system has an alarm that is used as an alert for parents for physical attention when a specific time is passed the alarm starts alarming to notify his/her parent. The advantage of the system is that, that the system has already recorded voices for the surety of their parent. But the disadvantage of the proposed system may cause an electrical shock to the baby.

2.4. Non-invasive health monitoring system for infant using IoT

Pradeep Doss M in[4] designed a safe and healthy monitoring system for infants. The design system is based on a Raspberry pi 3B+ module and microcontroller base project which operates through a web application. The design system uses temperature for the measurement of temperature. Microphone Module to detects crying, adhesive sensor RAS45 for the measurement of the respiration rate, heartbeat sensor for the measurement of the heart rate condition,

H. blood gas sensor to monitor type 1 diabetes twice a day. After detecting different parameters by sensors it sends a signal to raspberry pi and displays the final output data to their parent through the network. The benefit of the design system it is display various health parameter to users. But disadvantage of the design system is that the sensors are fitted to the baby's body and there is a chance to affect cells and may affect baby health.

2.5. Design and Development of a Smart Baby Monitoring System based on Raspberry Pi and Pi Camera

Aslam forhad symon in 2017 in [5] proposed a baby monitoring system using pi camera. The implemented system is specially designed for busy working parents outside the home using the raspberry pi B+ module. The proposed system seizure various body movement of the babies using PIR sensor and capture the movement of the baby using Pi camera and display output on a monitor screen. The author of the proposed system uses a condenser Mic for crying detection of the baby. The advantage of the developed system is that it uses 512 MB RAM and a 700 MHz microprocessor which is useful in terms of speed. But the flaw is that it is expensive also the design system is not user-friendly in the sense that the user is not able to do anything it just displays the output on the screen to the caretaker.

2.6. Smart Baby Cradle an IOT based Cradle Management System

Aniruddha Rajendra Patil In [6] proposed a cradle management system. The author implemented Arduino Microcontroller to combine all the components. The implemented system gives an alert SMS system to the parent when the wet is detected in the cradle, an Arduino camera is used to see the baby online, and a PIR sensor to detect the light intensity in the cradle. The system is beneficial in terms of giving alerts to the parents about the baby's condition. But the flaw is that the system is not controlled by their parent as per parent requirement

3. Limitation in existing system

Vijayamahantesh in [1] proposed a low-cost electronic cradle that needs continuous electricity for operation means it is not feasible in a country where is a load shading issue and also it may cause electric shock. The author of the paper in [2] Pradeep Doss M designed a non-invasive health monitoring for infants which uses too many sensors to measure different parameters of the infant so, it's not feasible to use too many sensors and cant monitor infants online. The design system in [3][4][5] detects the wet condition, temperature, and video monitoring but they can't store the baby records at least for a month. The previously proposed system has some common limitation like storing records, and health safety but our proposed system is comprised of IR IP-Camera which is specially installed for night vision also the proposed system updates sensor data on the database server and store the infant record for one month, health safety mosquito net which automatically closes when mosquito or other harmful insects is detected, air freshener to avoid bad smell in the baby room.

4. Methodology

Table 1 Comparison table with previously designed system

Research papers	Temp Sensor	Infant record	IR IP-Camera	Automatic fan	Screech Sensor	Microphone	Android app
Automatic cradle system with measurement of baby's vital biological parameters.	✓	×	×	×	×	×	✓
IoT Based Smart Cradle System with an Android App for Baby Monitoring	×	×	×	×	×	✓	✓
Non-invasive health monitoring system for infant using IoT	✓	×	×	×	×	×	✓
IoT Based Internet of base Baby Monitoring system for smart cradle	×	×	×	×	×	×	×

Smart Baby Cradle an IOT based Cradle Management System	✓	×	×	✓	×	✓	×
Smart infant Baby Cradle with IP-Camera using IoT technology	✓	✓	✓	✓	✓	✓	✓

Smart Infant cradle is an IoT-based cradle system in which an android application is used to check parameters and the infant environment using variant sensors each sensor sent its values to the android application updates its value on a regular basis and stores a previous record for one month also the proposed system uses IR IP-Camera which is connected to the internet using HC-05 and GSM SIMA900A Module through which caretaker/parent can monitor and see the infant in real-time even in the night. This section of the proposed system describes the whole mechanism step by step.

