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Development of an Automatic Baby Cradle System

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Abstract

Infant care can be challenging in the fast-paced atmosphere of today, where parental responsibilities can compete with rigorous employment. An important step toward improving newborn health and reducing parent concern is the incorporation of an autonomous baby cradle system. This cutting-edge framework combines thorough planning with the seamless incorporation of several childcare components, providing carers with a priceless tool. Modern technology is incorporated into the system, including an Espressif Systems32 camera that allows parents to monitor children from a distance, a voice recognition system that enables swinging to react to spoken cues, and an advanced moisture sensor that monitors changes in bedding conditions. A sensor boosts the system's effectiveness and adds to its excellent mobility and versatility. In a hectic setting, the Automatic Baby Cradle System redefines infant care. This system offers a comprehensive solution that addresses several aspects of newborn well-being by effortlessly integrating technology into caring. Modern capabilities like speech recognition, temperature management, wetness sensing, and remote monitoring show how technology has the power to fundamentally alter parenting habits. This research lays the framework for future developments and advances in newborn care and parental assistance as technology advances

Keywords: *Arduino microcontroller; Automatic swinging; Sensors; Detection; Temperature; Servo motor; Cradle; ESP32 cam; Wheels*

1. Introduction

In today's busy era technology plays a vital role in every livelihood. Every child doesn't get parental attention due to office and commercial purposes. Due to which taking care of infants has now become a challenge for every parent and corporate families. Then they add trust in third person or hire care takers. To overcome these criteria of incorporation the system is developed to care for the infant with smart module. This system updates every single motion of the baby and alerts the parent. In general conditions such as temperature, cry, sleep weight or diaper change conditions can be notified or visualized. In this prototype we designed a formula of cradle that has enough features to monitor every activity of the child Automated baby cradles are one of the innovative solutions that have been made possible by technological advancements. This study investigates the development of an automated baby cradle with several functions to enhance the comfort, security, and observation abilities of caregivers. Modern technologies like an ESP32 Wi-Fi camera and smart remote-controlled wheels allow the cradle to perform better monitoring tasks. It also has automated swing activation that is triggered by speech, moisture,

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temperature, and weight detection sensors. The cradle uses voice detection technology to identify the baby's cry. The cradle has salient features of foldability, which will be more efficient in transportation. Thus, this project fills the gap between the working parent and child. The total integrated system works with the program of providing convenience to parent's safety and security to child as updating the real time movement of the baby.

2. Literature Survey

Cradles are the basic need for infants for their good sleep and comfort, but it doesn't provide actual comfort to the infant. Thera are various types of monitoring and caring devices for infants but as a technological and innovative part of view smart cradles are much needed for today's generation. As infants are totally dependent on parents, they cannot the well-designed health care and monitoring system is required to overcome the process. In support of the above understanding authors have developed systems based on IOT, mechatronics, GSM modules, Cloud computing.

In paper [1] Author had made a smart newborn coat which is perfect for parents who have upper limb issues because it allows for remote temperature and weight monitoring. Finite element study simulated a baby's weight a 94.14 N load, ensuring stability. Ten trails confirmed a fast voice control system, precise sensor responses, and insensitivity to the position of the baby.

In paper [2] Author had made a smart cradle this prototype aims to create an Internet of Things -based incubator system for monitoring premature babies by concentrating on vital data such as temperature, heart rate, moisture content, and weight. Reducing the frequency of unplanned neonatal deaths is its aim. It accomplishes this continuously checking heart rate, CO_2 levels, and ambient variables. It then uses a mobile app to warn parents and caregivers of any changes. To raise the standard of healthcare, this system provides real-time observation via wireless technology.

In paper [3] Author presents Mechatronic cradle system which mainly aims of childcare and women burden. The increasing number of women entering the workforce in developed countries has increased the need of childcare because both parents work, which puts more stress on moms. To address this, a baby monitoring system that uses audio and video surveillance is being proposed. Its goal is to allay worries by providing notifications on the need of infants in real-time. This prevention of sudden infant death syndrome (SIDS) is still concern, and measures like temperature control and solid sleeping surfaces can help lower the risk.

In paper [4] Author have created the smart cradle monitoring system which majorly aims to monitor the baby by moisture sensing. Toy control, audio player, camera,] just for presence sensing this is totally based on the android application.

In paper [5] Author had developed low-cost indigenous electronic baby cradle. The speed of the cradle controlled with baby cries, for that purpose to detect the cry sound, microphone was used electric signal was used to convert the cry into sound signal, to amplify the signals received through MIC the signal conditioning circuit was used. To find the give feedback for their health issues they cannot express the discomfort except by crying. Hence conditions wet and cry the alarm was implemented with the system.

