Network for Research and Development in Africa
International Journal of Knowledge and Dynamic Systems
ISSN: 2384-5368, Volume 13, Issue 6
PP 75-92 (December, 2023)
DOI: 6732-1453-71-1368
arcnjournals@gmail.com
https://arcnjournals.org

Design and Construction of Sound and Moisture Detection System to Aid Deaf Mothers

[1]Adam Bababe Bukar, [2]Mohammed Alkali Abbo , [3]Usman Ali
[1]Department of Computer Engineering, Ramat Polytechnic Maiduguri, Nigeria
[2]Department of Electrical Engineering Technology, Ramat Polytechnic Maiduguri, Nigeria
[3]Department of Computer Engineering, Ramat Polytechnic Maiduguri, Nigeria

Abstract*: The rising complexities of routines of today's parents and the need for infants to be observed frequently to avoid any kind of injuries or accidents cannot be overlooked. This project present an arduino based sound and moisture detection system in order to aid deaf mother's recognize when their baby is crying or she has wet the bed. this system is operating on 434MHz RF transmitter and receiver module, its input from a microphone module and moisture sensor which is interfaced to the microcontroller, vibrator is used at the output of the receiver enabling the deaf mother reliazed at the instant signal is received. the system is useful for hearing-impaired and working parents.*

Keywords: *Detection; Deaf Mothers; Microphone Module.*

1.0 INTRODUCTION

Technology advancement has covered an impressive milestone over the years. The most notable developments are those that have contributed to people's relationship with society and their environments (Fullerton, 2013). Such developments are key, especially to physically challenged individuals. One of the most common types of disability is deafness. About 5% of the world's population are deaf, which accounts for three hundred and ninety million people of the entire world's population (Fullerton, 2013).Out of this 5%, those found in sub-Saharan Africa find it difficult to interact in society and have independent lives. It is often difficult for a deaf parent to relate to their babies without getting most of their help from other people. Newborn babies cannot talk or call out to their parents; therefore, they often rely on their cries to get their parent's attention. If the deaf parents are poor, they cannot afford the very few and expensive options on the market. Finding a cheap option has been the challenge for many years now. Only very few researches exist in this area. Hence, this project seeks to research and develop a cheap solution to this problem. This device will bridge the gap of emotional trauma that hearing babies and deaf parents face in the first few years of the baby's life. This system will enable the parents to attend to their babies with little help from other people, thereby giving them control over their baby. Parents in the present

world are busy in their professional life so they do not get sufficient time to take care of their babies. Today's woman has to manage home along with their office work simultaneously. The system has vibrator and display that indicates two conditions, first when the mattress is wet, it is an important parameter to keep the baby in hygienic condition, second when baby does not stop crying within a stipulated time which intimated the baby needs attention. The system is useful for hearing impaired parents and working parents

1.1 PROBLEM STATEMENT

The rising complexities of routines of today's parents and the need for infants to be observed frequently to avoid any kind of injuries or accidents cannot be overlooked. Today's parents, especially the deaf ones, greatly need a device that can help monitor their child's activities even when they are away from their home or in another room. Babies need continuous attention to ensure their safety and health. Surveys show that physically challenged deaf parent, feel the most helpless when they cannot take care of their babies without help from others (Liow *et al.,* 2013).A device that bridges this gap will strengthen the bond between the parents and their babies. Certain ailments that would have otherwise occurred because the baby cries too much could be avoided. The babies will spend less time crying because their parents can find out easily. Hence, there is a great need to embark on this project.

1.2 OBJECTIVES OF THE STUDY

The aim of this project is to design and construct sound and moisture detection system to aid deaf mothers. The objectives of the project are as follows

i. To design a baby monitoring system for a deaf mother
ii. To provide an effective way deaf parent to monitor their babies
iii. To prevent problematic situation were a baby get hurt and cries out for their parent, but they did not attend to the baby on time because they could not hear.
iv.

1.3 SCOPE AND LIMITATION

The scope of this project is to focus on designing sound and moisture detection system for a deaf mother, the project is limited to detection of baby's cry and wetness using microphone module, RF transmitter/receiver, microcontroller, moisture sensor, vibrator and LED's.

2.0 REVIEW OF RELATED WORK

This section provides an overview of related works and previous researches on the existing system. Research has shown that the development of the bond between parent and their children is dependent on the parents ability to be responsive and sensitive to their child's physical and emotional needs Das (2019) this project explore a different approach to solving the problem of deaf parent being unable to know when their baby is crying the implantation of this project make use of microphone module and moisture to know when a baby cry or has wet the bed.

Sanuratu (2020) designed an automated baby monitor for financially challenged deaf parents in Africa, the system is operating on a 433MHz RF module to aid wireless communication. Its input is from a pulse/heartbeat sensor, which checks the beat per minute (BPM) of the baby when it is higher than 145BPM, indicating that the baby is crying. The Microcontroller used

is ATMega328P. The focus of the system is to help a deaf parent recognize that their baby is crying when the parent is not in plain sight of the baby or the parent is sleeping. Hence, this system has two devices, one of which will be worn by the baby and another which will be worn by the parent, and communication is wireless. The drawback of the system is that its detect only baby cry.

According to Arianna Anderson *et al.,* (2019), the use of algorithms such as an app could help one know when a baby cry. The cries of over 2000 babies were sampled and used to build an app that can categorize the cry of a baby into pain, fussiness, and hunger. They achieved this by looking at the different frequencies in the cries and different patterns of cries and silence. The duration of silence while the baby cries was used to analyze the possible reasons why the baby might be crying. The app was used on iPhone and Android devices. The app works such that five seconds of the baby's cry is recorded and uploaded to a database. The cry properties such as frequency are compared with other rates to determine why the baby is crying. The result is displayed in the bar graphical form major setback of this design is that the deaf parents must be aware of their baby crying before they could use the app to tell why the baby is crying. Another setback is that sophisticated phones and knowledge about graphs are needed to operate the system. A financially challenged or illiterate deaf parent cannot be able to use the app because of its complexity.

