

## SMART CRADLE SYSTEM

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**Abstract** - In the current world full of technology and growing data with digitalization. We are able to bridge the gap between working parents and children. We are proposing a system which can be helpful for modern parents who can't make enough time to look after their child.

So, the proposed system is called Smart Cradle System which can be monitored by parents on mobile apps. The System has very distinct features. It has Four Sensors which are used to check the condition of the baby. There are 2 apps to monitor the baby one for Swinging the cradle and checking all the accurate responses. Another is for Live monitoring of the baby. This System is made using Two Main Modules Arduino and Raspberry Pi3.

Proposed system will decrease the difficulty of these hurdles, and release the stress of parents. Most importantly, the baby will be safe, healthier and he will sleep without any discomfort.

**Key Words:** Sensor, Baby Monitoring, Android Application, Arduino Mega, Raspberry Pi 3, Raspberry Pi Camera Module, Servo Motor

### 1. INTRODUCTION

For a parent, it's an important role to take care of a child. In the current growing world, it's very difficult for a parent to look after their work and take care of their baby. After long working hours, it is hard for parents to constantly watch out for their kid. Keeping an eye on a child or employing a caretaker is an expensive undertaking which not every parent can bear the cost of. The scope of this project is to make a smart, safe and economic cradle for babies to give them basic support and care.

Thus, Smart technology acts like a savior in managing this issue. Hence, the use of the Internet of Things helps in handling this issue. Smart systems help parents to monitor their child as they get ready messages and updates. In addition to that, when the child cries or makes noise for some reason it swings the cradle consequently and it turns on the camera and analyses the facial expression and detects the mood of the baby. This allows the system to take an action of swinging the cradle and send the notification to the parent. This way, the proposed system bridges the gap between parent and the kid and empowers guardians to take great consideration of their

child. This proposed system gives basic support and care to the child.

The motive of this mission is to lessen the bodily interface of the running parents with extra reliability, efficiency, higher adaptability, protection and value effectiveness. The whole device works with the motive of supplying comfort with the aid of constantly tracking each activity of the little one and thereby supplying actual time information and updates to the parents. The proposed work has been successfully monitoring the activities which include conditions like movements of infants, Care taking through Surveillance, Cradle Swing and Alerts to parents. This device makes use of eco-friendly digital sensors for detecting the diverse moves and activities of the child. Also provides various updates of the child to the parent through mobile application. This device can be advertised amongst the overall audience as it is very affordable and anybody from distinct backgrounds and tradition can manage to pay for it.

### 2. BACKGROUND AND RELATED WORKS

#### 2.1 Motivation and Problem Statement

As we are very well aware of how parents face issues to look after their infants. Especially, when both the parents are working. It is impossible for a parent to give 100% attention to the infant. Thus, to overcome problems like this we need to develop a system which could help Parents to have a watch on the Baby and can get message alerts about the same. Thus, we have proposed a system to design called Smart Cradle System which would help a parent to look after the infant by monitoring continuously from any place. It is an efficient and basic prototype to take care of a child. This system has all required features to keep the baby protected. In order to make the system we need technologies and methodologies like IOT, modules like Arduino, Raspberry Pi, Temperature sensor, Wet sensor, Raspberry Pi Camera module, PIR Sensor, Sound Sensor, Cradle Swing and Facial Expression to detect the mood of the baby. Also, we have a live stream to monitor the baby and a user-friendly Android Mobile Application to get all the readings of the system and sensors. An instant mobile notification will be generated if any unusual activity is detected in the Android Mobile Application which has been developed. It has UI controls which consist of the function of controlling the swinging mechanism of the cradle (may be turned on, became off),

manipulated for switching at the digital digicam stay footage. This System will absolutely cope with the child and supply fundamental support.

## 2.2 Related work

Previously, most of the papers included how a basic prototype of a cradle system is made. However, some of the papers included more than two features in a cradle system. Many papers provided the good use of technology. Although, the most important factor of technologies is how they ease the work of humans. In upcoming technologies, the main characteristic affects selection is the efficiency, reliability, error rate and productivity of the technology.