In paper [6] Author have originated an automatic baby rocker with noise sensor implemented to detect baby crying. That sensor which picks the sound signal from surrounding consists of electric MIC having pre- amplifier circuit. Signal generated from noise sensor is fed to microcontroller which was used to control the DC motor attached with the rocker. A few colorful lights made up of LED were used to entertain the baby being rocked.

In paper [7] Author have designed automatic & indigenous E cradle. When baby cries then E Cradle swings automatically, to detect the baby crying voice microphone was used and the cradle swings accordingly till the baby stops crying. A wet sensor is used to detect the wetness. The system was developed with an alarm that determines two conditions – first swing of cradle when baby doesn't

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stop crying within the period of 2 minute. And second if the mattress is wet, that is the important parameter to keep the baby hygienic.

In paper [8] Author gave an approach towards designing an automatically swinging cradle system. It was integrated with a wet sensor and alarm if the baby is found in wet condition which indicates that baby needs immediate attention. DC motor was interfaced to obtain the rotational motion. As per programming, the motor stated rotating in clockwise direction it pushes the baby bassinet as the free wheel mounted on shaft is in contact with the semicircular strip under the bassinet and then for time interval it rotated in anticlockwise direction.

In paper [9] Author had made a detailed study and designed the smart cradle system using sensor technology in which item has two electrical wires and a mesh- like construction that it uses as a moisture sensor. The ground is linked to one of these leads, while the other lead is connected to the microcontroller through a pull- up resistor. The two leads meet one another when a baby wets the mattress due to the wetness, which results in a short circuit. The microcontroller receives a signal because of the short circuit. This signal is then sent by the microcontroller to an alarm system. This complete set-up makes sure that if the infant wets the mattress, an alert will go off, keeping the baby's environment clean and hygienic.

In paper [10] journal paper author designed a smart cradle using the GSM module application in which the smart cradle has an ability to detect the wet condition, cry detection, automatic swinging. This prototype is well maintained and designed parent friendly, it aims for the baby security and safety with hygienic environment.

In paper [11] author have created smart cradle using Arduino microcontroller which aims to detect the wet condition and many other logistics such as camera to track the baby's growth. They ended up giving future scope as modules can be attached to the cradle such as noise detection and urine detection.

In paper [12] the study is cantered on the challenges that modern parents have in raising and watching their children while they work. It displays an Internet of Things (IoT) Smart Cradle with an integrated camera for continuous surveillance and an automated swing that activates in response to an infant's cries. Using Arduino, sound, wetness, and other electrical components, this creative solution outperforms traditional cradles. It provides a trustworthy and practical substitute for contemporary parenting.

In paper [13] author studied and developed about how newborn's health depends on measures like breathing, oxygen saturation, and sleep patterns being tracked. Traditional methods are challenging for working parents since they don't offer real-time updates. Modern technologies have made remote monitoring possible, providing quick information and 10 preventative guidance. It is possible for parents to be swiftly notified of any unfavorable situations by regular comparison with defined standards.

In paper [14] the idea proposes to build an automated caretaker room for working parents using sensors and a microcontroller. The technology tracks the baby's movements, saving parents time and effort by providing them with realtime status updates on their newborn. The area adapts based on predefined parameters, eliminating the need for periodic physical inspections. Its main objective is to increase parental convenience using technology.

In paper [15] the author have worked on a new automated oscillating cradle that focuses to swings automatically when baby cries and the DC motor is used to oscillate the cradle.

3. Work Methodology

3.1. Features and Their Algorithm

1) Automatic Swinging mechanism

Step 1: Start
Step 2: Check if the sound frequency is greater than 700 Hz.
Step 3: If yes start swinging cradle
Step 4: Check if the baby has stopped crying.
Step 5: If yes, notify parent and stop
Step 6: If not, continue the process then stop. [11]

