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Smart Cradle

(IoT Based Smart Cradle for Real Time Child Monitoring)

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Abstract - *The advancement of digitization and technology provides a large-scale availability of data that can be made use of technology to assist the working mothers to look over their child without having to compromise their work. This research paper proposes the use of "Smart Cradle" an E-Cradle that involves the use of the Internet of Things (IoT). The solution proposed of the smart cradle involves a real-time monitoring system of the child through a mobile application remotely. The smart cradle arrangement makes use of sensors to monitor the baby's vital parameters, like the ambient temperature, respiration, moisture, and crying. The smart cradle integrates a noise sensor which is used for detecting the kid's crying activity and in respond to that it will automatically start swinging the cradle to pacify the child. The temperature sensor connected via a Bluetooth module sends an alert to the parent about the body temperature of the child in a text message form when the temperature goes above the set threshold. This solution also includes a moisture sensor which helps to maintain the hygiene of the baby. Parents can also monitor their babies' condition through an external web camera which is the baby monitor. This proposed system is an illustration of a fabricated and tested way to prove its effectiveness in terms of cost and ease and to make sure safe operation to enable the baby-parenting anywhere and anytime through the Internet of Things which has made it possible. The smart cradle system is beyond doubt effective in monitoring the baby's situation and the nearby environment which is compatible with the prototype.*

***Key Words*: E-Cradle, Internet of Things, Cry Detection, Sensors, Automatic Baby Monitoring**

1.INTRODUCTION

In the current world scenario, female participation in the workforce has been boosted to a great extent, thereby affecting infant care in many families. Both the parents are required to work due to the high cost of living. Though hiring a nanny or a baby caretaker is an option for some families, but some parents do worry about the safety of their babies in the care of others. The smart support option enables guardians to screen their children as they get ready messages that furnish them with vital data. The scope of this is to make a system infrastructure that minimizes the physical constraints of working parents with efficiency, better adaptability, greater reliability, security, and cost-effectiveness against a conventional cradle. The entire system works to in a manner to benefit the parents by continuously monitoring every activity of the infant and thereby providing all real-time details and updates to the parents. Conventional cradles are manually swung and require manpower. It lacks automation and is not electronically equipped to have any add-ons.

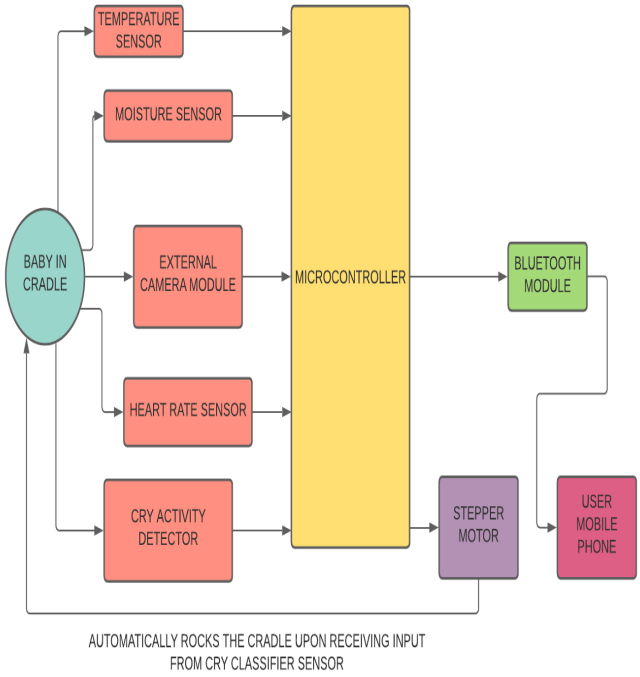
The main circuits used for this work are the Noise sensor, Moisture sensor, Servo motor, Pulse Rate Sensor, External Bluetooth Camera module, and Temperature sensor. The sound sensor is employed to detect the sound level of the baby's cry and contrasts it with the threshold limit. In this framework, the motor is accustomed to swinging the cradle. Hence, when the baby cries, the motor starts to begin its automatic swinging activity until the infant stops crying. A hygienic environment is crucial for the infant's wellness. Consequently, to ensure this, we are using the wet sensor to check for the bed wet condition. The sensor's output values recovered will be uploaded to the cloud and remotely monitored. When the wetness is perceived, the oldsters are intimated through a buzzer. The camera module integrated with the cradle establishes a uniform channel between the infant and the parent. It shows live feed of all the movements of the baby and subsequently, the parents have a choice to see their child on the mobile application made specially for the smart cradle system.[1] This will be able to intimate the parent about any unpredictable activities or any kind of irregularities. The temperature sensor gauges the baby's body temperature and alerts the parents if the temperature exceeds a certain threshold range. There is a provision of pulse rate sensor that measures the heart rate of the baby.