The papers we analyzed were restricted into three parts. First part was to focus on how various sensors work. Also, how sensors can play the role of good efficiency in future and give less harm to any human intervention. Second part we mostly focused on the hardware part of the system. The proposed system which we have decided should have a specific frame design. We have explored many papers for the system architectures and design. Third and most important aspect, which we have focused on, was the algorithms. Many authors have used different kinds of algorithms for a single feature. We precisely found suitable algorithms for the features like cry detection, facial expressions and audio processing.

For monitoring the system, we researched some papers which had multiple choices of technologies. Few papers were very informative about how to simplify the communication between human and machine. It was necessary for us to study all the papers in order to know the pros and cons of each component used for the system. Our work was to understand all the concepts to make it easy to implement the prototype "The Smart Cradle System" which can be difficult to establish on large scales. The ethics-oriented papers focus on the major problems faced by current state of the art technology and how to attempt to reduce these problems.

In reference [1] paper presents a basic idea of the baby monitoring system. It also showed how efficient work is needed for a proposed system. Therefore, an Internet of Things-based Baby Monitoring System (IoT-BBMS) is proposed as an efficient and low-cost IoT based system for monitoring in real time. A new algorithm for this system that plays a key role in providing better baby care while parents are away.

In [2] it shows the use of "Smart Cradle" an E-Cradle which involves the use of Internet of Things. The proposed solution involves live monitoring of the child through a mobile application remotely. The smart cradle incorporates the use of PIR sensor for monitoring the movement of the child; Noise sensor for the detection of

the child's crying activity and swings the cradle to soothe the child.

The project idea from this paper can be used from birth to twelve months of age to detect the infant's cry immediately and the e-baby cradle that swings. The speed of the cradle can be controlled as per the user's need. The system has an alarm and GSM module and 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. This product is useful for working parents and hearing-impaired parents.[3]

In [4], it presents an idea of the personification of a Smart Baby Cradle, brought about by integrating distinctive features i.e., cradle swing (using cry detection system), interactive toys and communication module (for monitoring purposes), in a single unit. This paper proposes the use of "Smart Cradle" an E-Cradle which involves the use of Internet of Things. The proposed solution involves live monitoring of the child through a mobile application remotely. The DHT sensor notifies the parent about the body temperature of the child via text message, when the temperature goes above the set threshold. The solution also includes a moisture sensor to maintain the hygiene of the child. The proposed system uses the cloud service for remotely monitoring the child.

In [5] the author has developed a system that provides solutions for the above problems by making the crib smart using the wireless sensor networks (WSN) and smartphones. The system provides visual monitoring service through live video, alert services by crib fencing and awakens alert, monitoring services by temperature reading and light intensity reading, vaccine reminder and weight monitoring. It also showed the pros and cons of using wireless sensors and networks.

Some of the ideas in [6] present a baby monitoring system for busy parents so that they can ensure the proper care and safety of their babies. This system can detect the baby's motion and sound; especially crying and video output of the baby's present position can be displayed on a display monitor so that the mother or another responsible person can watch the baby while away from him or her. This baby monitoring system is capable of detecting motion and crying conditions of the baby automatically.

The reference [7] concerns the practical design and implementation of professional tool using GSM-GPRS Arduino Shield (GS-001) with SIM 900 chip module in wireless data transmission system for data acquisition and control of power induction melting furnace, we will respond with innovative, value added technique and

services that improve quality, productivity, costs, environmental protection and working conditions.

Here [8] we can learn about the message alerts in a design of a Baby Monitoring System based on the GSM network. A prototype is developed which gives a reliable and efficient baby monitoring system that can play a vital role in providing better infant care. This system monitors vital parameters such as body temperature, moisture condition, movement of an infant and using the GSM network this information is transferred to their parents. Measurements of these vital parameters can be done and under risk situations conveyed to the parents with an alarm triggering system to initiate the proper control actions.

The reference [9] is summarized in below table.

