DESIGN AND IMPLEMENTATION OF BABY MONITORING SMART CRADLE

Project/Thesis ID. 2022: 1

Session: BS. Fall 2019

Project Supervisor: Dr. Muhammad Shahid Iqbal

Submitted By

M. Fawaq Azhar

Adil Ahmed Satti

Mehran Ali

Electrical Engineering Department

National University of Technology (NUTECH)

Certification

This is to certify that **Adil Ahmed Satti, Reg. No. F-19603028, Muhammad Fawaq Azhar, Reg. No. F-19603014,** and **Mehran Ali, Reg. No. F-19603024** have successfully completed the final project **Design and Implementation of Baby Monitoring Smart Cradle,** at the **National University of Technology (NUTECH), Islamabad** to fulfill the partial requirement of the degree **BS of Electrical Engineering.**

External Examiner

[Name of Examiner]

[Designation]

Project Supervisor

Dr. Muhammad Shahid Iqbal

Assistant Professor

Chairman

Department of Electrical Engineering, National University of Technology (NUTECH)

Design and Implementation of Baby Monitoring

Smart Cradle

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SD G No	Description of SDG
SDG 1	No Poverty	**SD G 9**	**Industry, Innovation, and Infrastructure**
SDG 2	Zero Hunger	SD G 10	Reduced Inequalities
SDG 3	**Good Health and Well Being**	SD G 11	Sustainable Cities and Communities
SDG 4	Quality Education	SD G 12	Responsible Consumption and Production
SDG 5	Gender Equality	SD G 13	Climate Change
SDG 6	Clean Water and Sanitation	SD G 14	Life Below Water
SDG 7	Affordable and Clean Energy	SD G 15	Life on Land
SDG 8	**Decent Work and Economic Growth**	SD G 16	Peace, Justice and Strong Institutions
		SD G 17	Partnerships for the Goals

Range of Complex Problem Solving			
	Attribute	**Complex Problem**	
	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
	Familiarity of issues	Involve infrequently encountered issues	
	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
	Consequences	Have significant consequences in a range of contexts.	
	Interdependence	Are high level problems including many component parts or sub-problems	
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	
	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

Abstract

The main goal of this project is to help mothers for empowering their capabilities with less stress of handling their babies back at home. Ladies working to help their families financially cannot carry out their routine tasks easily when they have new born babies back at home. Conventional ways of handling babies by swinging them with hands or using simple cradles which needs physical motion causes mothers to be present near the babies every time.

This project will bring up a change in the conventional ways and the Baby Monitoring Smart Cradle will nurture the baby efficiently with a number of features like automated swing with crying sound detection, collision avoidance for safety of baby, wet condition detection for healthy environment, automatic fan with temperature sensing and weight measurement for keeping check upon baby health. Also the live monitoring will help to monitor all the activities.

This project report will propose the designing of the Smart Cradle and how to implement this for completion of a prototype. This Baby Monitoring Smart Cradle will detect the crying sound using Sound Sensor and the Arduino will make the swing to start automatically and if any object comes in the range of Ultra-Sonic Sensor the swing will be stopped until the object is removed and also start again if the crying is detected. The Wi-Fi Camera will monitor the baby live and will be showing the status of features like Temperature sensor, Moisture Sensor shown on the display panel. Also the Weight Sensor (Load Cell) will help to measure the weight of the baby to keep track of baby health and automatic fan will turn on when defined value of temperature increases.

This innovation will result in improving the life of people in different aspects and will break the gap between people and technology. It will also help people to learn about the advantages of technology and how this advancement will be making their life easy in future.

Keywords: Cradle, Slider Crank Mechanism, Collision Avoidance, Crying Detection, WiFi Camera, Load Cell

Undertaking

I certify that the project **Design and Implementation of Baby Monitoring Smart Cradle** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

[Adil Ahmed Satti]

[F-19603028]

[Muhammad Fawaq Azhar]

[F-19603014]

[Mehran Ali]

[F-19603024]

Acknowledgement

All the acclamation and appreciations are for Almighty ALLAH who created the universe and bestowed the mankind with knowledge and wisdom to search for its secrets.

We feel great pleasure and honor to express my deepest sense of gratitude, sincere feelings and regards to our supervisor Dr. Muhammad Shahid Iqbal for his efficient guidance, tremendous help and special way of advice for the completion of our studies. We also like to extend our special thanks to Dr. Nauman Razzaq, Dr. Waqar Udin, for their encouragement and support.