Figure 1. Conventional baby cradle.[2]

2. PROPOSED SYSTEM

The projected system involves numerous modules exploiting sensors for the aim of watching very important parameters of the baby like a vital sign, moisture, respiration rate, and crying. Any undesirable modification at intervals the set price of these parameters are reaching to be amid a corresponding alarm causing feedback to the fogeys via the GSM module on their mobile phones, rigorous needed applicable action. to boot to this, there is a camera unit with a face recognition package to form certain safety and security by causing 24/7 live feed to parents via Bluetooth.

3. SYSTEM ARCHITECTURE



Flowchart 1. Cradle system Architecture

The Cradle system consists of following components:

3.1 Cradle Design

For this baby cradle, we tend to design the cradle dimensions and so the most parts, that allowed swinging and attachment of the developed watching system. The baby cradle is rectangular and has fences that keep the baby from a slump the front and aspect. The baby will still look outside from their cradle. The backside is analogous to a door, however, it does not operate sideways and it moves to ninety degrees from the initial state. A latch is used to shut and fasten the cradle. The designed baby cradle could also be a 2-in-1 sort. It ar typically an Associate in Nursing jury-rigged baby cradle with technology hooked up. It can also be a dynamic table, as a result of the backside of the cradle ar typically emotional down, thereby remodeling it into a table. Hence, it's easier for the end-user to vary the baby's diaper or garments. The fabrication started with look drawings, as well as precise measurements. Then, the fabrication stage was completed, and eventually, the installation of the final word project was done. added processes, as well as cutting, paneling, drilling, sawing, forming, 3D printing, and machining, were performed at intervals during the workshop. The wood underwent a plaining method to avoid wood chips before the cutting and assembly method. The casing of the sensing element was created by 3D printing. once finishing the cutting and so the 3D processes, all the items were joined supported the design created.

The aggregation method was performed victimization glue, screw, and nut, that hold all elements of the baby cradle as well as its legs and electrical elements. each half had to be secured by glue to form certain strength and strength. Four rotating wheels with locks on every wheel were utilized within the baby cradle paradigm to allow it to maneuver around the house of the user. The rotating wheels, shown in Figure three ar put in at intervals the four corners below. the paradigm. Whenever the baby is placed at intervals in the cradle, the user should lock the wheels of the cradle to forestall cradle movement. The wheels may be unfastened or fast supported by the user's preference. All the electrical parts are placed within the Associate in Nursing electrical box beside the cradle wall. The electrical parts are secured and do not affect the system and safety of the baby if a circuit shortage happens.

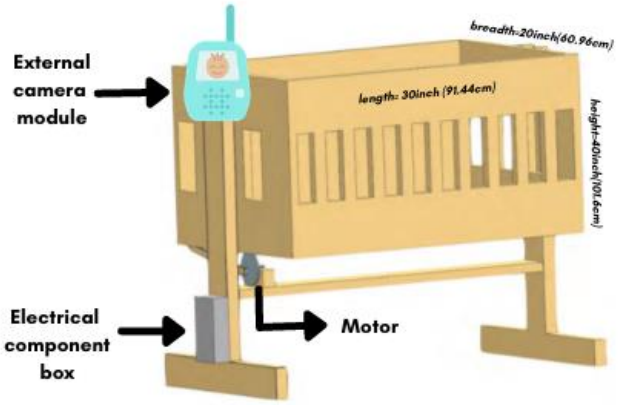


Figure 2. Cradle Sensor Placement

3.2 Arduino UNO

The Arduino UNO might even be a microcontroller board supported by the ATmega328. it's fourteen digital and six analog input/output pins. It operates at a clock speed of sixteen megacycles. It needs an additional power offer. Here, Arduino can receive the input from the Sensors through the input pins consequently and may be quantified to accumulate the data to assist the baby. The Arduino can facilitate the North American nation to integrate the camera module via that the fogeys will see the baby.