Sr. No	Components	Working
1.	Wet Sensor	Wet sensor is used to check that the baby has pee? If any kind of wetness is detected it will send the alert message to the parents.
2.	Sound Sensor	Sound sensor will be attached to cradle in such a way that it will take input sound of baby only, it will conclude the activity to be performed as per the range of sound in decibels, if the sound is more than certain amount then system will automatically start swinging the cradle, if baby still not sleepy or stop cry alert will send to the parents
3.	Temperature Sensor i.e., DHT 11 and LM35	There will be two temperature sensors used that are DHT11 and LM35, DHT 11 will check the temperature of the whole room and LM 35 sensor will measure the temperature of the baby, and it will alert the parent if there is a huge change.
4.	Motion Sensor i.e., PIR sensor	Motion sensor, that is PIR sensor will detect the motion it is used for security purpose and in point of view of any danger, if there is too much motion detected alert will be sent to the parents.
5.	Smart Cradle	Basic frame design of the system and swinging automation.

6.	GSM Module	If the baby is making noise or baby is crying then sound sensor will hear that frequency and it will start swing. Also, SMS alert will send to parent through the GSM module. If the baby had wetted the matrices of the cradle, then alert SMS will send to the parent through the GSM module. If the body temperature of the baby changes rapidly with comparing atmosphere, then alert SMS will send to the parents through GSM module. If baby is moving in cradle or any kind of movement detected by the PIR sensor then alert SMS will send to the parent through the GSM module.
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Table 1: Summary of reference[9]

The aim of this research is to develop a portable, efficient and cost-effective automatic infant's cry detector and self-soothe with real time monitoring system for employed parents. The cry detection algorithm has developed according to the crying signals and it is segmented using the short time energy function which is used as a voice activity detector to disable the operation of the algorithm when voice activity is not present. Immediate cry detection and self-soothing systems help to increase a baby's cognitive development process. This all-in-one module approach gives great benefits to the first-time parents, adoptive parents, caretakers, researchers or physicians by both economically and scientifically.[10]

### 3. HARDWARE AND SOFTWARE REQUIREMENTS

• **Software Used:**

1. Arduino Ide
2. Python Idle
3. Android Studio
4. RaspController App.

• **Hardware Used:**

1. Arduino Mega
2. DHT11 Digital Temperature and Humidity Sensor
3. Sound Sensor
4. IR Sensor
5. Water Sensor
6. Bread Board
7. Mobile Phone
8. Raspberry Pi 3
9. Servo Motor
10. Raspberry Pi Camera Module

#### 4. PROPOSED SYSTEM

The System framework is designed in such a way to give good care and support to the baby.

It has eco-friendly Sensors connected to the Cradle. Using a camera module and facial expression algorithm we can detect the baby's mood. If the baby cries the automated swinging principle comes into the picture which will swing the cradle consequently. All the data of sensors is sent to an application to the parent.

This would help a user to manage the system easily and properly.