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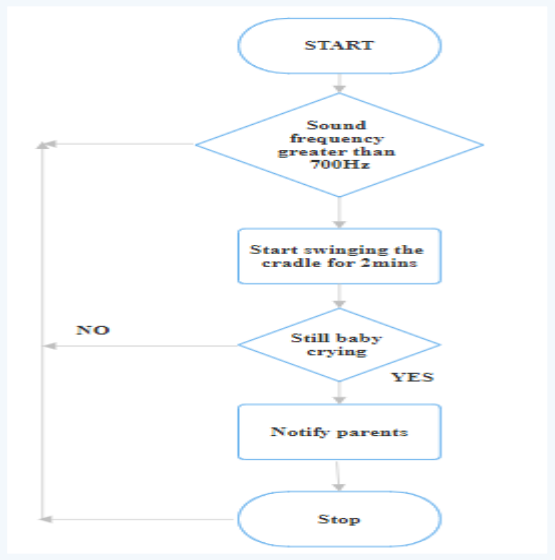

Figure 1 Flowchart of Automatic Swinging Mechanism

2) Temperature Detection

Step 1: Start

Step 2: Check if the body temperature of baby is greater than 37°C.

Step 3: If yes, activate the alarm for 10 sec and notify parents.

Step 4: If no, stop [11]

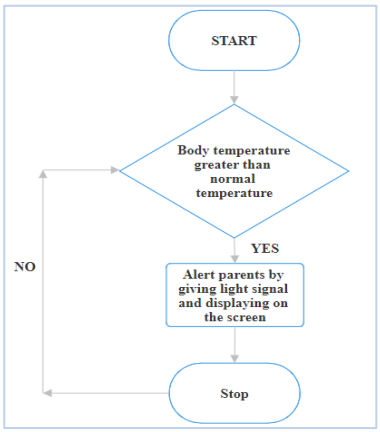

Figure 2 Flowchart of Temperature Detection Mechanisms

3) Weight Detection Sensor

Step 1: Start.

Step 2: Check the weight of the baby on the Load cell.

Step 3: Display on the screen, stop.

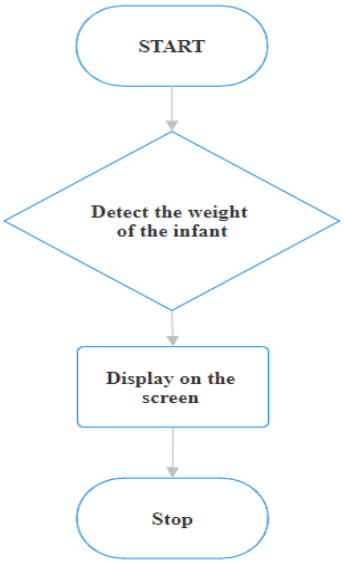

Figure 3 Flowchart of Weight Detection Mechanism

4) Wet Detection

Step 1: Start.

Step 2: Check if the wetness is detected.

Step 3: If yes, alert parents by giving light signal and displaying on the screen.

Step 4: If no, stop [11]

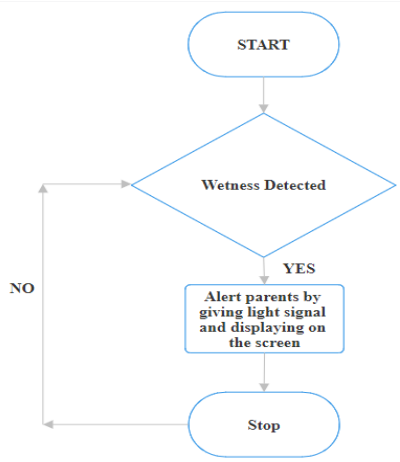

Figure 4 Flowchart of Wet Detection Mechanism

3.2. Working

The proposed system monitors the baby. It mainly aims for the safety of the baby and hygienic

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environment. This is segregated into different modules as shown in the above algorithms. The temperature sensor detects the temperature and data will be displayed on the screen and if the temperature is above normal temperature, then it gives alert signal to parents as shown in Figure 2. A sound detecting sensor is placed in the cradle which detects the infants cry and start automatic swinging of the cradle as shown in above algorithm Figure 1. Automatic swinging will work with the help of the servo motor which is connected to the microcontroller and works accordingly. Moisture sensors are strategically placed within the cradle, the sensor will detect the baby's wet condition and alerts the parent to prompt them to change the cloth. It is notified by blinking the LED light or it is displayed on the screen Figure 4 This proactive approach not only ensures the baby's comfort but also helps prevent potential skin irritation and discomfort. The Esp32 Wi-Fi cam which is placed on the cradle enables you to monitor a newborn. It is directly connected to a mobile application, where the parents can directly monitor the live updates of infants from any location of given range. For the growth of the baby the wight sensor is also attached in the form of load cell which is also a transducer, detects the weight or daily growth change of the baby and display the weight on the screen daily and updated as shown in above algorithm Figure 3. To make the cradle transportable and portable friendly the cradle is designed with foldable capability. So, it can be carried as per comfort. The cradle has an autonomous feature which makes this prototype more elegant. It has smart remote-controlled wheels which are remotely handled. The presence of fan and light in cradle makes infant more comfortable and good sleeping environment. In conclusion, the smart baby cradle system's technique entails a thorough approach to guarantee the health and safety of the child. The sing mechanism, wet detection, Baby monitoring through camera, smart wheel movement, foldable feature, and fan system are all smoothly integrated into the system giving caregivers a strong tool to build a safe and loving atmosphere. This technologically advanced solution improves the infant's comfort while also giving parents and other caregivers' useful information and peace of mind, thereby improving the infant's overall wellbeing.