Figure 3. Arduino Uno

3.3 Temperature Sensor

The DS18B20 digital measuring instrument that provides 9-bit to 12-bit Celsius temperature measurements. It has an alarm operate with non-volatilisable user-programmable higher and lower trigger points. The DS18B20 interfaces over a 1-Wire bus that needs only 1 knowledge line and a ground line for communication with a central microchip to boot, the DS18B20 will derive power directly from the info line ("parasite power"), eliminating the requirement for Associate in Nursing external power offer. Every DS18B20 options a singular 64-bit serial code, that permits multiple DS18B20s to operate on an equivalent 1-Wire bus.

Figure 4. DS18B20 Temperature Sensor

3.4 Sound Sensor

The sound detection sensing element module detects the intensity of sound wherever sound is detected via an electro-acoustic transducer and fed into an LM393 Comparator that features a planned threshold worth. It contains an associate aboard potentiometer to regulate the setpoint for sound level. Its operative Voltage is three. from 3V to 5V DC. This Sound Detection sensing element Module consists of an electro-acoustic transducer, resistors, capacitor, potentiometer, comparator LM393 IC, Power, and standing LED in an associate computer circuit. LM393 Comparator IC is employed as a voltage comparator during this Sound Detection sensing element Module. Pin two of LM393 is connected to planned (10KΩ Pot) whereas pin three is connected to the electro-acoustic transducer. The comparator IC can compare the edge voltage set victimization the planned (pin2) and therefore the electro-acoustic transducer pin (pin3).

Figure 5. LM393 Sound Sensor

3.5 Stepper Motor

A Stepper Motor is a brushless, electric motor, that splits up a full revolution into a variety of steps.[3] in contrast to a brushless DC motor, that rotates unendingly once a hard and fast DC voltage is applied thereto, a step motor rotates in separate step angles. Stepper motors will flip a certain

quantity of degrees (or steps) as desired. this provides you total management over the motor, permitting you to maneuver it to a certain location and hold that position. It will therefore by powering the coils within the motor for terribly short periods of your time.

Figure 6. Stepper Motor [4]

3.6 Moisture Sensor

The wet sensing element FC-28 consists of 2 probes that square {measure} accustomed measure the volumetrical content of water by conniving the resistance worth to live the wet. The sensing element module in the main board has an association with the LM393 comparator, a potentiometer, an indicator LED lights – Power and Digital Output Indicator LEDs; normally red led is for power indication and the blue led is an indication for digital output. The FC-28 module has digital and analog outputs. The analog output AO of the FC-28 provides right away the analog worth of sensing element readings, as a result of its worth of dip across the probe. Therefore analog output worth returns a voltage worth proportional to the resistance. That is, worth is going to be high once the cradle bed is dry, and therefore the worth decreases because it gets wet. The FC-28 module has a threshold change rheostat used for the digital output which is set to the desired limit. The sensing element worth is going to be compared with this threshold worth by the LM393 comparator. Once the sensing element value has crossed the set threshold value, the digital output DO can switch to a HIGH state (+5V), that's if the cradle's bed is less wet then the voltage across the probe which in turn becomes high and switches the digital output to a high state. The output LED is simply inverse to the digital output if DO is High then the LED turns OFF, the associated ON DO LED indicates that the resistance is lower than the edge. The sensing element gets activated once the baby urinates the diaper. It is utilized to stay the baby healthy and hygienical.