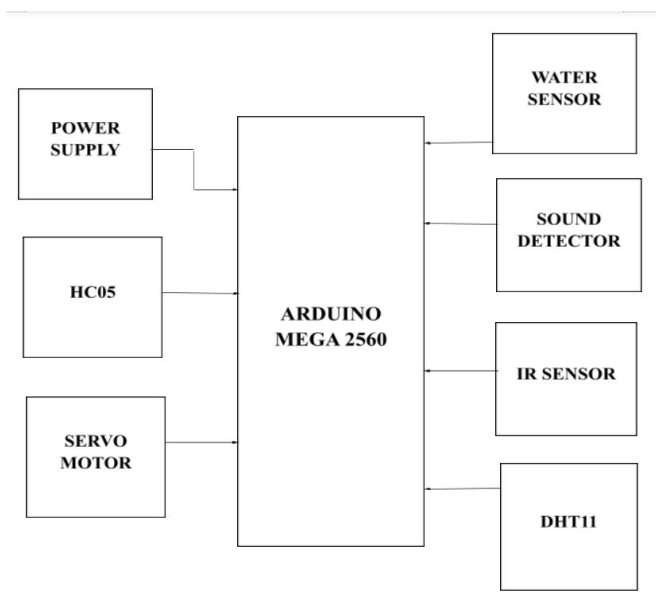


Figure 1:- Block Diagram of the System

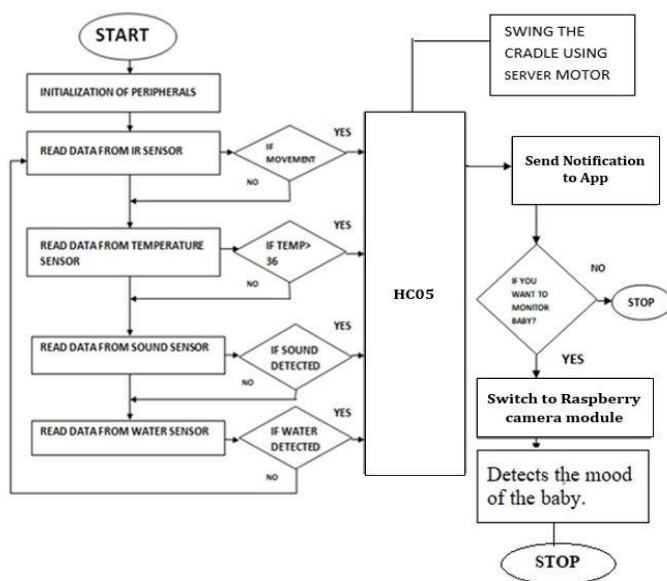


Figure 2:- Flowchart of the System.

The above two diagrams are the Block Diagram and Flowchart of the system. Block Diagram shows all the sensors and Servo motor connected. The Bluetooth is connected for the Android Application purpose where the Application can connect to the system and control. The flowchart shows the working of the System.

#### 5. FEATURES AND THEIR FUNCTIONS:

##### 5.1 Cradle Swinging Principle:

The Cradle Swing will be triggered as soon as the Sound sensor crosses the threshold level. The Servo Motor will help in swinging the Cradle.

1. Start the System.
2. Check if the baby is making any noise or cry.
3. If yes, it triggers Servo Motor which leads to swinging of the Cradle.
4. It also sends the alert message for the same.
5. You can Turn On/ Off the Cradle Swing by the Android Application.

##### 5.2 Wetness Condition:

This Sensor helps in detecting whether the baby's diaper is wet or dry. If it is detected Wet, it will be intimated to the parent via an Alert Message. This will help to keep the baby in a healthy and hygienic Environment.

1. Start the system.
2. Keep checking if the baby's Diaper is Wet or Dry.
3. If yes, notify the same to the parent via message.

##### 5.3 Temperature/ Humidity Check:

This Sensor helps in detecting continuous change in temperature. It sends a message regarding the temperature change to parents.

1. Start the System.
2. Keep checking the Temperature of Baby.
3. If yes, it sends a message to parents through Application.

##### 5.4 PIR (Motion Detection):

This sensor helps in motion detection in this system. It checks whether the baby is inside the cradle or not. If

there is any unusual activity detected, it sends an alert message to the parent.

1. Start the System.
2. Check if there is any movement in the Cradle.
3. If motion is detected, it sends an alert message to the parent.

### 5.5 Facial Expression:

This Algorithm is used to show the baby's mood in the Cradle. The Raspberry Camera Module sends the data to the ML data model which analyses facial expression of the baby and sends the message regarding the same. The emotion could be anything like Sad, Happy, Neutral etc.

1. Start the System.
2. Camera Module is On
3. Sends the live data to the Model.
4. It analyses and sends the response to the Application.
5. Ends

### 5.6 Live Baby Monitoring :

The Camera Module will be on for 24/7 for the live surveillance of the baby. This will help parents to keep an eye on their baby. This will be streamed on the Application for the entire time. You can also switch it on/off using the UI controls in the Application.

## 6. IMPLEMENTATION METHODOLOGY

The project working and methodology is as follows:

The Prototype is connected properly and makes sure that each and every component according to the circuit diagram is working. Now the parent can use it to monitor the baby and control the system with an application.