Again Ariana Anderson (2018), designed a baby monitor with the use of voice recorder

The system was embedded in a toy. It is used to monitor whether the baby is crying or not. The cry detector consists of a voice recorder, an XBee module for communication, and an Arduino. When in operation, a notification from the toy module is sent to a watch module that the parent wears. The watch module consists of a screen that displays the data of the time the baby is at rest, and when he/she is crying. It also includes a vibrating motor that vibrates when the baby is crying, the system works successfully but its setback is that its limited to baby crying alone.

Anju Krishna and Harsha Ponnamma Dev (2019), presented work on Automatic cradle system with measurements of babies vital biological parameters. In their work they develop a new low cost indigenous electronic cradle because the existing cradles are imported and costly, This presents the design a implementation or a new indigenous low cost E-Baby cradle that swing automatically when baby cries, for this it has a cry analyzing system which detects the baby cry voice and accordingly the cradle swings stops crying, the speed of the cradle can be controlled as per the user need. The system has inbuilt alarm that indicates the condition - when baby do not stop crying within a stipulated time, which intimated that baby need attention. This system helps parents and nurses to take care of babies without physical attention by already recorded voice input to FN-Ml6P model and at this same time cradle also moves according to the user need. The drawback of this is used from birth to twelve months of babies, to detect the infant cry e baby cradle that swings automatically with soft music while the speed of the Cradle is not automatic unless it can be controlled as per as the users need and it's a audio baby cry detection not a vibrant.

Aslam Forhad Symon *et al.,* (2017) designed baby monitoring system to detect baby's activities like motion and cry sound. The system is accomplished with display unit, buzzer and camera module. Whenever baby motion or cry is detected, camera module is turned on to display baby motion on display unit and buzzer to indicate baby's cry Detection. To overcome this scenario, we design a sound and moisture detection system which is user

friendly and of low cost for a deaf mother which consists of RF transmitter and receiver module, microphone and moisture sensor module which has been interfaced with microcontroller, the use of vibrator at the output of the receiver which enable the deaf mother to realize at the instant when the cries or whenever she wet the bed the radio frequency transmitter allow the system to be in operation even when the device are not in line of sight as long as they in range of operation of the device. The system can go a long way in addressing challenges face by a deaf mother.

3.0 METHODOLOGY

In this section, attention would be focused on the design analysis of the system. Block diagrams and schematic diagrams are used to explain the operation of the various units of the system. The materials and equipment used in the implementation of the system were stated in this chapter. Also, the procedure undertaken in the system design and implementation are discussed in this section. The principle of operation of the system is explained clearly.

3.1 SYSTEM ARCHITECTURE

The system comprises of five units which are integrated to function as a system fig 3.1 below shows the general architecture of the system.

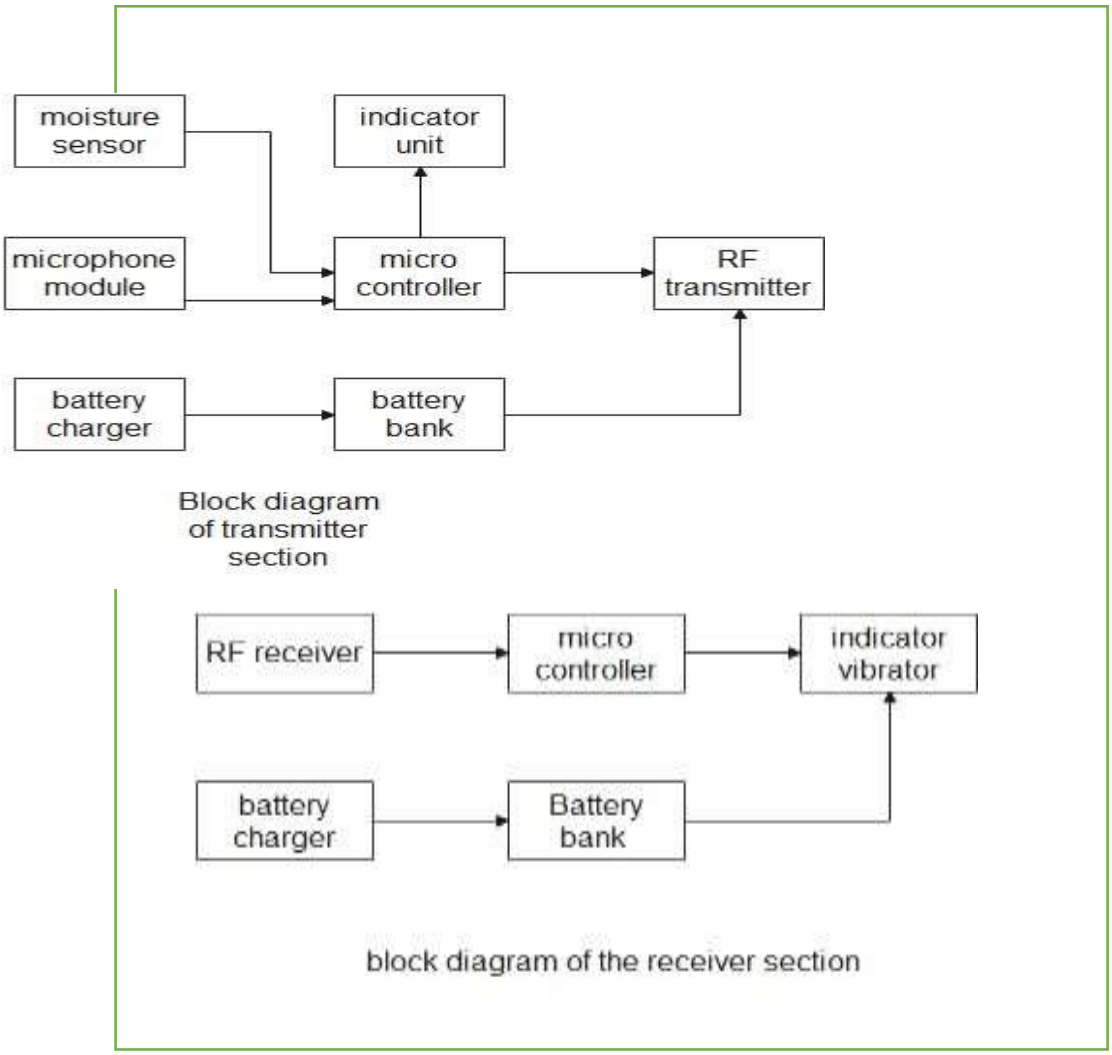

Figure 3.1: Block Diagram of the System

3.2 FLOWCHART OF THE SYSTEM

Fig 3.1 and 3.2 shows the Flowchart of sound and moisture detection system to aid deaf mothers