We have gained a lot from National University of Technology (NUTECH) during last four years, and have made many friends.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Chapter 1

INTRODUCTION

1.1 Background

As from past few years the countries have concerns about the increasing birth rate. The birth rate has risen above the replacement level, which is the minimum number of children required to maintain a stable population. This increase in the rate is effecting the parent's abilities to provide adequate resources and services to their children's equally in regard of education, healthcare, and many other necessaries related to their life.

However, not only the birth rate is the only concern also ladies face the challenge of taking care of their new born babies, including handling a crying baby. Due to this the ladies cannot help their husbands financially to meet the requirements for a good life style and all their attention is taken by their baby. Crying is a natural and normal for babies to express their needs. This crying of the baby keeps mothers in the stress which effects the health of the mother and make them unable to do any kind of job to support the family financially.

From the figure 1.1 it can be seen how the birth rate has been increased from the past years.

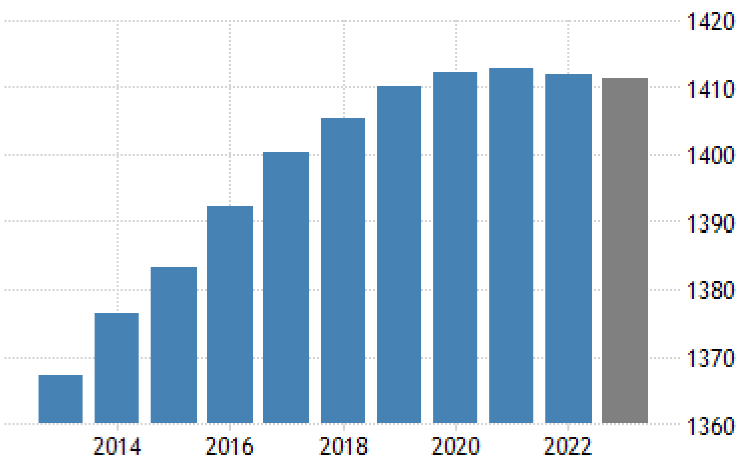

Figure 1.1: Birth Rate among Past Years.

1.2 Problem Statement

Parents face difficulty in monitoring their baby's sleep, especially in the early time period after their birth. Especially the mother's face so much difficulty at night in handling the baby when they start crying or during their job timings they cannot nurture their baby in a good way. To overcome these issues parents often take their babies with them or hire caretakers for their babies.

But to address these challenges, there is a need for an innovative solution which can help parents monitor their babies sleep and well-being.

However, creating a smart cradle for baby monitoring can help parents overcome this challenge and the device needs to be designed with comfort of the baby in the mind and safety of the baby and its surroundings and provide a piece of mind for the parents.

1.3 Aims and Research Objectives

The aim of this research is to develop a smart cradle which can monitor and nurture the babies more efficiently using automation. This aim is achieved using the following research objectives:

The objectives of this study are:

- To identify the key features and functionalities required in a smart cradle for monitoring the baby effectively.
- To find out the correct equipment's for building up the smart cradle.
- To identify the design which effectively takes care of the baby comfort and identify any hazards associated with their use.
- To identify the baby sound and swing automatically.
- To make the usability easy to enhance the user experience.
- To make it applicable for household, day-care centers, and hospitals.

1.4 Scope of Research

This research will help out in making a smart cradle to help the parents in taking care of their babies more efficiently. The scope of this research is:

An IOT based smart cradle system which will provide convenience and surveillance to parent in real time as compared to conventional cradle.

The cradle will also be ensuring the safety of the baby in time when the parents are not physically present near to the baby.

This cradle will be easy to use and will take care of the infant in proficient manner.

1.5 Novelty

The novelty of the research is provided in the detail as given below:

The idea of smart cradle is very innovative with respect to the conventional cradles used. This innovation will change the stress full life of the parents in some respect. Also this innovation will bring up a good impact of automation on minds of people and in the society. Many daycare centers and hospitals will also get help in taking care of new born babies. It consist of features with in a cost effective range.Also the Slider Crank Mechanism is first time used in this idea of Smart Cradle.

1.6 Report Layout

This report is divided into seven chapters as given in detail below:

Chapter-1: Introduction.
Chapter-2: Literature Review.
Chapter-3: Designing.
Chapter-4: Hardware of Project.
Chapter-5: Software Simulations and Hardware Working.
Chapter-6: Project Results and Evaluation.
Chapter-7: Conclusion.

1.7 Summary

This chapter comprises of information about the introduction of the project and different parts of introduction like background, problem statement, aims and objectives, scope of research, novelty of the project and report layout. All the necessary information about the idea of this project are being discussed in this chapter.