The user has to search for the Bluetooth device (HC-05) in the Application and pair it in order to connect to the system. Now the user has control over the entire system. The Application shows all the four sensor readings.

Using the PIR sensor, the parent can know whether the baby is in the cradle or not. As PIR can detect any moving object within the field of view. This message can be seen by the parent in the Application.

Using a Temperature and Humidity sensor, the parent gets the reading of the baby's temperature. If it exceeds a normal body temperature, the parent gets notified of the

same on the Application. This can help parents to take quick action if needed.

Using a Wet sensor, a parent can see the wet condition of the baby's diaper. This can help them to make changes. When the baby in the cradle makes noise or cries, the sound sensor detects the noise level and notifies the same to the parent.

When the baby cries or makes any noise, if sound levels exceed a certain threshold the swinging triggers. The Servo Motor which helps in swinging the cradle starts. This Cradle will swing consequently till you stop. Also, parents can control cradle swing with the help of android application. With the Swinging ON/OFF button it can be turned on and off. These all components are connected to Arduino Mega which helps in controlling the system with Android Application.

With the help of Raspberry Pi Camera Module which is connected to Raspberry Pi, a parent can monitor the baby's movement on the application. The Camera will be live streaming 24/7 for surveillance. It will be attached on the top of the cradle. Also, a parent can get to know about the baby's mood on the application. Facial expression is captured through the camera, by using ML, the system analyses the baby's mood and returns the result of the same on the Application.

## 7. RESULTS AND DISCUSSION

### 7.1 Smart Cradle Android App

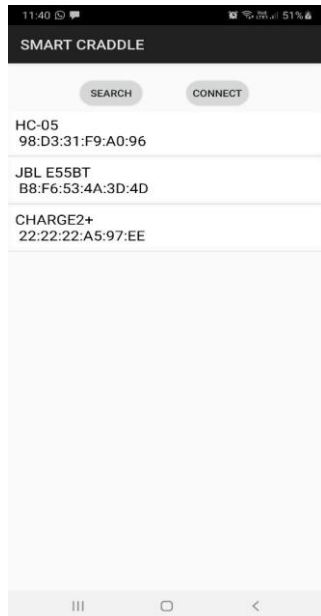


Fig3

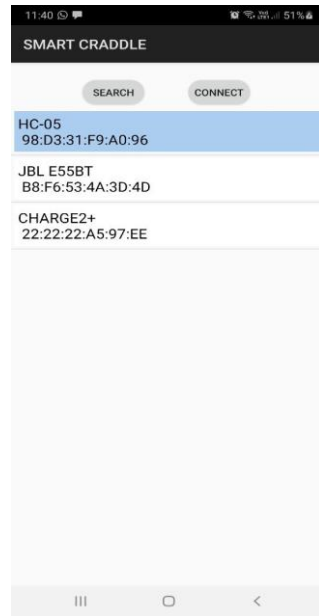


Fig4

The Smart Cradle App is used to handle the controls of Arduino Module. The Fig3 (Available Bluetooth devices) is the Interface for connecting the Bluetooth module of the System i.e., HC-05. Followed by Fig4 (Connection to HC-05) where the Bluetooth Module is selected to connect. The Bluetooth module can be connected to any android apps above version 4.

The Fig 5(Connecting to the App.) shows how the system is asking for turning on the Bluetooth in order to connect. Followed by Fig 6(Device connected) where the System is connected to the Application via Bluetooth Module. One of the readings is displayed on it.