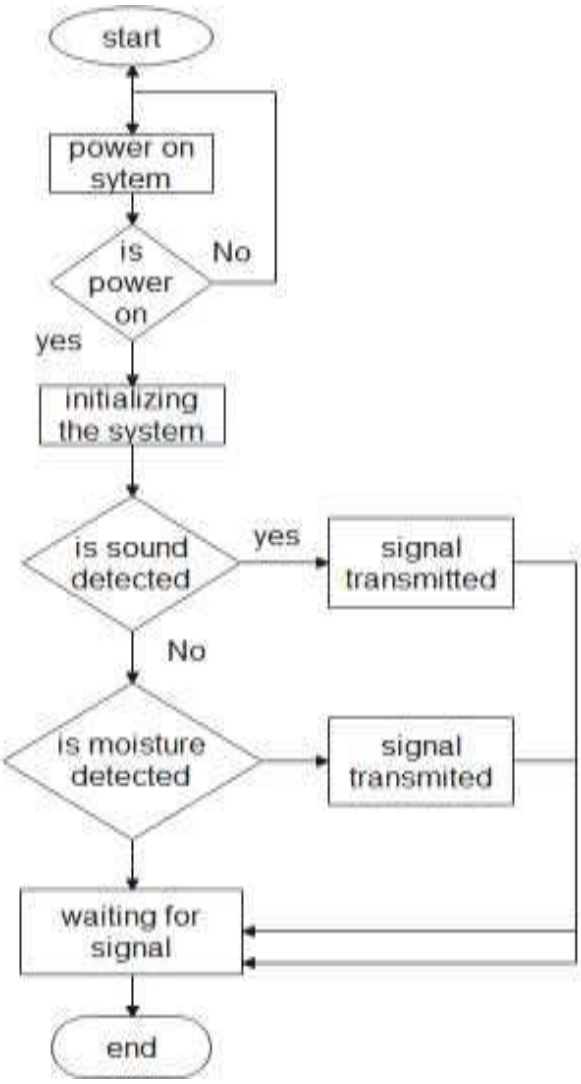

Fig 3.2a: flowchart of transmitter section

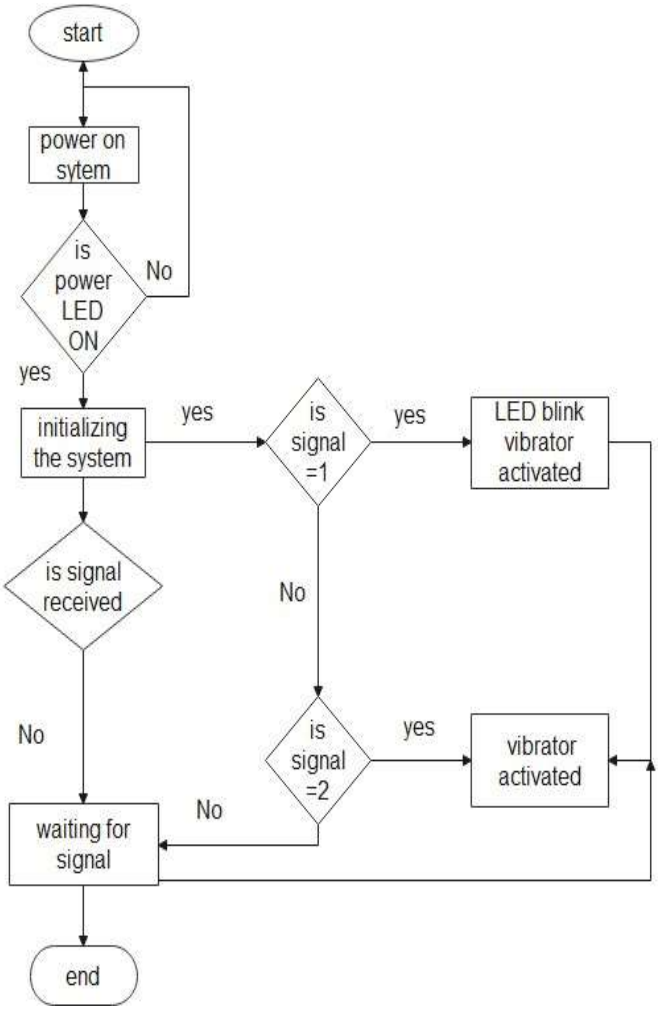

Fig 3.2b: Flowchart of receiver section

3.3 DESIGN DETAILS OF THE RF MODULE

In this section we will discuss about RF transmitter and Receiver module and how they are interface with micro controller and there working principle is explained.

3.3.1 RADIO FREQUENCY MODULE

RF Module is a cheap wireless communication module for low cost application. RF Module comprises of a transmitter and a receiver that operate at a radio frequency range.
Usually, the frequency at which these modules communicate will be 315 MHz or 434 MHz.
The image of the RF module pair is shown in fig.3.6
In this project, we are using a 434 MHz RF Transmitter – Receiver pair. This module can be used for communication for distances up to 10 meters.

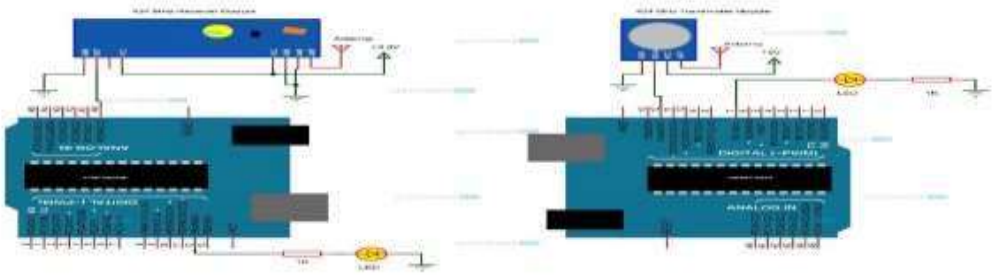

Fig 3.3: Diagram of RF Transmitter and Receiver Pair

3.3.2 CIRCUIT DESIGN OF RF TRANSMITTER AND RECEIVER PAIR

3.3.2.1 TRANSMITTER PART

The transmitter part consists of Arduino and the 434 MHz Transmitter module. An external LED can be used but on board LED would be sufficient. The design of the Transmitter part is as follows.