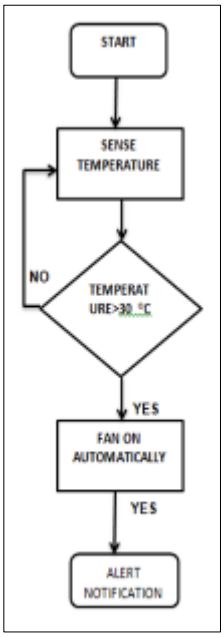

Figure 1 Temperature Detection Flow Graph

First, the system initializes and checks whether the infant screech is detected or not. If the screech is detected using the Microphone Module for 10 seconds then swing and baby music gets started to keep the infant in comfort and continue until the baby stops screeching. Now if the screech is continuing for more than 10 seconds then the alert notification is sent to the Caretaker/Parent that now baby needs the physical attention of the Caretaker/Parent and at the same other parameter are checked to find out the reason why the infant get started to screech (Figure 1). At the same time when the screech is sensed then it checks urine in the mattress if urination is sensed then it sent an alert notification to the caretaker/parent for changing the infant's mattress, then at the same time it checks the body and room temperature of the infant. Now if the temperature is greater than 30 ^{o}C then the mini-Fan will automatically turn ON (Figure 2).

Using a PIR sensor to sense mosquitoes or any other harmful insect body then the mosquito net will automatically close to avoid infants from harmful insects. Air freshener is used to avoid bad smells in the room. A weighting scale is used to check infant mass on regular basis and each record is stored online for thirty days and then automatically deletes recorded history.

This portion of the proposed system is comprised of components, a schematic diagram, a circuit diagram, and visual data using an android application. the detail of each component including hardware and software are given below:

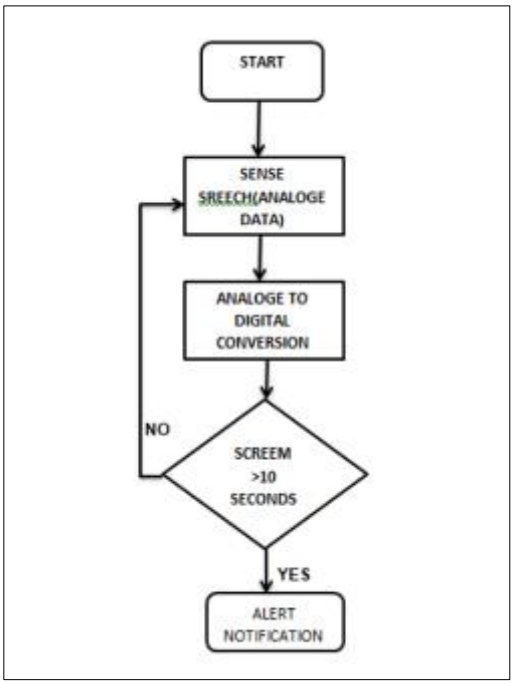

Figure 2 Sceech Detection Flow Graph

4.1. Components

4.1.1. Android AT Mega 2560:

It is a microcontroller board based on At Mega 2560. Its operating voltage is 5V and the input voltage is ranging from 7 to 12V. it usually design complex IoT project which needs more numbers of digital and analog I/O Pins. It has more flash memory, SRAM, EEPROM, and a clock speed of up to 16 MHz