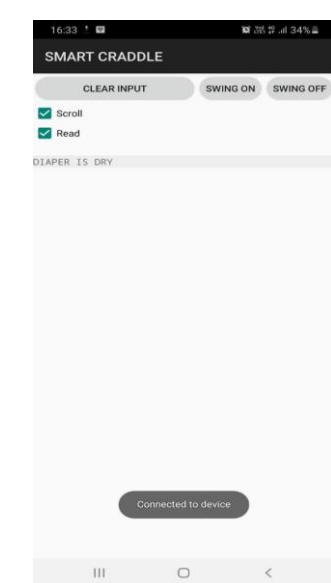


Fig5

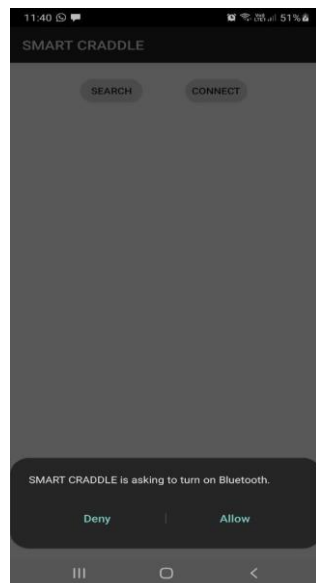


Fig 6



Fig 7

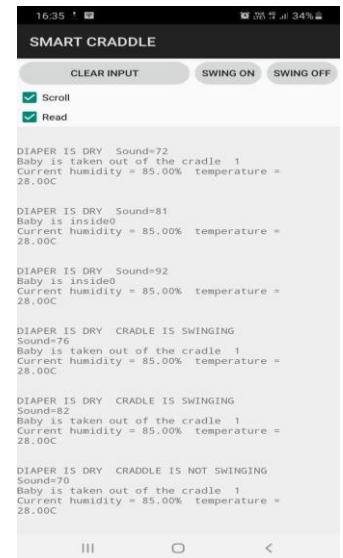


Fig 8

Fig 7(Accurate Sensor Readings.) and Fig 8(Cradle Swing button) shows the Readings of the Sensors. Here you can see how the movements and activities of the baby are being recorded. It shows whether the Diaper is Dry or Wet. This is detected using a Water Sensor. The IR sensor reads the activity of the baby. As you can see if the baby is carried out from the cradle or not is being alerted by the App. The DHT11 sensor detects the temperature and sends the readings as well. We can see the Cradle is being operated to Swing. The Application has the UI controls where the Smart Cradle can be swung using the App. On the top right it has On/Off controlling buttons

## 7.2 RaspController Application Results

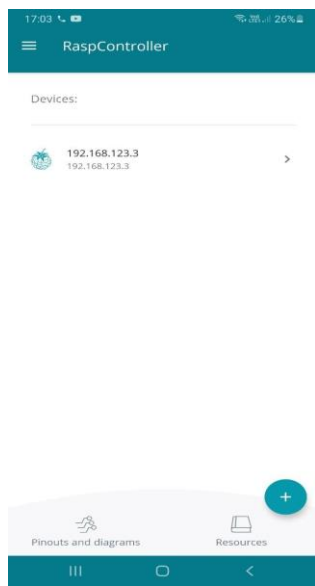


Fig 9

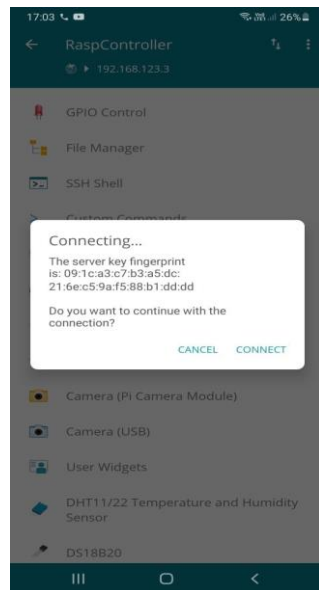


Fig 10

The RaspController App is used to operate the Raspberry Pi Module and Raspberry Pi Camera Module. It also helps in Facial Recognition by running the code in the SSH shell. Fig 9 & Fig 10(Searching for the devices) shows whether the Devices are available or not. The Fig 8(Searching for the devices) shows available devices.

Fig 11(Setting up Connection) shows how to set up a new connection. Here, it is setting up the Connection for the Raspberry Pi Module. Fig 12(Setup Complete) shows the completed setup.