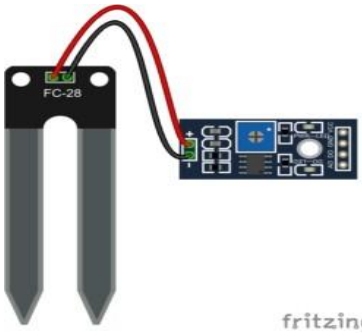


Figure 7. FC-28 Mositure Sensor [5]

3.7 ESP-32 Camera Module

The ESP-32 CAMERA is a wireless local area network Bluetooth Module accompanied by an OV2640 Camera Module which has a feature of in-built flash 2MP for Facial Recognition. It is a competitive small-sized camera module which will operate severally within a minimum system with a footprint of solely 40*27 mm; a deep sleep current of up to 6mA and is widely utilized in numerous IoT applications.

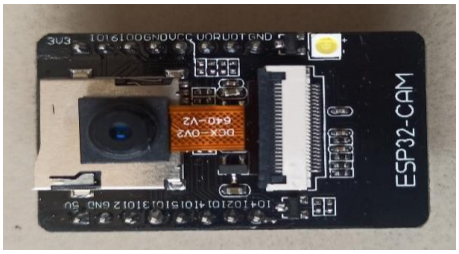


Figure 8. ESP-32 Camera Module

3.8 Pulse Rate Sensor

The functioning of the Pulse/Heart Beat sensor is very straightforward. The detector has 2 sides, on one side we have some circuitry and on the other side we have the LED which is placed along with an ambient light sensor. This circuitry is responsible for the amplification and noise suppression work.[6] The LED present on front side of the detector is to be placed over a vein in our human body. This vein can be either at your Finger tip or your ear tips, but it should have a direct contact with a vein. Now the LED starts emitting light which will fall on the vein directly. The veins which have blood flow inside them when the heart is pumping, and if we monitor the flow of blood we can monitor the number of heart beats as well.[7] Once the blood flow is detected then the ambient light detector will pick up more light since they will be reflected by the blood. This minuscule change in received light is analyzed over time to determine our heart beats.

Figure 9. Pulse Rate Sensor[8]

3.9 Mobile Application Server

A wireless local area network module is employed to attach the sensors of the cradle system to the university app inventor server via Arduino. It uses a graphical program (GUI) terribly the same as the programming languages, which permits users to tug associated drop visual objects to form an application that will run on automaton devices. It notifies the oldsters instantly on their mobile phones hard acceptable actions just in case of

any emergency besides sanctioning the user with 24/7 live watching feed of the baby.

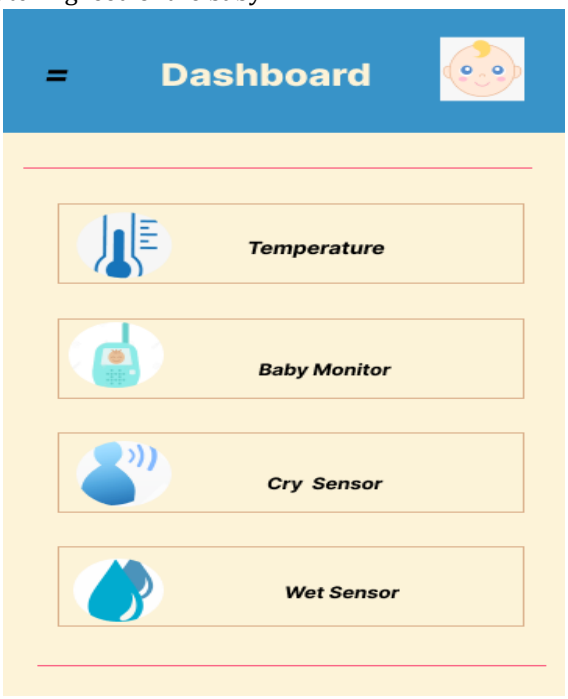
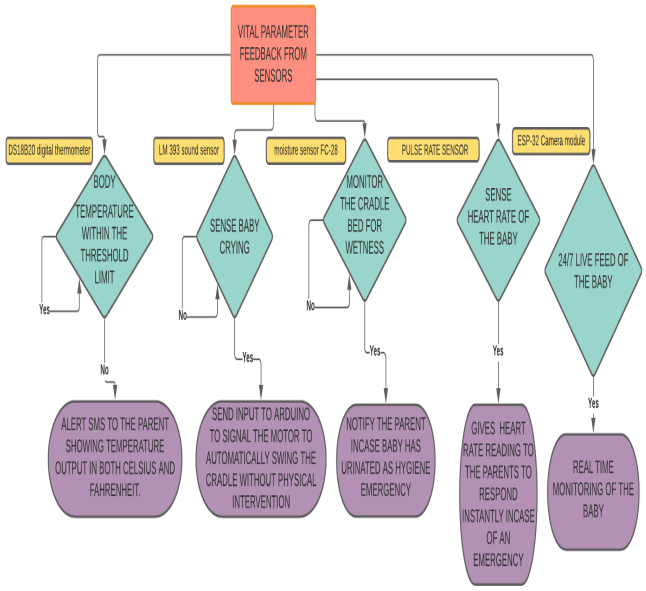