The RF Transmitter Module consists of 4 – pins: VCC, GND, Data and Antenna. VCC and GND pins are connected to 5V and ground respectively. The data pin is connected to any of the digital input / output pin of Arduino. Here, it is connected to Pin 12.

The antenna pin must be connected to an antenna which is nothing but a wire wound in the form of a coil. We are using the on board LED for demonstration but an external LED along with current limiting resistor can be used.

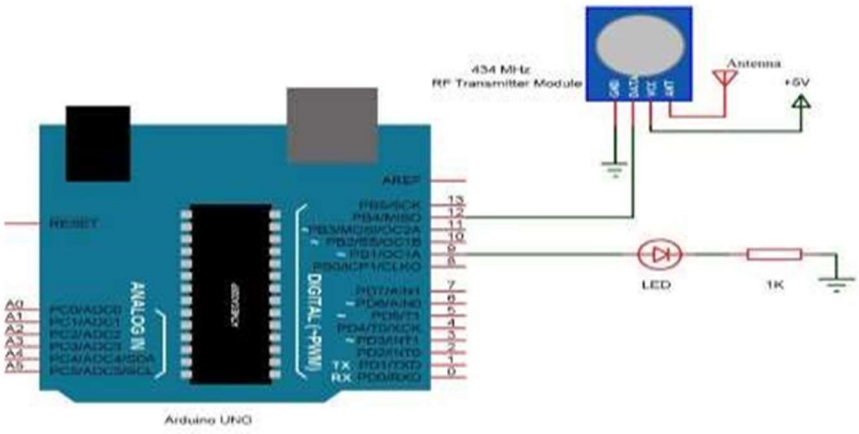

Fig 3.4: RF TRANSMITTER SECTION

3.3.2.2 RECEIVER PART

The receiver part consists of Arduino UNO and the 434 MHz Receiver module. An external LED can be used along with a current limiting resistor but on board LED would be sufficient. The design of the Receiver part is as follows.

The RF Receiver Module consists of 4 – pins: VCC, GND, Data and Antenna. VCC and GND pins are connected to 3.3V pin of the Arduino and ground respectively. The data pin is connected to Pin 12 of the Arduino. An antenna similar to the transmitter module is connected to the antenna pin of the 434 MHz Receiver module. The on board LED which is connected to the 13th pin of Arduino is used in the project although an external LED can always be used

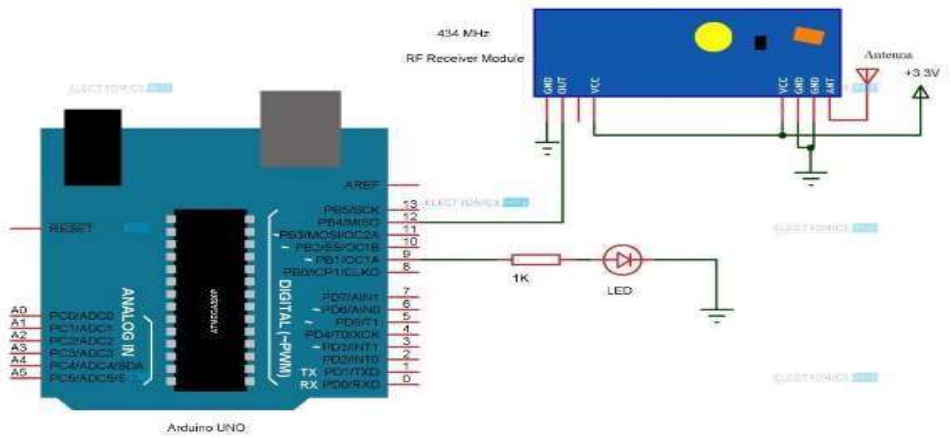

Fig 3.5: RF RECEIVER SECTION

3.3.3 WORKING PRINCIPLE OF RADIO FREQUENCY TRANSMITTER AND RECEIVER PAIR

In this project, a simple demonstration of RF Communication with the help of Arduino boards is given. The aim of the project is to successfully transmit data between the RF Transmitter – Receiver modules using two Arduino microcontroller boards. The working of the project is explained here. The project can be implemented with or without the help of a special library called "Virtual Wire.h". The project implemented here uses the library.

Virtual Wire.h is a special library for Arduino created by Mike McCauley. It is a communication library that allows two Arduino's to communicate with each other using RF Module i.e. transmitter – receiver pair. This library consists of several functions that are used for configuring the modules, transmission of data by the transmitter module and data reception by the receiver module.

In this project, the transmitter simply sends two characters i.e. it sends the character "1" and with a delay of few seconds, it sends the character "2". Whenever the "1" is sent, the LED on the transmitting side of the project will blink. As this "1" is transmitted via RF communication, the receiver will receive the data "1".

When the receiver receives "1", the Arduino on the receiver side of the project will blink a LED and vibrator will be activated.

Similarly, when the data "2" is transmitted by the RF transmitter, the LED on the transmitter side will blinks. As a result, the receiver now receives "2" and vibrator will be activated.

Hence, the receiver is responding based on the actions of the transmitter.

3.3.4 Wireless Protocols Used In Radio Frequency Modules

RF modules are frequently used to communicate according to a pre-defined wireless standard, including:

- Zigbee
- Bluetooth Low Energy
- Wi-Fi

- IEEE 802.15.4
- Z-Wave
- Wirepass

3.4 DESIGN OF THE MOISTURE DETECTOR

The moisture sensor is design using rain sensor. A rain sensor is one kind of low-cost electronic sensor which is used to detect the rainfall or water drops. It works as a switch. Normally the switch is open condition. This sensor is consisting of mainly two parts, one is Sensing Pad and another one is the Sensor Module. When rainfall or water drops fall on the Sensing Pad surface, then the switch will be closed. The Sensor Module reads data from the sensor pad and processes the data and converts it into a digital/analog output. So, the sensor can provide both types of output Digital output (DO) and Analog output (AO).