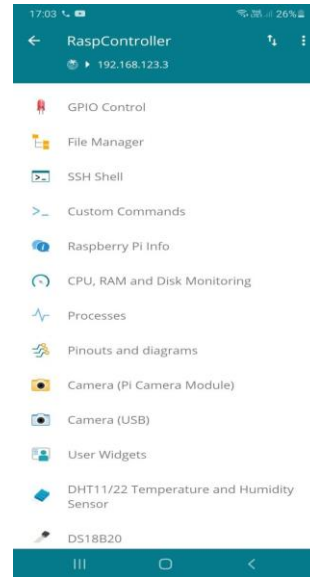


Fig 13

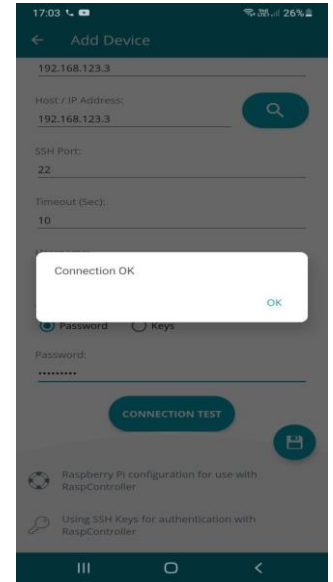


Fig 14

The setup which has been established can be seen in the Fig 13(Device found). Fig 14(Connecting to device) shows the connection to the device.



Fig 11

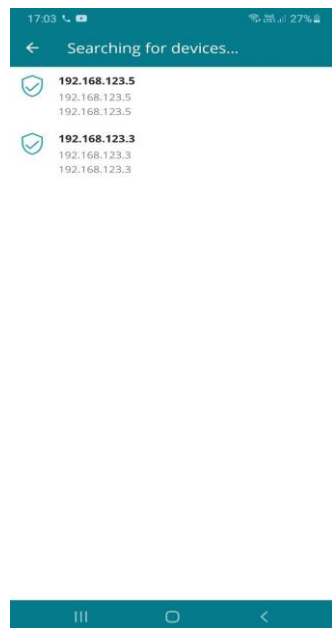


Fig 12



Fig 15

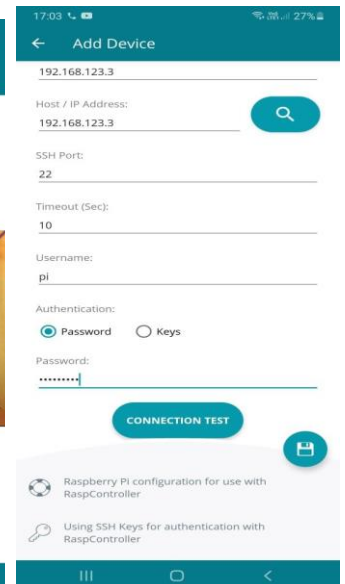


Fig 16

The RaspController Shows the components which can be used. In our System only Camera Module is used which can be controlled by this app. And another use of this app is to

run the code for Facial Expression. Fig15(Modules Menu) shows the menu of the modules. Fig 16(Camera Module) is the Camera ( Pi Camera Module). It is used in this system to keep a watch on the baby. It helps to monitor the baby for 24/7 live streaming.



Fig 17



Fig 18

The SSH shell is selected from the Menu of the Raspberry controller app. The code for facial Expression is being executed in Fig 15(SSH shell to run code.). When the sound is detected in the cradle by the baby. It triggers the Camera Module which switches on. The Camera Module scans the face and sends the emotions of the baby to the device. In Fig 16(Emotions detected.) it shows the emotions of the baby where there are some emotions shown like sad, fearful, neutral, happy etc. This will help parents to know about the baby's mood. If the baby is sad the parent can switch on the swinging which might help the baby to feel better. This way the facial expression algorithm is used.