Figure 10. Smart Cradle App Dashboard

4. SYSTEM OVERVIEW



Flowchart 2. System Overview

5. CONNECTION AND OUTPUT

The below shown circuit (Fig.11) is designed and implemented for sensing the temperature of the baby while he is sleeping in the cradle.

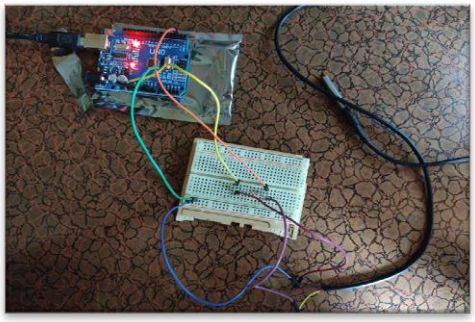


Figure 11. Connection of Temperature Sensor

The output shown (Fig.12) is of Temperature Sensor obtained is in both degree Celsius as well as degree Fahrenheit so that the user can easily interpret the results and data.

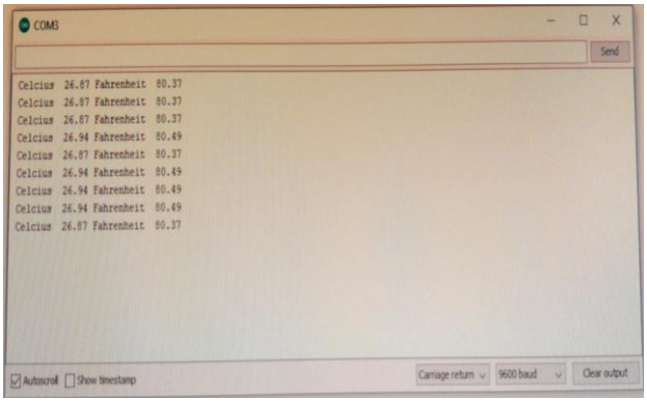


Figure 12. Output of Temperature Sensor

The below shown circuit (Fig.13) is designed and implemented for sensing when the baby has woken up from the sleep and starts to cry. Detecting the cry noise it will swing the cradle.

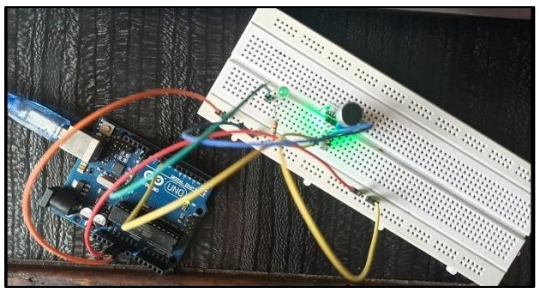


Figure 13. Connection of Noise Sensor

The output shown (Fig.14) is obtained from the noise sensor which is set at a frequency range. Here you can see the out shown is 1901Hz.