4. Design Of Integrated Prototype

4.1. System Requirements

Hardware requirement

Computer/Laptop with a minimum of 8GB RAM.

Software requirements

Operating System: Windows, Arduino IDE

Adams Software: For analysis of cradle

Fusion 360: Designing Cradle

Arduino IDE: For microcontroller

4.2. Design of Cradle

Designing the cradle involves several steps to ensure safety and functionality.

Introduction: The cradle design is a crucial aspect of engineering, particularly in the development of structures or devices meant to support and secure various objects. Whether it's for holding a baby in a crib, supporting a mechanical component, or securing a spacecraft during launch, the design steps of a cradle play a vital role in ensuring safety and functionality. Several steps were involved. Using Fusion 360 Software the cradle is well designed for this project.

1 Preliminary Research:

Begin with an in-depth review of Baby Cradle design principles and mechanical engineering concepts.

Gather information on industry standards and best practices for cradle.

2. Gathering cradle Specifications.

Identify and compile the specific requirements and specifications for the Cradle, including dimensions, load-bearing capacity, and materials.

3. Sketching Initial Design Concepts:

Create rough sketches or concept drawings of the cradle, exploring different design possibilities and configurations**.**

4. Creating 2D Drawings.

Start with 2D sketches to outline the components and measurements of the component. Utilize 2D drawing tools to ensure accurate representations of the design.

5. Utilizing CAD Tools:

Transition of 3D modelling by using CAD 3D design

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tools. Employ features such as Line, Circle, Extrude, and Revolve to build the assembly.

6. Creating Detailed 3D Model:

Develop a detailed 3D model of the bearings, including all components, fasteners, and precise measurements. Pay close attention to alignment, precision, and proper scaling.

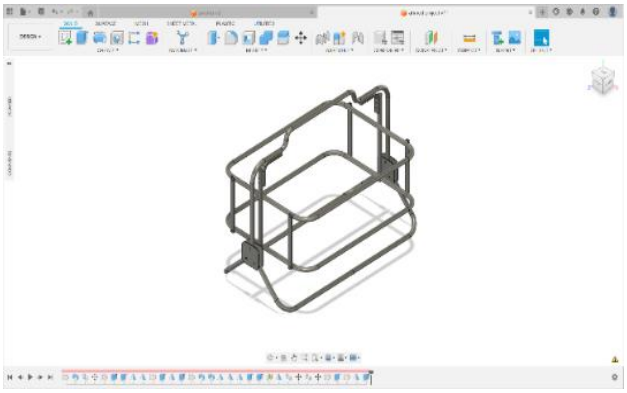
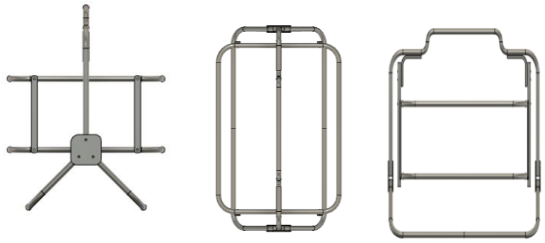


Figure 5 End Cradle Design



(a) (b) (c)

Figure 6 (a) Front view, (b) Top View, (c) Side View

The complete views of cradle have shown in Figure 5. The above pin diagrams give brief clarity of the circuit connections present in the prototype. In this Figure 6 which is named as first principle, in these primary functions of the prototype are connected such as moisture sensor, temperature sensor, humidity sensor, servo motor, sound sensor, pulse sensor, Load sensor are connected.