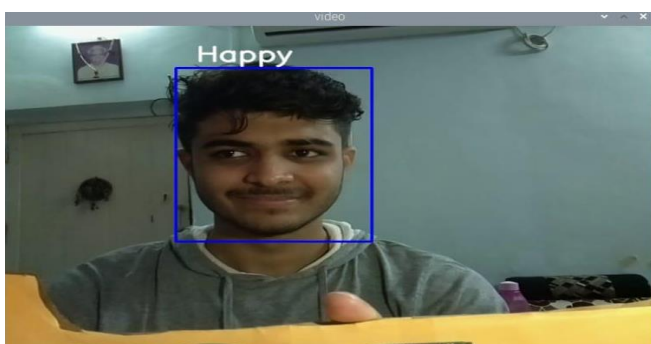


Fig 19 Facial expression1

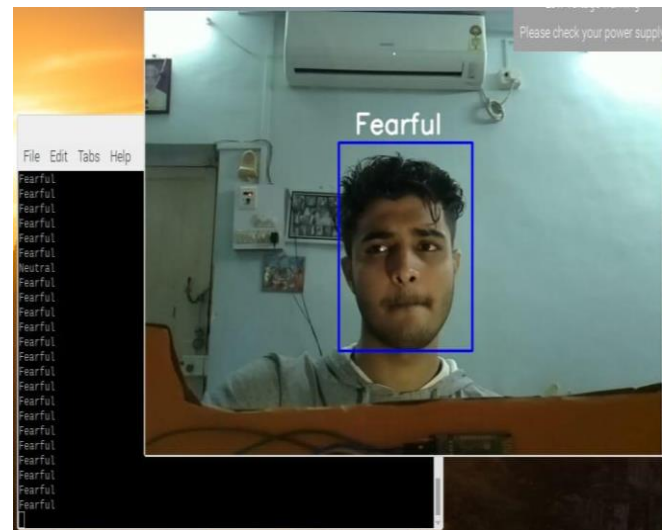


Fig 20 Facial Expression2

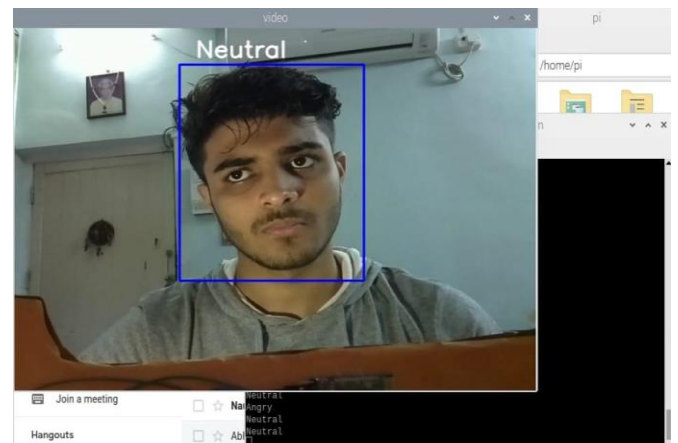


Fig 21 Facial Expression 3

The above three figures 19,20,21 are some emotions detected by the facial recognition algorithm. With the help of this facial expression the parent can check the mood of the baby. This Facial Expression is made by running an ML algorithm with thousands of facial expressions' dataset. This feature makes the prototype different from all other systems. This can bring a market value in the industry.



### 7.3 System Snapshots



**Fig 22 Final Prototype**

This is the Final Prototype of the Project. The frame design was simple to show the basic support for the baby. The sensors connected inside and the camera module are connected on the top of the Cradle. The Servo Motors are Connected on the top ends of the Cradle which helps in swinging the Cradle. This is the Final Prototype Snapshot.



**Fig 23 Top view of the Final Prototype**



**Fig 22 Side view of the Final Prototype**

## 8. CONCLUSION

As we know in this current world of growing technology how technologies help people in various ways. The Smart Cradle System becomes the bridge between a child and parent in this busy world where parents work for hours and could not give total care to their child. All the sensor's data and alert messages like the baby's temperature, wet condition and movement of the baby is measured. All the activities of the baby, like the baby's mood, are measured by the Facial Expression Algorithm and sent on the mobile application. Using this application which has live streaming of children gives an advantage to the parents to take any required action if needed. This system assures them that their baby has basic support and is safe in the cradle. Also, this system is easy to use and efficient. It is less expensive and more secure with new features. This Smart Cradle System will help parents to do their daily work and look after their baby.

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