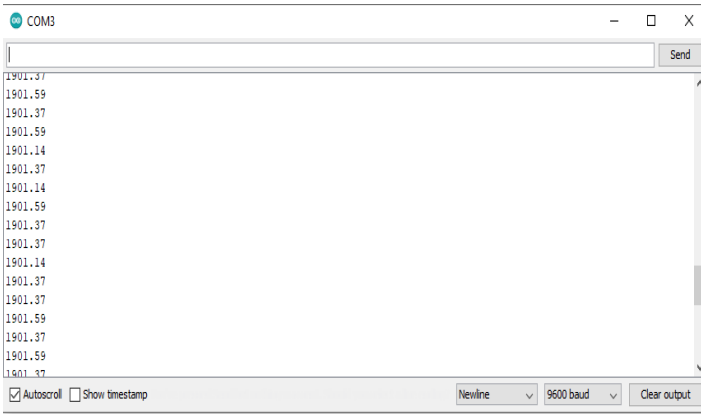


Figure 14. Output of Noise Sensor

The below shown circuit (Fig.15) is designed and implemented for keeping watch on the baby. It can be used by parents to monitor their child if they are far from the cradle or in some work.

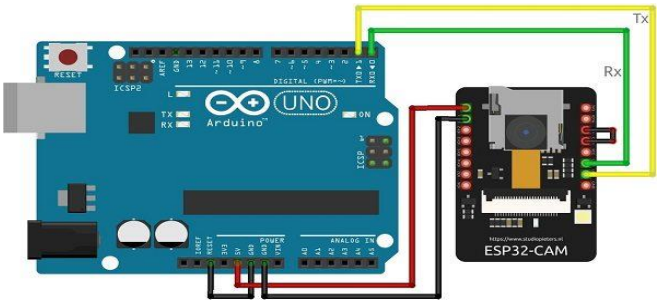


Figure 15. Connection of ESP-32 Cam Module[9]

The output shown below (Fig.16) is of ESP-32 Cam Module where you can see by connecting the module to household wi-fi parent can see video of the baby in the same manner.

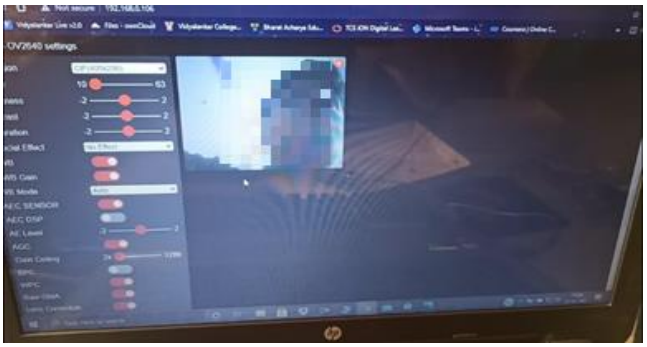


Figure 16. Output of ESP-32 Cam Module

The below shown circuit (Fig.17) is designed and implemented for wet sensor FC-28 of the cradle. It can be used by parents to ensure hygiene of the baby by changing diapers instantly as and when the baby urinates.

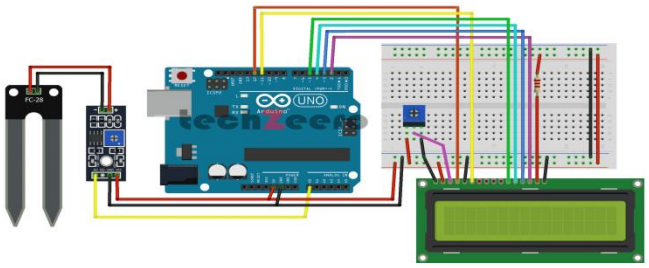


Figure 17. Connection of Wet Sensor[10]

The output (Fig.18) obtained is in the frequency range. Here you can see the out shown is 14% Moisture Content.

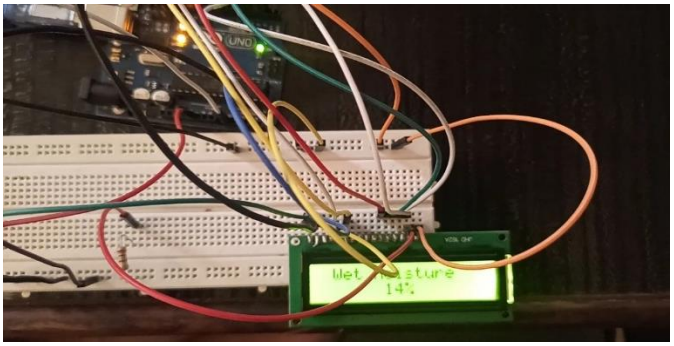


Figure 18. Output of Wet Sensor

The below circuit (Fig.19) is designed and implemented for monitoring the pulse rate of the baby. It can be used by parents to keep a watch on their baby's pulse rate and check for any kind of fluctuations or something.