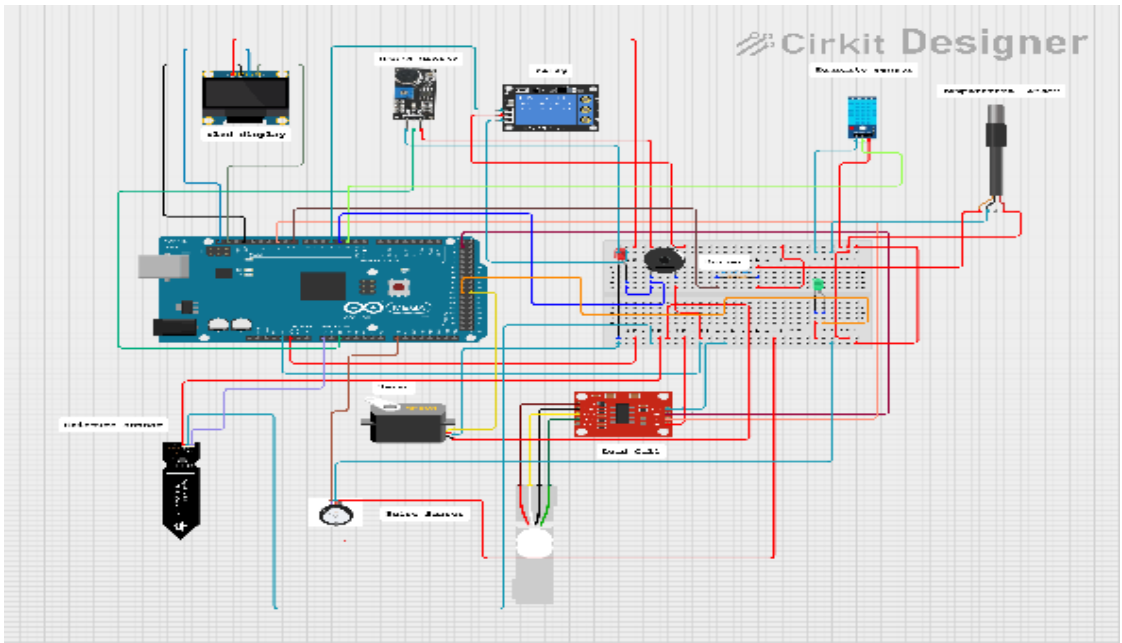


Figure 7 Pin Diagram of First Principle (Primary Circuits)

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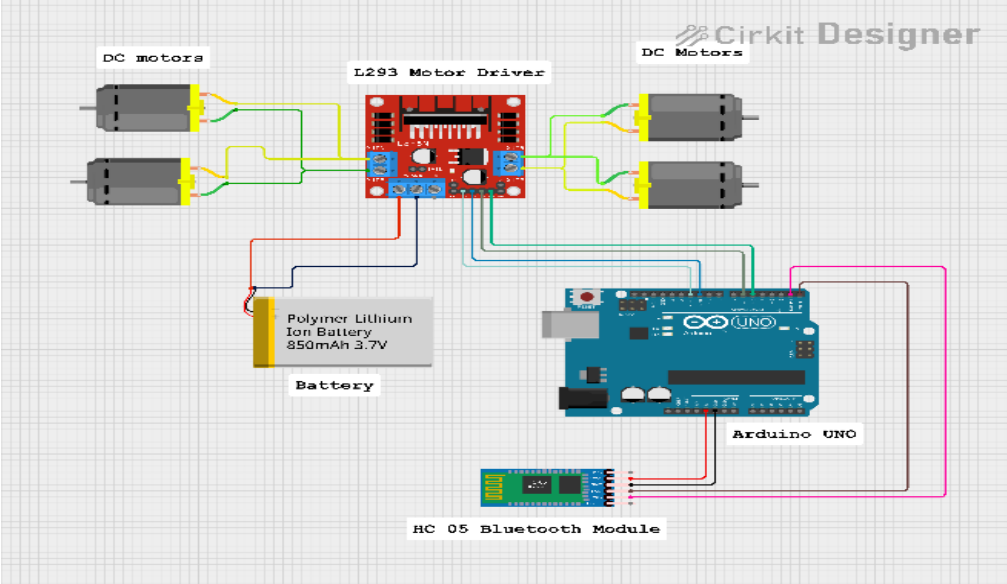