3.4.1 WORKING PRINCIPLE OF MOISTURE DETECTOR

At first, one need to connect the Sensing Pad to the Sensor Module through the jumper wire. Then connect the rain sensor module's Vcc & Gnd pin to 5v power supply. Then set the threshold voltage at the Non-Inverting input (3) of the IC in dry condition of the sensing pad by rotating the potentiometer knob to set the sensitivity of the sensor.

When water drops increase on the sensing pad surface then its conductivity will increase, and resistance will decrease. Then a Low amount of voltage from the sensing pad is given to the Inverting input (2) of the IC. Then the LM393 IC compares this voltage with the threshold voltage. In this condition, this input voltage is less than the threshold voltage, so the sensor output goes LOW (0).

When no water drops fall on the sensing pad surface then it has low conductivity and high resistance. Then the high amount of voltage will be allocated across the sensing pad. So, a High amount of voltage from the sensing pad is given to the Inverting input (2) of the IC. Again, the LM393 IC compares this voltage with the threshold voltage. In this condition, this input voltage is greater than the threshold voltage, so the sensor module output goes High (1).

3.4.2 Sensor Specification

- Adopts high quality of RF-04 double sided material.
- Area: 5cm x 4cm nickel plate on side,
- Anti-oxidation, anti-conductivity, with long use time;
- Comparator output signal clean waveform is good, driving ability, over 15mA;
- Potentiometer adjust the sensitivity;
- Working voltage 5V;
- Output format: Digital switching output (0 and 1) and analog voltage output AO;
- With bolt holes for easy installation;
- Small board PCB size: 3.2cm x 1.4cm;
- Uses a wide voltage LM393 comparator

3.4.3 Connections

Arduino --> Comparator
5V --> VCC
GND --> GND
DO --> D4
AO --> A0

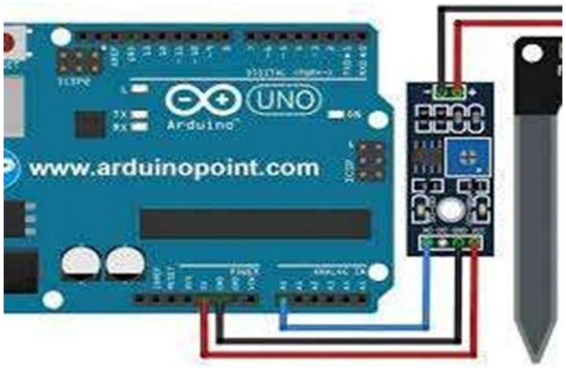

Fig 3.6: Interfacing of Moisture sensor with Arduino

3.5 PROCEDURE FOR PROJECT DESIGN AND IMPLEMENTATION

The method adopted in the design and implementation of the system can be group into the following categories:

1. Hardware Experiment; 2. System assembly; 3. Software part

3.5.1 HARDWARE EXPERIMENT

In this stage the circuit is implemented on a prototype board. It was conducted to predict the actual behavior of the system before soldering on the Veroboard. The components were temporary fixed on breadboard in accordance with the circuit diagram describe in the design analysis. After careful implementation of the circuit on the breadboard, the system was energies and its behavior and function was tested. The components were removed from the breadboard, when the hardware simulation was found to be successful.
The pictorial diagram for the hardware experiment is shown in fig 3.7 below.

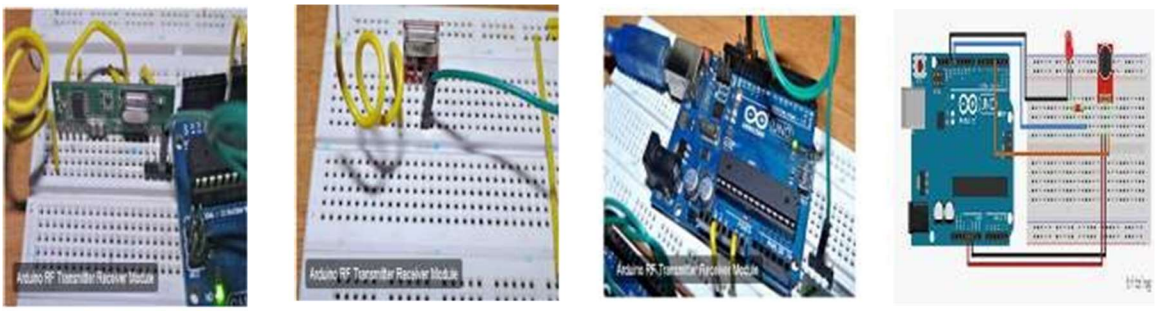

Fig 3.7: RF Transmitter and Receiver Pair

3.5.2 SYSTEM ASSEMBLY

At this stage, the circuit components were placed on vero board according to the circuit diagram of the system. When they were properly placed, the circuit elements were soldered on the vero board. The system was tested for open circuit and short circuit fault. The entire system was powered and tested. And4finally, it was enclosed in a rectangular wooden casing. Fig 3.12 below shows the pictorial diagram of the system from different view.

Fig 3.8: Pictorial diagram of the System

Fig 3.9: The 3-D View of the System

3.5.3 SOFTWARE PART

After successful implementation of the system hardware, the following procedure were undertaken to implement the software section of the system.

Arduino is an integrated software development environment (IDE) which is cross-platform and it is written in Java. Arduino uses Software programs, called sketches that are created on a computer using the Arduino IDE. The IDE is used to write and edit programs and convert these programs into HEX files that Arduino hardware understands. The IDE is also used to upload these instructions to the Arduino board.