Chapter 2
LITERATURE REVIEW

A literature review is an essential component of academic research and scholarly writing. It involves a systematic examination and evaluation of published scholarly literature, books, articles, and other relevant sources on a specific topic or research question. The purpose of a literature review is to summarize, analyze, and synthesize existing knowledge and research in a particular field or subject area. A literature review helps researchers identify the current state of knowledge in their field of study. By reviewing existing literature, researchers can identify gaps, inconsistencies, or unanswered questions that their own research aims to address. This helps to situate their work within the broader scholarly conversation. Conducting a comprehensive and systematic search is crucial for a literature review. Researchers use various search strategies, such as searching academic databases, libraries, and online resources, to locate relevant publications. They may use keywords, subject headings, or specific criteria to refine their search and ensure they capture the most relevant literature.

2.1 Idea Background

In the past era the first automated cradle[1] that swings side by side horizontally which has exactly the same motion which is done by human oscillation of cradle. Spring motors were used to provide to and fro motion to cradle. Spring motors were attached to crib of cradle which produce swing same as human efforts. Spring motor is of any type such as gear operating phenomena stopped when the slight resistance to the movement when it's happening The only advantage of this system is less cost, safety for the babies because the mechanism will stop swinging of crib when resistance encountered. The limitation of this system is that it has no video monitoring and has no auto swing on baby cry pattern which has specific range of frequency other this domain of frequency the cradle will not swing as well as it also does not have any obstacle detection mechanism[1].

It is the need in this era for a baby monitoring that can accurately monitoring the baby's condition. Currently many baby monitors comprises of video camera or combination of video camera and alarm system. The authors of [2] proposed a baby monitoring system consisting of alarm system due to which it detects only babies movements and all other activities and then convey or send the message of the currently babies conditions to the concerned authority through mobile or display. Families need to secure their babies from dangers and risks.in the current era when parents are busy in their carrier so baby monitoring system is solution for monitoring babies regularly instead of day care centers or hiring any other person for them. Continuously monitoring a baby is the very tough job and it is not easy for the parents to carry their babies all the time while working. In this baby monitoring system there is no automated swing of cradle on baby cry pattern. This system only consist of monitoring the live activities of baby and alert the parents[2].

As the authors in [3] said that we all know that the development and the use of internet and mobile phones have increased the IOT based equipment. Those parents who are busy in their carrier or work can monitor kids in live with the help of mobile phones is different concept. The concept of smart cradle is enhanced with video monitoring. As well as it alerts by buzzer. Firstly if the baby cries and requires personal care or the cloth of cradle became wet so automated rotated toy is fixed in the cradle for entertain baby. For only those parents who are far away from their babies can still see their infant through mobile phones. Main feature of smart cradle is that it is enhance with live video monitoring and alert the parents through notification when cries exceed beyond the set limit even that parent is in the next room they can still watch baby's movement. This is the project which representing baby monitoring system which helps mainly the busy parents to keep eye on their infants. In this smart cradle system raspberry pi B+ module that controls the hardware of the system and baby's movement which is monitored through video with the help of camera[3]. There was no such automated swing of cradle on baby cry pattern which is the main drawback of this smart cradle system.

The first safe and automatically rocking cradle was invented by Marie R. Harper. The spring –loaded motor was used which gives the oscillatory motion in order to rock[4] to avoid the rock by mother. In addition the conventional crib is attached with electronic device for rocking the cradle. It contain the sensitivity control, when the baby cry voice is detected through microphone will start rocking action for specific time interval using timer. The system of smart cradle also monitor the health using android mobile phone in which the raw data is collected from sensors which are used in smart cradle and alert through message using GSM module[4].

Later on a device is used to detect the baby cry voice then sound signal is amplified with the help of amplifier and further the pulse is generated by pulse generator circuit. This pulse signal is input to signal recognition circuit that indicates baby cry detection as an output result. This smart cradle idea was based on IOT based which also includes the wet detection and alert through SMS[4].

The basic principle behind the automated swing of cradle is that the baby cry sound which is measured in decibel and it is compared with the preset value. After this the input signal is amplified and then converted to digital signal to sound required sound level.

2.2 Proposed Solution:

Our proposed solution is to “Design and implementation of Baby Monitoring Smart Cradle”.

The proposed smart cradle contains several important features that ensure the well-being and safety of the baby. One of the most important mechanisms is the automatic swing function, which is triggered by the baby's crying pattern. Using a cry sensor with a threshold value of 22, the system can quickly detect a baby's cry and start swinging the cradle seat. This automatic response provides comfort to the baby and helps parents effectively soothe their baby.