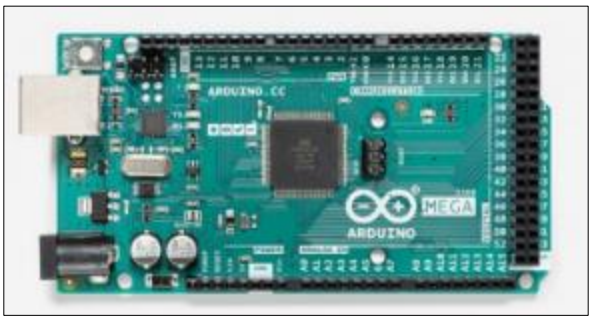

Figure 3 Arduino AT Mega 2560

4.1.2. GSM SIM900A-D57 Module

This module is available in mobiles and PDAs. This module is specially designed for communication purposes between embedded and IoT devices in electronic and IoT projects. It works on two frequencies i.e.: 900 MHz and its double frequency (1800MHz).

Figure 4 GSM SIM900A-D57

4.1.3. Temperature sensor LM35DZ

This sensor is an electronic sensor which takes input data from its environment readout and produces output in centigrade temperature. There are many advantages of LM35DZ sensor. Its temperature ranges from -55 OC to +150 OC and suitable for distantly areas. Control circuitry is easy because of precise, linear output and low operating voltage. It has low self-heating because of low internal resistance.

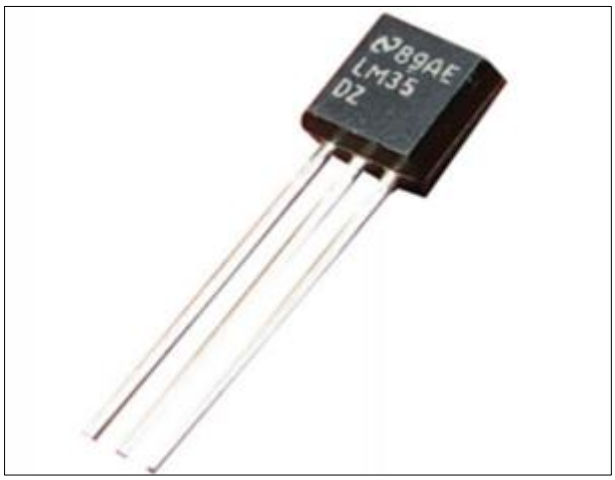

Figure 5 Temperature Sensor LM35DZA

4.1.4. Microphone Module KY-038

This module is used to sense the very basic module for sound detection. In the proposed system Microphone Module KY-038 is used to sense the screech of an infant baby cradle. The module sense screech in the form of analog data and then covert it into an electrical signal and an infant screech is detected.

Figure 6 Microphone Module KY-038

4.1.5. Baby weighing scale

EQ-BE-55 infant weighing scale is a digital scale that is used for the measurement of the accurate mass of the infant baby. It has to build a 1.2-inch LCD display and have a maximum weighting capacity of 25Kg. it has built-in memory for eight toddlers and 15 records of every single toddler. EQ-BE-55 infant weighing scale comes with a delta weight feature and has ability to calculate the difference in weight from the previous reading.

Figure 7 Baby weighting scale EQ-BE-55

4.1.6. Automatic Fan

Mini Fan is a lightweight, portable, and handy Fan to reduce the intensity of temperature. It has long battery life USB power and charging abilities. Its input voltage is up to 5V and its output voltage is 4-6V.

Figure 8 Automatic fan

4.1.7. Automatic Mosquito Net

Automatic anti-mosquito net has a useful feature to protect the infant from harmful mosquitoes and other harmful insects specially design for the summer season. The net has automatically an ON/OFF feature when an object is detected near the mosquito net.

Figure 9 Automatic Mosquito Net

4.1.8. Power Bank

The power bank is the power storage and power supply device. In the proposed system power bank is used to operate the design hardware system is case of load shedding or lack of electricity. It has a maximum power storage capability of up to 25000mAh. Smart infant cradle is a mini IoT-based project and for small and mini project power bank is beneficial.