3.5.4 ARDUINO SKETCH

The basic format of the Arduino language is very simple and has got at least two parts. These two required parts or functions enclose block of statements

```
Void setup ()
{
Statements;
}
Void loop ()
{
Statements;
}
```

Where setup () is only run once during program execution, loop () function is the main function of Arduino and runs infinitely. Both functions are required for the program to work. setup ()

The setup () is called only once when a program starts. It is used to initialize communication ports and setting pin Mode. Setup must be included in every program even if there are no statements to run. Loop ()

After calling the setup () function, the loop () function loops consecutively allowing program to change, respond and control the Arduino board.

3.5.5 PRINCIPLE OF OPERATION OF THE SYSTEM

From the circuit diagram in fig 3.15, 220V ac is step down to 12V ac using 220V/12V transformer. A bridge rectifier converts this voltage from ac to dc. An electrolytic capacitor is used to eliminate ripples from output of the rectifier. A linear IC LM317 is configured as variable power supply and adjusted to a suitable level to charge the battery banks for both the transmitter and receiver subsystem.

In the transmitter section, the system is powered on, it will first initialize and start checking the status of the sound sensor and moisture sensor. On detection of sound signal, it will send this signal to the microcontroller and the microcontroller will process this signal and transmits digital value “1” via the RF transmitter. Similarly, when the moisture sensor sensed moisture, it will send it to the microcontroller, and the microcontroller will process it and transmits digital value “2” via the RF transmitter.

In the receiver section, when the system is powered on, it will initialize and wait for signal from the RF transmitter. When the RF receiver detects signal, it will demodulate it. The

microcontroller will check this signal, if the signal received is equal to "1" the microcontroller will command digital pins to activate LED to be blinking and activate Vibrator simultaneously. Similarly, when the demodulated signal is equal to "2" the microcontroller will command digital pin to activated the vibrator. In these ways, the mother will differentiate the received signals based on the mode of alarm it presents to the mother.

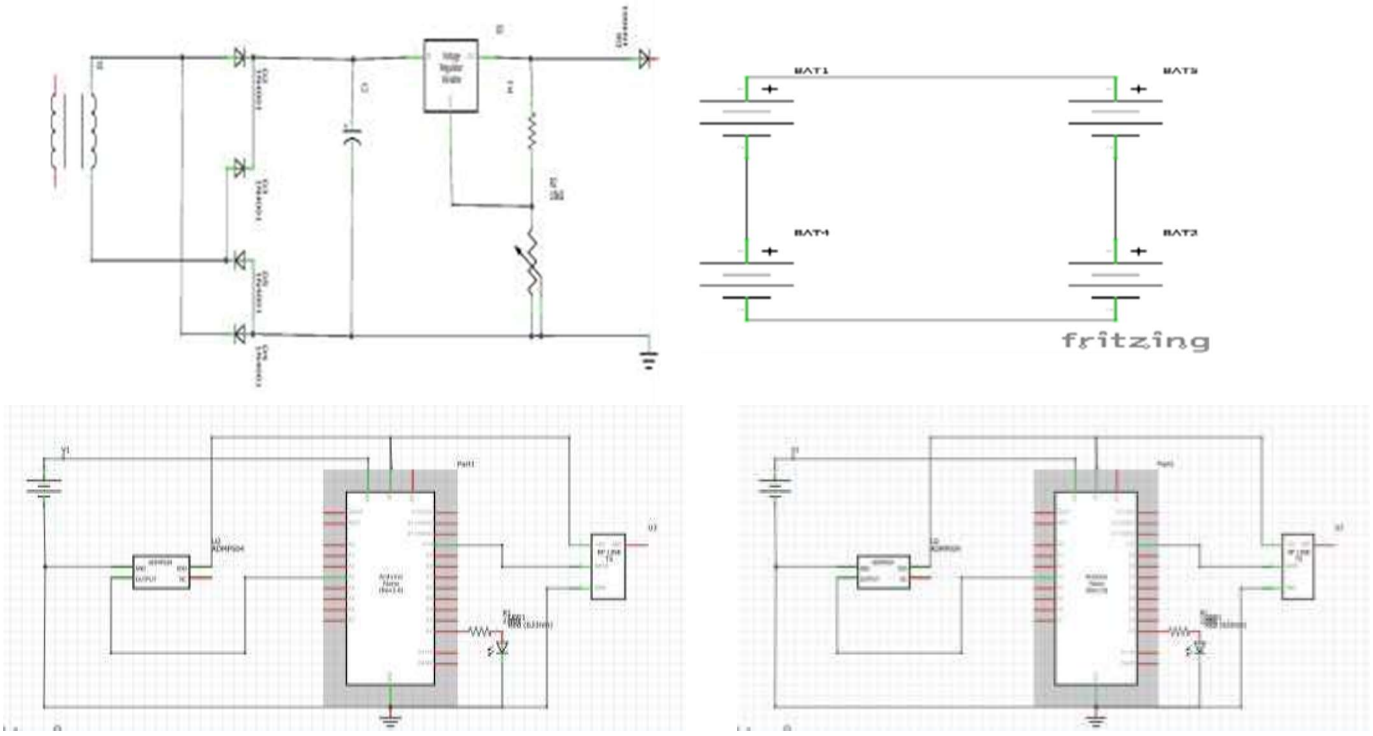

Fig 3.10: Complete Circuit Diagram of the System

4.0 RESULTS AND DISCUUSION

A careful inspection of the circuit implementation on the vero board shows that it was correctly implemented according to the polarity of the component used. Table 4.5 below shows the result obtained from the battery charger sub- unit of the system.