Moreover, the smart cradle is equipped with an obstacle detection system to ensure the safety of the baby and prevent possible collisions and accidents. The sensor is used to detect the presence of a person or child in a certain area. When an obstacle is detected, the system stops the automatic swing of the cradle seat and prevents damage to a person walking nearby. This feature greatly improves the overall security of the smart cradle.

In addition to automated swing and safety mechanisms, the smart cradle has an innovative alarm system. When the baby urinates, the LED indicator lights up to alert parents that a diaper change is needed. This function promotes hygiene and ensures that the baby remains in a clean and healthy environment, reducing the risk of discomfort or infection.

In addition, the smart base offers a convenient remote control with video. With live streaming, parents can track and monitor their baby's activities in real time. This feature gives parents the confidence that they can stay informed about their baby's well-being and ensure their safety at all times.

The smart cradle goes beyond the basic functions, as it includes additional functions that promote the overall well-being of the baby. One such feature is the integration of a temperature sensor that actively monitors the ambient temperature. When the temperature reaches a predetermined value, the system automatically activates the fan to maintain a comfortable environment for the baby. This ensures that the baby remains at the optimal temperature, reducing the risk of overheating or discomfort.

In addition, the smart cradle has a weight sensor that accurately measures the baby's weight. This feature provides parents with valuable information to monitor their child's growth and overall health. By regularly checking the weight reading, parents can monitor the baby's development and make sure that the baby is developing as expected. This feature gives parents added comfort and peace of mind, allowing them to proactively monitor their baby's well-being.

The automated swing of the smart cradle will be carried out through Crank mechanism. This mechanism rotate in circular motion which in result will make the cradle to swing i.e. To and Fro motion. In previous models **No** such mechanism was used but our swing mechanism is based on this. It helps to meet the required torque and force for the swing purpose. Also this mechanism help to reduce the friction during rotation and is easy to make and fitting of this mechanism is easy.

These additional functions, together with previously mentioned features such as automatic swing, obstacle detection, urine alarm and remote video access, form a complete and advanced intelligent system. The integration of these features and the crank mechanism underscores the commitment to provide a complete solution that prioritizes baby's well-being and safety while providing parents with comfort and peace of mind.

2.3 Summary

This chapter includes the information about the findings done in previous attempts about a smart cradle concept and the workings of the procedures taken out to give these concepts a real-time working product[1]–[4]. Also the proposed solution in light of these findings about problem of handling babies is discussed in this chapter comprising all those features which are necessary for the solution of this problem.

Chapter 3

DESIGNING

The fundamental elements of the design process include the establishment of objectives and criteria, synthesis, analysis, construction, testing and evaluation. Thus, the prime purpose of engineering design is to apply scientific knowledge to the solution of technical problems. Designing allows engineers to analyze the problem at hand, consider various options, and come up with an optimized solution. It involves identifying requirements, constraints, and objectives and developing a plan to meet them effectively. Designing facilitates effective communication and collaboration among multidisciplinary teams. Engineers use design documents, drawings, models, and prototypes to convey their ideas and concepts to other team members, stakeholders, or clients. This helps ensure everyone involved has a clear understanding of the project, promotes collaboration, and enables efficient decision-making.

3.1 Baby Crying Frequency

The frequency of a baby's crying sound refers to the pitch or tone of the cry, typically measured in Hertz (Hz). The specific frequency of a baby's cry can vary depending on the individual. In general, the fundamental frequency of a baby's cry falls within the range of 300 Hz to 600 Hz. This range corresponds to the pitch level of the cry, with higher frequencies indicating a higher-pitched cry and lower frequencies indicating a lower-pitched cry. While the frequency of a baby's cry provides some information about its pitch, it is just one aspect of the overall crying sound. Factors such as intensity, duration, and patterns of crying are also important considerations when interpreting a baby's cry. We have adjusted the induction of sound intensity within the specific domain of frequencies by adjustable gain of sound sensor.

3.2 Motor

Motors are devices that convert electrical energy into mechanical energy. They play a fundamental role in various applications and industries, powering machines and devices that range from household appliances to industrial machinery. The development of motors can be traced back to the early 19th century. The discovery of electromagnetic principles in the 19th century laid the foundation for motor development. Scientists like Hans Christian Orsted, André-Marie Ampère, and Michael Faraday conducted experiments that demonstrated the relationship between electricity and magnetism. In 1831, Michael Faraday discovered the principle of electromagnetic induction. He demonstrated that a changing magnetic field can induce an electric current in a nearby conductor. This breakthrough provided the basis for the development of electric motors. In 1831, Michael Faraday discovered the principle of electromagnetic induction. He demonstrated that a changing magnetic field can induce an electric current in a nearby conductor. This breakthrough provided the basis for the development of electric motors. One of the earliest motor designs was the Faraday disk, invented by Michael Faraday in 1831. It consisted of a copper disk rotated between the poles of a magnet, causing an electric current to flow through the disk due to electromagnetic induction. Although not very efficient, it demonstrated the principle of converting electrical energy into mechanical motion.