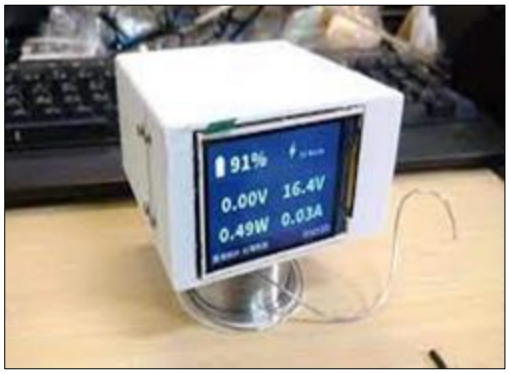

Figure 10 Power bank

4.1.9. IR IP-Camera

An Internet protocol camera is a digital video camera that can control and receive video, images, and audio via IP-Network. It does not require any recording device. This is a fixed camera that monitors the infant cradle area. For local storage, users pay cloud subscription fees which have looping storage, and users can view and download clips within a specified interval of time.

Figure 11 IR IP-Camera

4.1.10. Air Freshener

To avoid bad smell aside from the cradle an automatic air freshener is used. Users can fill it with their own fragrance choice. Users can also set a timer for spraying. Usually, it sprays twice an hour. It has a built-in battery which is rechargeable.

Figure 12 Air Freshener

4.1.11. HC-05 Blue-tooth Module

This module is usually used for long-range communication in IoT Based projects. the module has two modes (Master and Slave). In the HC-05 Bluetooth module, the master mode is used for the desired connection means that it can pair with any device while slave mode needs to wait for the master to establish a connection. the module works on a small range and has a 2.1 MHz, frequency band. it uses two communications.

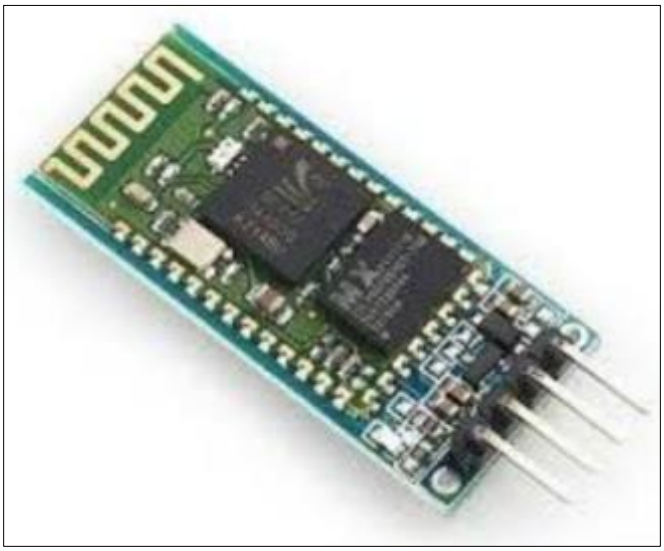

Figure 13 Bluetooth HC-05

4.1.12. Schematic diagram

The section of the proposed system discusses the connection of different components with Arduino Module as shown in the figure given below