TABLE 4.1 RESULTS OF HARDWARE EXPERIMENT TEST

AC OUTPUT FROM SECONDARY SIDE OF TRANSFORMER	RECTIFIED CALCULATED OUTPUT	RECTIFIED MEASURED OUTPUT	ERROR
12V AC	16.97V DC	14.57V DC	2.4 V DC

4.1 RESULTS OF SOFTWARE SIMULATION TEST

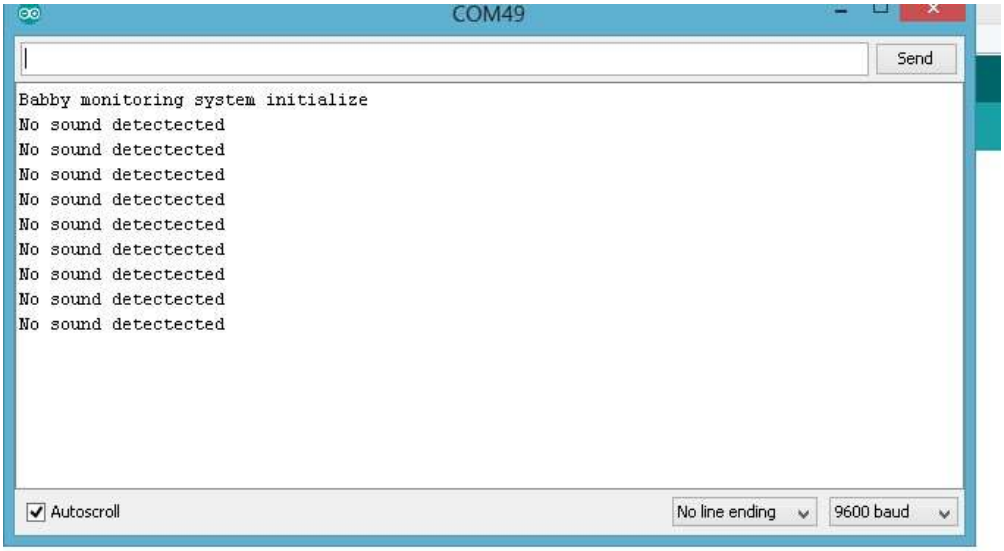

Fig 4.1: Result of Software Simulation

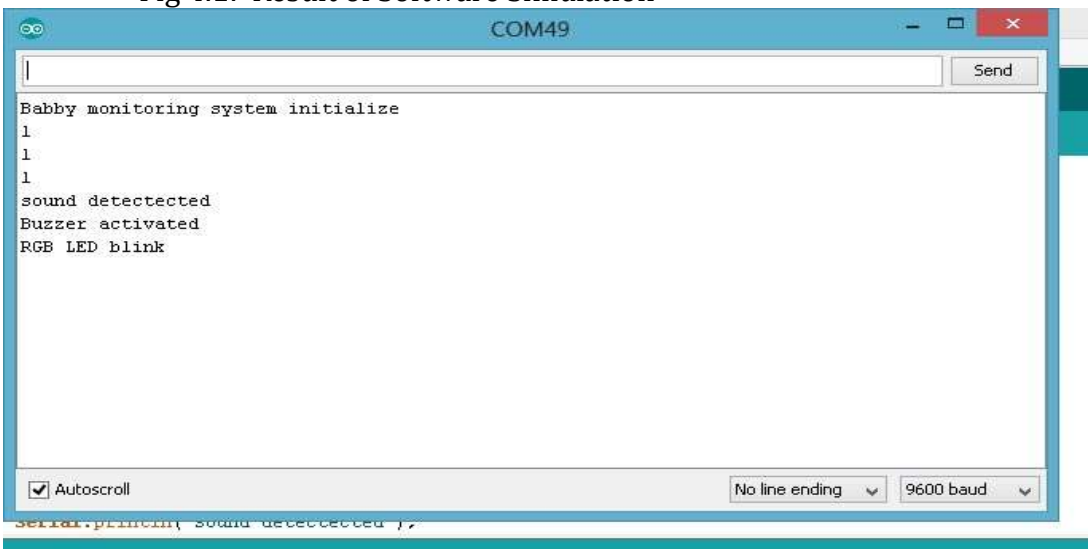

Fig 4.2a: Result of Software Simulation

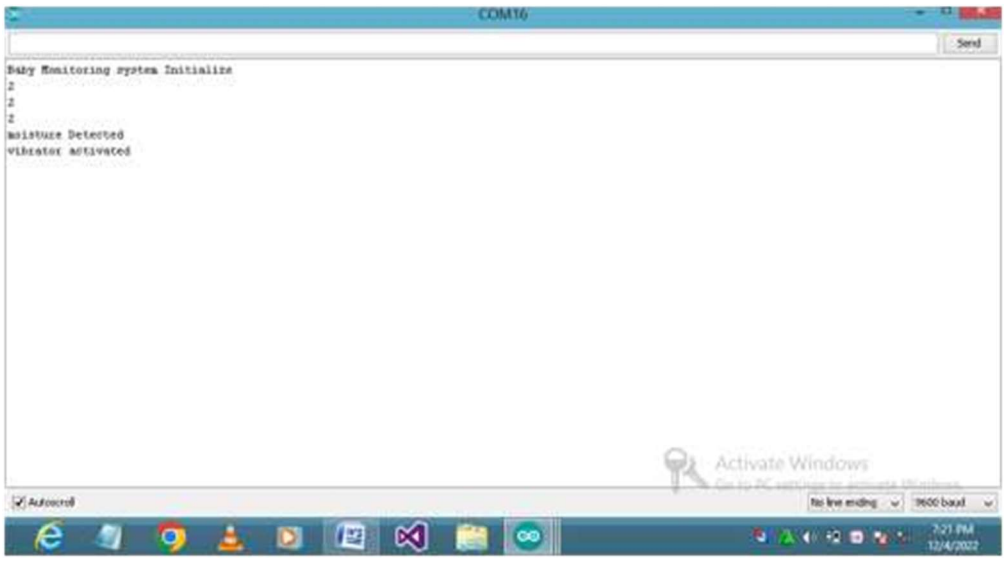

Fig 4.2b: Results of Software Simulation

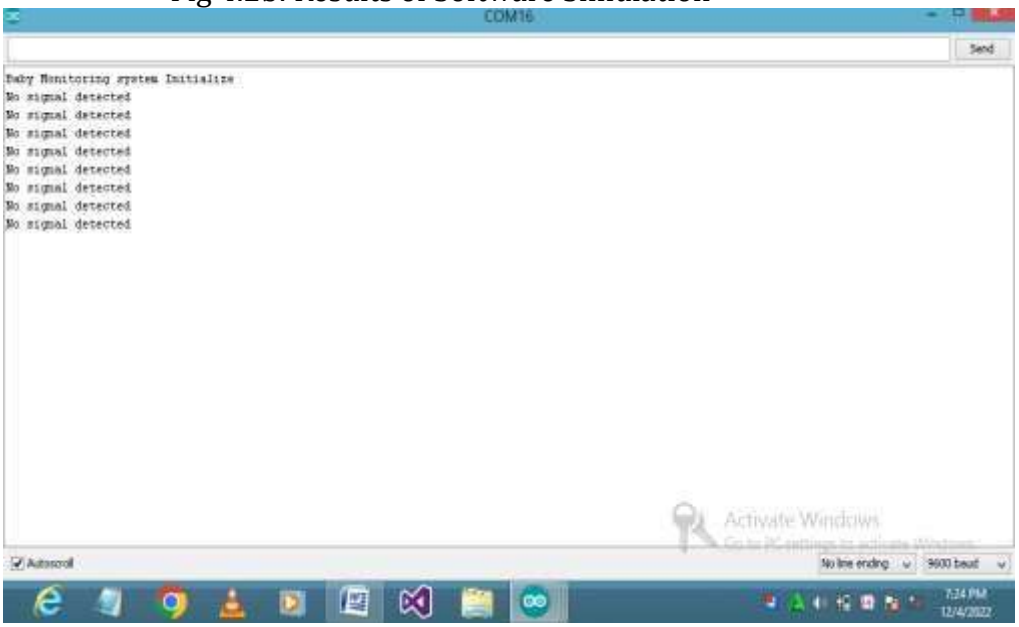

Fig 4.2c: Result of Software Simulation

From the system level test conducted, the receiver detects a signal transmitted within ten meters irrespective of the presence of obstruction or not. In addition, the receiver response to the two different input in different manner, such that one can differentiate the triggering input based on the response. For sound detection, the receiver alerts the mother using visual and vibratory signal while for moisture detection, the receiver alert the mother using vibratory signal.

Table 4.1 present the result of the hardware experiment test of the power supply unit. From the result, a discrepancy of 2.4 V arises between the calculated value and the measured value. This discrepancy arises as a result of the voltage drop of the diodes used in the bridge rectifier

circuit. Since this is inevitable, it was put into account during the design of the system. Hence the measured output can serve the power demand of the system.
Finally, based on the result of the system test, the system can operate effectively within ten meters and signal transmission and reception is not affected by obstruction such as wall or building provided that the separation between the transmitter and receiver is within the range ten meters.
The same test was conducted at various intervals and it presents the same result. This shows that the system is reliable for operation.

5.0 CONCLUSION

The sound and moisture detection system to aid deaf mothers presented in this work has successfully achieves its objectives. RF transmitter and receiver module has been interfaced with microcontroller, microphone module and moisture sensor has been interfaced with microcontroller and monitoring and control instructions had been imbedded in the microcontroller. The transmission and reception of the signal between the RF transmitter and receiver is not affected by opaque object or other obstructions such as building, gate etc, if the transmitter and receiver are within the operational range. The used of vibrator at the output of the receiver enable the deaf mother to realize at the instant signal is received. The radio frequency transmission allows the system to be operation even when the devices are not in the line of sight as long as they are in the range of operation of the device. The system can go a long way in addressing the challenge face by deaf mother.