3.2.1 Types of Motors

There are different types of motors which have different types of specifications according to their structures like AC Brushless Motors, DC Brushed Motors, DC Brushless Motors, Servo Motors, and Stepper Motors.

3.2.2 Working Principle of Simple Motor

The working of a simple motor can be like following. A simple motor has a magnet and a coil of wire. When we pass electric current through the wire, it creates a magnetic field around it. This magnetic field interacts with the magnet's field, causing a force. This force makes the wire coil spin. To keep it spinning continuously, we use a split metal ring called a commutator and brushes that make sure the direction of the current changes at the right time. This spinning motion can be used to power various devices.

3.3 Selection of Motor:

At start to handle the swing with the occupied weight the first step in designing process involved the selection of motor. The selection of motor for the swing have to be carried out by keeping a number of factors in mind that could meet the requirement of the system. To carry out the process of swing smoothly the motor which is best fitted among the factors is D.C Wiper Motor. The factors which make it suitable for this process are discussed below:

- Long Life span.
- No need of angle control through motor because of mechanism used.
- Reliable.

- Low cost.
- Easily available in markets.

So, all these points are satisfied by the D.C Wiper Motor that's why it was finalized to be used in this project.

3.4 Mechanism for Swing:

A mechanism is a combination of different parts moving together to carry out a task or process for a required solution. There are different types of processes carried out by different type of mechanisms like gear mechanism, belt and pulley mechanism, chain and sprocket mechanism, worm gear mechanism, cam mechanism and crank mechanism.

3.4.1 Slider Crank Mechanism

The slider-crank mechanism is a fundamental mechanical linkage that converts rotary motion into linear motion. It consists of four main components: a crank, a connecting strips, a slider, and a frame. The crank is a rotating lever that typically has an offset from the center of rotation. It provides the driving force and produces rotary motion. The crank is connected to a power source, such as an electric motor. The connecting rod connects the crank to the slider. It transmits the motion from the crank to the slider and converts the rotary motion of the crank into linear motion. The slider, often in the form of a piston, moves in a straight line along a guide. The connecting rod is attached to the slider, allowing the linear motion of the slider to be controlled by the rotation of the crank. The frame provides a stable structure for supporting the other components and maintaining their relative positions. It holds the crank, connecting rod, and slider in place, ensuring proper alignment and functioning of the mechanism. As the crank rotates, it imparts a reciprocating motion to the connecting rod. The connecting rod transfers this motion to the slider, causing it to move linearly back and forth.

After the selection of motor, a mechanism was to be designed which can make the swing possible. As to make the rotational motion of the motor into translation motion for making the swing of the cradle possible the **"Slider Crank"** mechanism is selected. It consists of two strips **A** and **B** as shown in **fig 3.1** from which strip **A** is fitted with the rotating body while the strip **B** is attached with the strip **A** and it moves back and forth as the rotating strip **A** makes its rotation along with the rotating body. This mechanism help to swing the cradle seat smoothly and meet the required torque for the swing.

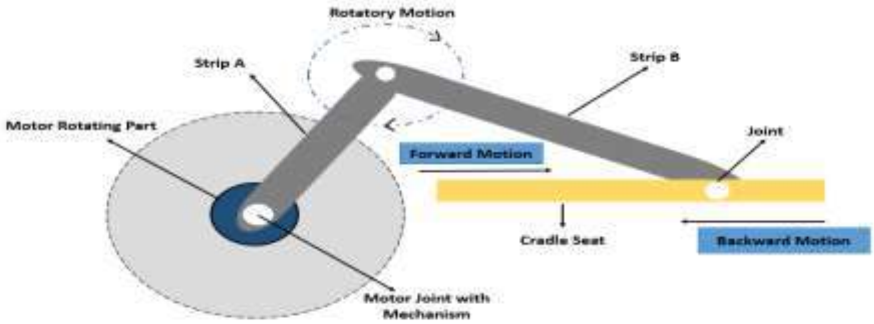

Figure 3.1: Slider Crank Mechanism.

3.4.2 Mechanism Length's

The slider crank mechanism of the smart cradle have to strips which have following lengths **strip A** (9.5 cm) connected with the motor and **strip B** (26 cm) connected with the cradle seat.