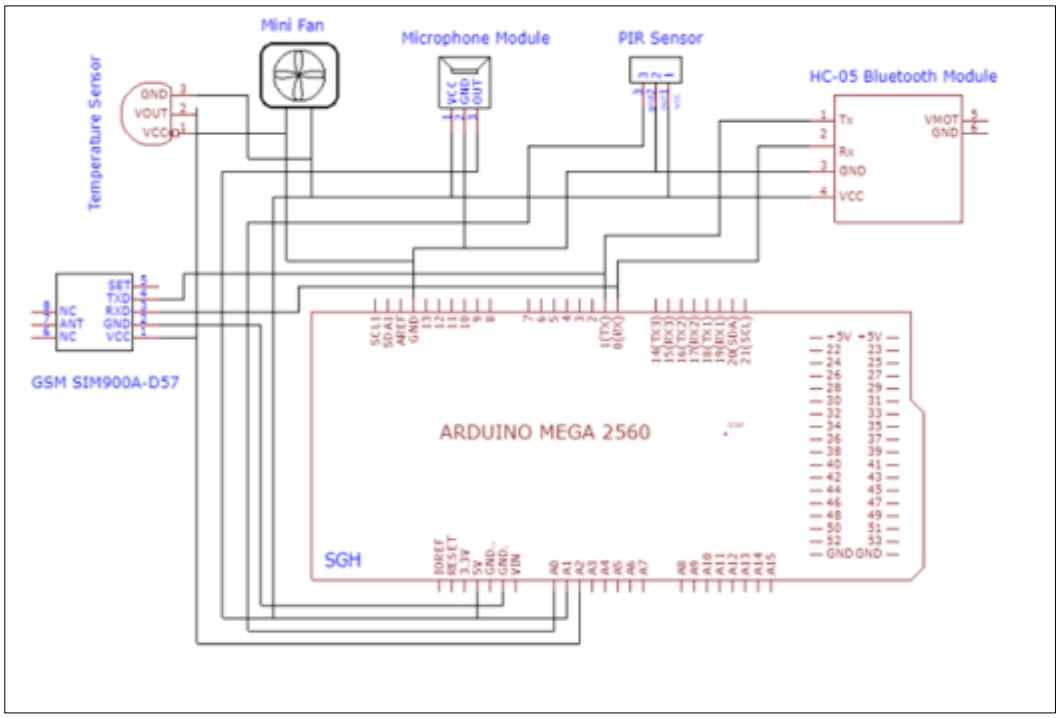

Figure 14 Schematic Diagram

4.1.13. Circuit Diagram

The portion discusses the practical implementation of the project by combining all the components in the breadboard as given in the figure.

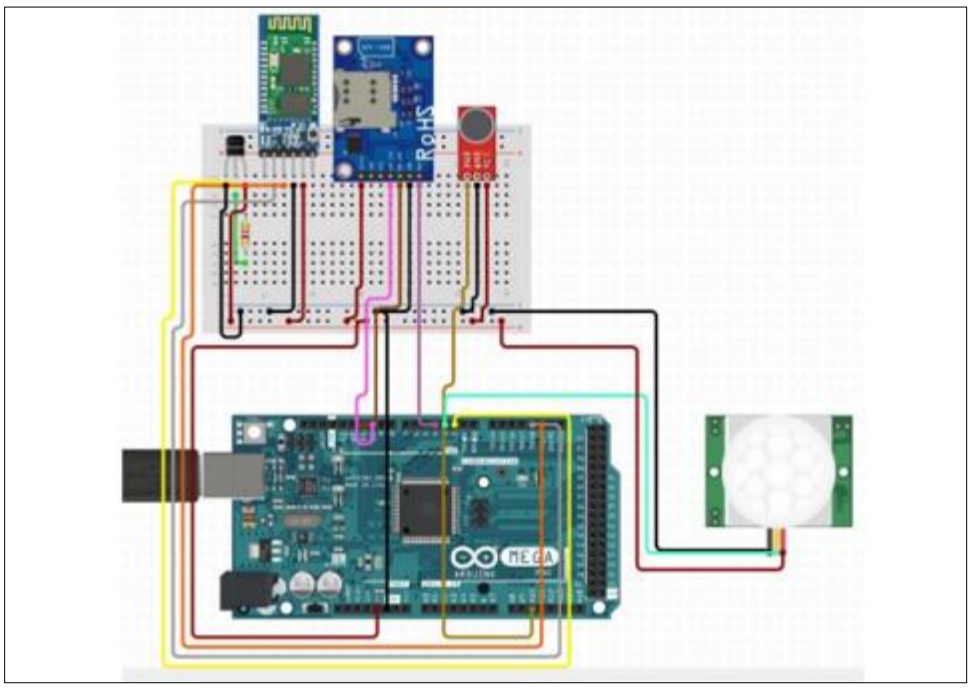

Figure 15 Circuit Diagram

4.1.14. Block Diagram

This is the simplest way to represent the project detail of the components as shown in the figure.