Despite the success achieve in the design and implementation of the sound and moisture detection system to aid deaf mothers, there is room for improvement in future work. The present system monitors only two aspects of the condition of the baby, i.e. weather the baby is crying or has wet bed with urine and covers only ten-meter distance. Hence there is need in future work to incorporate multiple sensors to detect additional parameters for monitoring baby temperature, humidity etc. and transmit the signal to the mother in such a manner that she can decode it and know the actual status of the baby. This can be achieve using microcontroller shield such as DHT11.

REFERENCES

Anju Krishma G. S and Harsha Ponnamma Dev, (2019).” Design a smart cradle system by using messaging and sensing technology”, international journal of engineering and technology. [volume 6].

Ariana Anderson, (2018).” Design a baby monitor with the use of voice recorder”.Available:https://newsroom.ucla.edu.

Aslam Forhad Symon, Nazia Hassan, Humayun Rashid, Iftekhar Uddin Ahmed, S M Taslim Reza,(2017). “Design and Development of a Smart Baby Monitoring System based on Raspberry Pi and Pi Camera”. Proceedings of the 2017 4th International Conference on Advances in Electrical Engineering pp 117-122.

B. Vaughn and A. Sroufe,(2019).“The Temporal Relationship between Infant Heart Rate Acceleration and Crying in an Aversive Situation”, *jstor.org*. [Online]. Available:

https://www.jstor.org/stable/1129435?seq=2#metadata_info_tab_contents. [Accessed: 09- Nov- 2022].

D. Das,(2019).“How to Interface RFM69HCW RF Module with Arduino for Wireless Communication”, Circuitdigest.com, Available:,https://circuitdigest.com/microcontroller-projects/how-to-interface-rfm69hcw-rf-module-witharduino. [Accessed: 24- Feb- 2021].

K. Fullerton,(2013).“Deafness in Sub-Saharan Africa”, The Borgen Project ,Available: https://borgenproject.org/deafness-in-sub-saharan-africa/. [Accessed: 11- Oct- 2019].

P. Pawar. (2015). “Heart rate monitoring system using IR base sensor & Arduino Uno - IEEE ConferencePublication”,*Ieeexplore.ieee.org*.Available:https://ieeexplore.ieee.org/document/7057005/authors#authors. [Accessed: 24- Aug- 2022].

S. Singer,(2018).“New app tells hearing-impaired parents when and why their baby is crying”, University of California,Available:https://www.universityofcalifornia.edu/news/app-helps-hearing-impaired-parents-know-whenand-why-their-baby-crying. [Accessed: 13- Oct- 2019].

Sanuratu Koroma,(2020)”an Automated baby monitor for deaf parents”, university of Ashesi.

W. Liow, H. Jiang and C. Yen. (2013). “Designing a communication device for deaf parents and a hearing infant”, *ResearchGate*, 2013. [Online]. Available: https://www.researchgate.net/publication/281719909_Designing_a_communication_device_for _deaf_parents_and_a_hearing_infant. [Accessed: 13- Oct- 2022].