3.4.3 Factors Affecting Slider Crank Mechanism

As when we come to the process of slider crank mechanism we performed some calculations to check out the different factors and parameters effect upon the functioning of the mechanism. We can go through the following things to discuss about the points: There are two strips **A** and **B** in our case which perform the required task of swing.

At first we will check out the distance covered by the swing through mechanism using the following equation;

$$X = r * Cos\alpha + (l^2 - r^2 * Sin^2 * \alpha) \qquad (3.1)$$

So, at a= 0o we get the distance of **x1= 0.355m** when Strip A = 0.095m and Strip B = 0.26m and at a = 180o we get the distance **x2 = 0.165m**.

To find out the total distance we subtract x2 and x1 and the distance covered by the swing is **x = 0.19m**.

Angle of Swing:

To find out the angle of swing following formula is used;

$$Angle = L/r * 180/\pi \qquad (3.2)$$

Through this we come to know that, if the length of the strip B is changed it makes no effect on the Angle of Swing but, if the length of Strip A is changed it increases the Angle of Swing and cause an effect on the distance of the swing also.

Speed of Swing:

For speed of Swing we simply take the derivative (d/dt) of e.q 3.1 which is;

$$\frac{dx}{dt} = -r * Sin\alpha + \left(\frac{-r^2 * Sin\alpha * Cos\alpha}{(l^2 + r^2 * Sin^2\alpha)^{\wedge}0.5}\right)\frac{d\alpha}{dt} \qquad (3.3)$$

Where $\frac{d\alpha}{dt}$ = w (angular velocity of crank).

So, it can be seen from the above e.q 3.3 for the **x** that the maximum speed will be obtained at an angle of **90^0** and **270^o**.

3.4.4 Advantages of Slider Crank Mechanism

The slider crank mechanism offers several advantages that make it widely used for various applications. It helps to convert rotatory motion into reciprocating (back and forth) motion. It is simple and reliable, the transmission of power is taken out efficiently. It also have control over speed and force. Moreover, it is cost effective and reduces the overall cost of manufacturing.

3.5 Comparison / Life Span of Different Motors:

A lifespan refers to the maximum or average duration of time that an object, or system is expected to live or function before reaching the end of its natural or expected life cycle. It is commonly used to describe the length of time an individual or entity can be expected to exist or operate. The life span of motors is calculated in years to checkout their reliability.

- **Stepper Motor life span:**

$$= 10{,}000 \text{ hours.}$$

When 24 hours multiply with 365 days we get the result 8760 hours. So, when 10,000 hours are divided with 8760 hours we get **1.14 years** life span of stepper motor**.**

- **Servo Motor Life span:**

$$= 20{,}000 \text{ hrs.}$$

When 24 hours multiply with 365 days we get 8760 hours and when we divide them with 20,000 hours we get **2.28 years** life span of servo motor**.**

- **DC motor Life span:**

$$= 30{,}000 \text{ hrs.}$$

When 24 hours multiply with 365 days we get 8760 hours and when divide them with 30,000 hours we get **4.5 years** life span of DC motor.

So, this comparison let us know that how well more life span of about **(4.5 years)** a DC motor have than other of the motors in comparison with it. This makes the D.C motor more suitable and reliable for use.

3.6 Angle Selection of Swing:

The angle carries out an important role in the swing of the cradle. As during the swing it is also necessary to take out measures for the safety of the baby and the angle of swing should be in a range which does not cause the baby to feel uncomfortable during the swing process. There were a lot of angles which can be used for the swing purpose but from the following table we can come to know about the different recommended angles specifically related to the baby swing used by different cradle manufactures around the world which can be used for the swing of the cradle.

Table 3.1: Recommended Angles for the swing.

Organization	Angle ^{o}
AAP	30-50
Fisher-Price sweet Snug puppy	40
4moms mama Roo	35

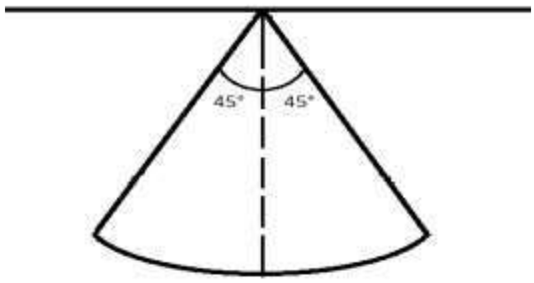

Figure 3.2: Angle Selection for the Swing.

So, from analysis from all of the recommended angles we decided to use the angle **(45 ^{o})** which safer angle for swing and suits our cradle frame and comfort of the baby during the swing.

3.7 Calculations for Required Force and Torque:

The following figure 3.2 helps us to perform the calculations required and gives us a details about the data required for the calculations.