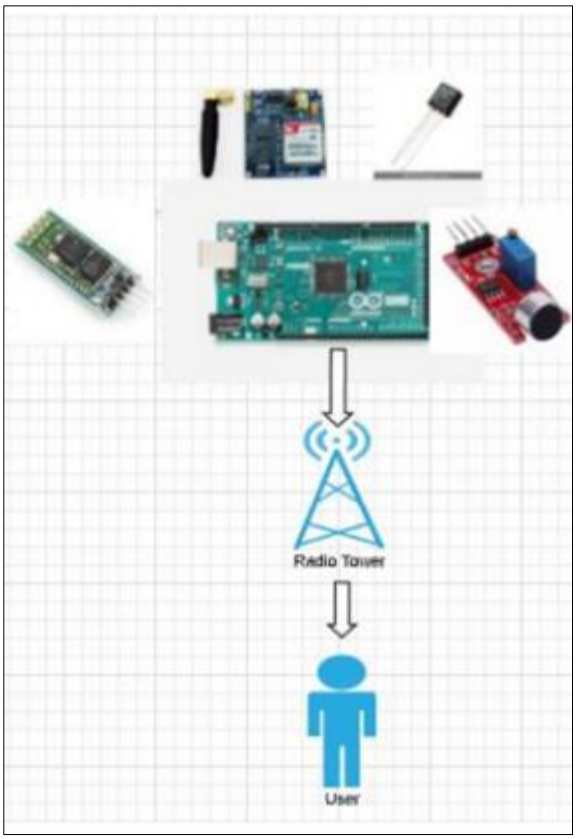

Figure 16 Block diagram

5. Results and discussion

Finally, all the hardware and software components are combined together and the project is now ready for the next stage this stage is called the testing stage. In this section, the proposed system is checked for the accuracy of the graph and user interface.

Figure 17 Mobile Application

5.1. Baby screech for less than 10 seconds

Figure 18 shows when an infant screech is detected for less than 10 seconds initially the infant screech is zero and with the passage of time when infant screech is detected the curve line is incremented and when it reached 10 seconds then the line becomes a straight line which indicates that infant is now in mute condition.

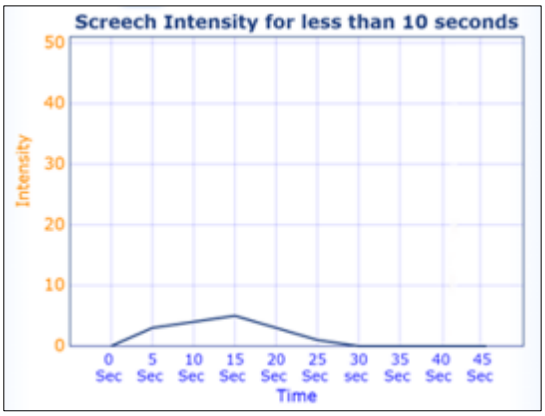

Figure 18 Graph intensity less than 10 seconds

5.2. Baby screech for Greater than 10 Seconds

Figure 19 shows when an infant screech is detected for more than 10 seconds initially the infant screech is zero and as time passed the curve line is moving in the up-word direction which is the indication that now infant is not controlled and needs the physical attention of Parent/Caretaker.