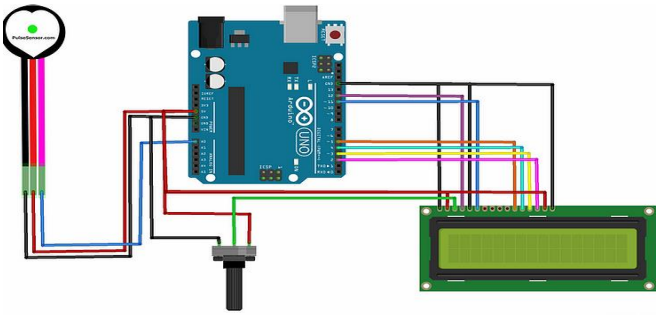


Figure 19. Connection of Heart Beat Monitor[11]

The output shown (Fig.20) obtained is in the frequency range. Here you can see the out shown is 112 Beats Per Minute.

Figure 20. Output of Heart Beat Monitor

6. CONCLUSIONS

A smart cradle system for child care is projected victimization the net of Things with the intuition of aiding the socio-economic class oldsters by providing a model capable of watching details of the child. The framework assures the oldsters that the baby is secure and safe. numerous options that square measure integrated with the cradle helps the oldsters to effectively monitor all the potential parameters remotely. they're going to likewise receive a moment notification just in case there's an anomaly or irregularity. Enhancements were created throughout the improvement phases to confirm that the analysis outcomes achieved the objectives. The finished model was tested by employing an itinerant with a baby crying ringtone, that was placed within the cradle. The model conjointly behaves as another to the prevailing advanced ways which generally involves (Electroencephalogram) encephalogram, Electro could gram (EOG), 2 or 3 lead chest EKG (ECG) to watch the baby, these square measure intrusive procedures and not well tolerated by infants and senior. Hence, the sensible cradle system comes as associate aid to folks and emerges as a reliable system for child care.

7. SCOPE

1.To enhance the security of the baby apart from the basic requirement more modules can be added like PIR sensor to detect the motion, camera to see the surroundings or the person who has been around the baby.
2. To extend the range of the signals we can implement the same circuit with help of GSM module and Wi-Fi module. Using the GSM module, the alert can be sent to parent even if they are in distinct city or a different country altogether, the parents can still monitor their baby when on business trips for companies.
3. Additional functionalities like triggering emergency, tracking the baby from app using GPS can also be added.
4. More sensors to record statistics of body like heartbeats, sleeping pattern can be observed and using data science technology more information about the baby can be known. The data received from the detectors can be stored in the database and using data analytics method a pattern can be documented when the baby cries or at what time of the day the baby wets the bed the most of the times. This would increase the credibility of the cradle using the machine learning techniques, prediction & modeling.
5.The respiratory sensor can be incorporated to detect the breathing of infant. When baby suffer from apnea, an alert will be sent to the parent by the micro-controller via the GSM Module.
6. With a more upgraded system, this smart cradle can be used in NICU and PICU wherein vital parameter can be monitored over a single central monitoring system reducing physical intervention which is absolutely necessary in the current scenario ofcovid-19 pandemic while also ensuring safety and security of babies.
7.Can be custom made to adjust to the user's requirement more coherently, like including vaccination and medicine schedules along with the doctor appointment reminder.
8.The cry patterns can be differentiated using much more advanced research and algorithms, along with machine learning to analyse the different types of cry signal and classify it.
9.Facial recognition can be integrated to give off alarm whenever there is an unauthorized intruder in the proximity of the baby to ensure safety and security of the infant.

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[6] PULSE SENSOR
[7] COMPLETE HOLTER MONITOR
[8] PULSE SENSOR PIN DIAGRAM
[9] ESP-32 CAM USING ARDUINO UNO
[10] SOIL MOISTURE SENSOR WITH ARDUINO
[11] ARDUINO PULSE SENSOR HEART BEAT MEASUREMENT