- **Data:**

The data obtained for the calculations is following; **Angle (θ)** = 45^{o}, **Total Mass** = 15kg, **Total Height** = 3feet, **Baby Mass** = 9kg approx., **Cradle Mass**= 6kg, **Height from seat to top** = 2feet.

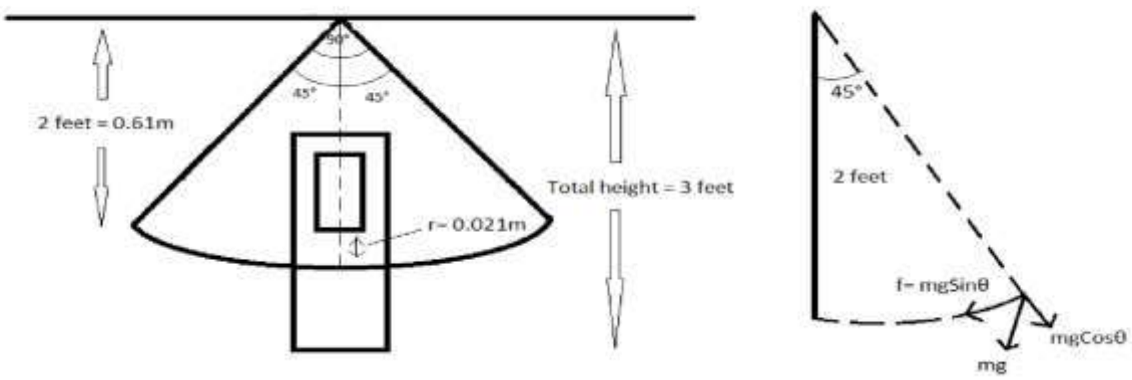

Figure 3.3: Different Angles and Length's.

To find out the Force and Torque for the automated swing following calculations are taken out:

- **Formula's:**

F = mgsinθ *(3.4)*

T = rfsinθ *(3.5)*

- **To Find:**

We have to find Force (**F**), Torque (**T**), and Radius from bottom to midpoint of slider crank mechanism (**r**), Angle (**θ**) using e.q (3.4) and (3.5).

- **Calculations:**

To find out the force, Using Eq. 3.4;

When 15 kg is multiply with 9.8 m/s at the angle sin 45 degree will get the force;

F=104.1N.

Now, for required torque:

$$R = 2ft\ approx.$$

Using Eq. 3.5 when 2 ft. is multiply with total height 0.30 ft., 15 kg of total mass and 9.81 m/s at the angle of sin 45^o will get the result of **63.5Nm torque**.

$$\boldsymbol{T = 63.5Nm.}$$

Now, for radius r:

*T= r*f* *(3.6)*

Using Eq. 3.6 when 2.2 Nm torque is divided by 104.1 Nm force will get the result of

T= **0.021m radius.**

All these calculations helped out in determining the necessary requirement which are to be needed to carry out the process of project smoothly.

3.8 Approximate Speed of Swing:

The speed of swing also plays an effective role in soothing of baby during the swing. If more speed of swing it can cause damage to baby health and if more slow speed of swing maybe it cannot meet the results. So, the **American Academy of Pediatrics (AAP)** recommends that baby cradles should not be set to swing or rock at a speed greater than 60 cycles per minute (CPM).

Recommended range is **40 to 60** cycles per minute.

So, to find out the Average speed of swing for the comfort of the baby following calculation is performed:
For Average speed we will add the 40 and 60 cycles per minute and divide them by 2. This will give us 50 cycles/min. by converting this 50 cycles/min into seconds we get the value of average speed in cycles/sec.

$$\boldsymbol{Average\ speed\ =\ 0.83\ cycles/sec}$$

3.9 Distance (Arc length):

The following figure shows the details about the Arc Length (L) which a swing will make after completing its one complete swing:

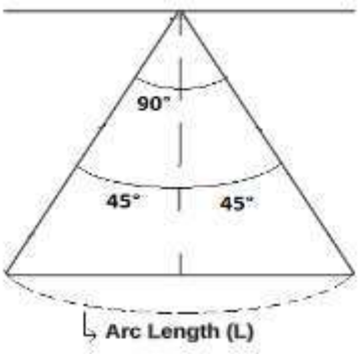

Figure 3.4: Arc Length (L).

To find out the length of the arc which will be completed when the cradle will complete its one whole swing following method is used with the help of the figure 3.3;

$$L\ = r\theta \qquad (3.7)$$

By using e.q 3.7 when a factor of 2 is multiply with 0.61 m radius at the angle of sin 45 degree we will get (**L= 86cm** Arc length) which will be completed upon one complete swing.