Figure 8 Pin Diagram of Second Principle

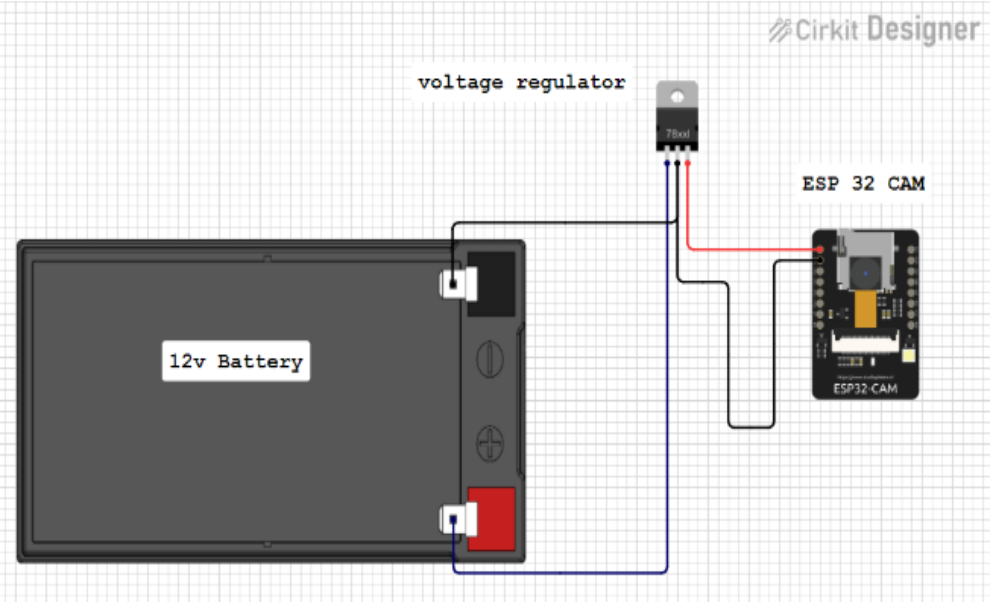

Figure 9 Pin Diagram of Third Principle (Esp32 Cam)

The working of the prototype is as similar as shown in Figure 7. In Figure 8 pin diagram of second principle is shown, which includes the smart movement of the cradle with the help of wheels and Bluetooth module. In this the L298 Motor driver is connected between the motors, this working of smart movement is totally dependent on the Bluetooth module and L298 module. The esp32 camera monitoring system is shown as third principle in Figure 9 this diagram the working of the esp32, this focus on then monitoring system, for safety enhancement voltage regulator is added for converting 12V into 5V. In this esp32 can directly see in live in mobile phone with the help of IP address of the Wi-Fi.

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5. Design and fabrication of cradle

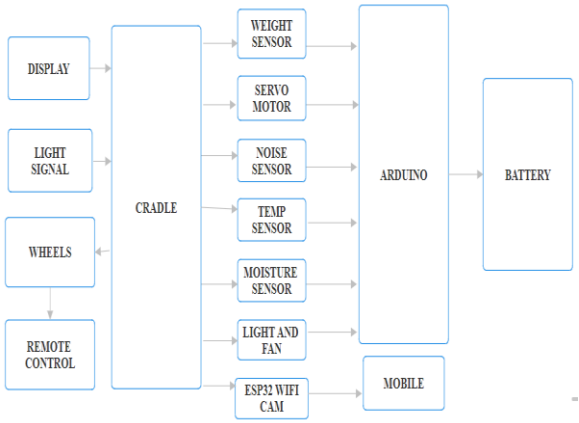

Figure 9 Integrated Module

In this integrated module Figure 9 gives the image of the end prototype in which it shows how each and every component is connected and work. It can be also name as the graphical representation of the end prototype.

Figure 10(a) Internal Arduino Setup of the Cradle

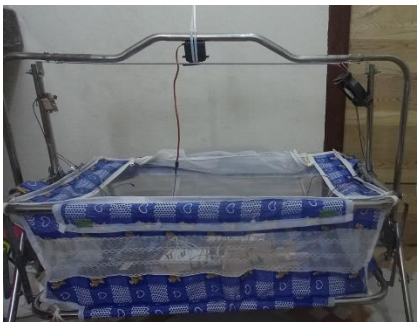

Figure 10(b) External Setup with Swing Mechanism

Conclusion

An automatic baby cradle system is designed as seen in Figure 10(a) and Figure 10(b) which has elegant features, to overcome every minor problem of the infant this prototype can be the best solution. Features such as

- Wet detection by capacitive moisture sensor,
- Automatic swinging mechanism after detecting infants cry,
- Monitoring infant through esp32 cam.
- Temperature detection sensing.
- Humidity sensing.
- Pulse rate sensing with pulse sensor.
- Smart remote controlled wheel movement.
- Weight detection by loadcell.

are the features involved in it. This involved technology is very precise, and it has 97% accuracy.

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