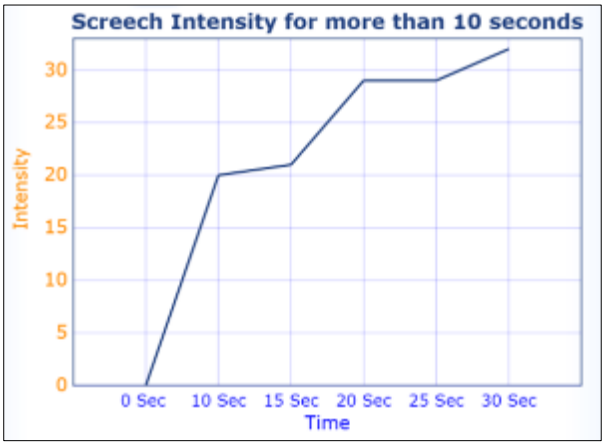

Figure 19 Graph intensity greater than 10 seconds

5.3. Case 3: when the temperature is Less than 30 oC

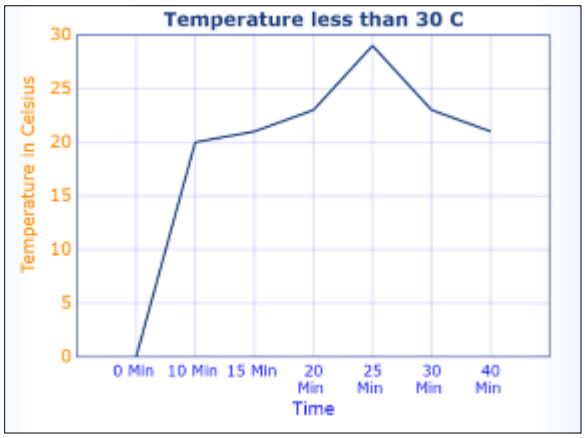

Figure 20 Graph temperature less than 30 ^{o}C

Figure 20 indicates initially the temperature is not measured since the system is not initialized and with the passage of time the temperature Vs time graph is exceeding but it is less than 30 ^{o}C and hence the mini is turned OFF.

5.4. Case 4: when temperature greater than 30 oC

Figure 21 indicates the temperature Vs time graph. Initially, the curve is its initial point. With the passage of time the temperature is increasing and when it exceeds 30 oC then automatically the mini Fan turns ON and sent an Alert-Notification to Parent/Caretaker.

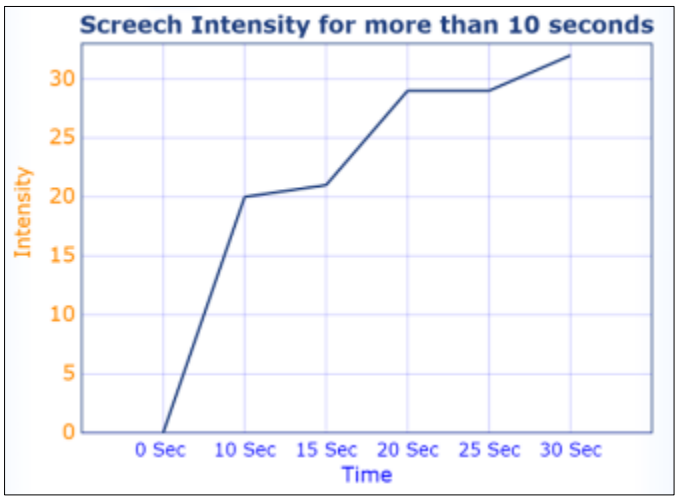

Figure 21 Graph temperature greater than 30 ^{o}C

6. Conclusion

Finally, we have combined all components together in "IoT Based Smart infant baby Cradle". The proposed system has five major functionalities. 1st It uses IR IP-Camera to distantly monitor the baby in a real environment. 2nd, it stores infant records like Mass, temperature, image, and videos seizures records online for one month. 3rd, it has an automatic mini fan which automatically Power ON when the temperature rises from room temperature. 4th, it uses an automatic mosquito net which automatically closed when an object or harmful insects is detected above the cradle so it's useful in terms of health management. 5th it has an automatic air freshener to avoid bad smells in the infant room. In the future, machine learning and AI algorithm can be added to control the cradle through voice commands.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

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