3.10 Summary:

This chapter comprises of all the necessary calculations which are to be performed to find out the required parameters like Force, Torque, Radius and Arc Length that are the part of the designing process and play an important role bringing up the project in its form of completion with more accuracy in keeping in mind about the automated swing and the comfort of the baby.

Chapter 4
HARDWARE OF PROJECT

The hardware constitutes the core of all projects and is the concrete foundation on which ideas and innovations come to life. In this chapter, we delve into the complex hardware world behind our project and explore the key components details that contribute to its functionality and success. By understanding the hardware architecture and how it interacts with software, we gain insight into the seamless integration of technology to achieve design goals. In this chapter, we will try to provide a comprehensive overview of the hardware elements that form the backbone of our project. We will explain the specifications of important components, such as processors, sensors, motor driver and communication interfaces, which together enable the functions of the project.

4.1 Cradle

A bed or cot type product which is used for babies. The babies are kept in these when they are infant or less than age of one year. They are used by parents in various ways like making their babies sleep or to make them calm down when they cry. There are two types of cradles one which does not allow the swing and the other one has that ability to swing. These cradles are made up of two type of materials like wood and metal. People use these cradles according to their needs. These are very useful in handling babies for the mother's as well as daycare centers and, hospitals also use them for their purposes. The figures below show these two type of the cradles.

Figure 4.1: Cradle with swing.

Figure 4.2: Fix Cradle.

4.1.1 Fixed Cradle

A fixed cradle is a type of cradle that has no rocking or other motion-producing mechanism. Instead, it is an infant bed that is stationary. Fixed cradles can be found in a wide range of styles and designs, but most have a rectangular or oval-shaped frame made of wood or another material, along with a platform at the bottom that holds a mattress or other soft padding for the baby to lie on. A canopy or other decorative components may be present on some fixed cradles.

4.1.2 Swinging Cradle

A swinging cradle, is a kind of cradle that rocks or swings. Swing cradles can gently sway back and forth, providing a soothing and calming motion for the baby in contrast to fixed cradles, which are stationary. A mattress or other soft padding for the baby to lie on is typically supported by a bottom platform on a swing cradle's wooden or metal frame. Although some swing cradles may have a canopy or other decorative components, their main characteristic is their ability to swing or rock. Swing cradles can be moved manually by gently pushing or pulling them.

4.2 D.C Wiper Motor

A DC wiper motor is a type of electric motor that generates rotational motion using direct current (DC). It typically consists of a wound stator, the stationary component of the motor that houses the electrical windings, and a permanent magnet rotor. The windings generate a magnetic field when an electrical current is applied; this magnetic field interacts with the rotor's magnetic field to cause the rotor to rotate. DC wiper motors are used in a wide variety of other appliances and machinery that require rotational motion, including fans, pumps, and toys, in addition to automotive applications.

Figure 4.3: DC Wiper Motor.

4.2.1 Working Principle of D.C Wiper Motor

A magnetic field and an electric current interact to form the basis of a DC motor's operation, including a DC wiper motor. In layman's terms, a force is created on a conductor when an electric current flows through it while it is in a magnetic field, causing the conductor to move. The stator and the rotor are the two main parts of a DC motor. The electrical windings are located in the stator, the motor's stationary component. The rotor, the motor's rotating component, is attached to the output shaft. A magnetic field is produced when an electric current is applied to the stator's windings.

Because of its permanent magnets or wound coils, the rotor also has a magnetic field, which interacts with the stator's magnetic field to cause the stator to rotate. The motion of the output shaft is produced by this rotation. The stator's magnetic field is produced in a specific direction depending on the electric current flowing through its windings. The direction of the motor's rotation can be changed by switching the flow of current.

4.2.2 Specifications of DC Wiper Motor

Table 4.1: Specifications of DC Wiper Motor.

Parameters	Specifications
Motor Operation Voltage	12V
Speed	55 (rpm)
No Load Current	2 A
Stall Current	45 kg-cm
Motor Power	120W
Shaft Diameter	10 mm

4.3 Arduino UNO R3

A microcontroller board called Arduino Uno R3 is based on the ATmega328P (low power, high performance) chip. It is suggested as a starter microcontroller programming device. It can be used to control switches, actuators, and speeds. It has six PWM output pins and six analog input pins among its fourteen digital input and output pins. It has a single power jack, a USB connector, an ICSP header, and a 16 MHz resonator. There are several ways to power the Arduino Uno, including using a USB cable, an AC to DC adapter directly connected to the device, or a battery. It can be programmed both online or offline.

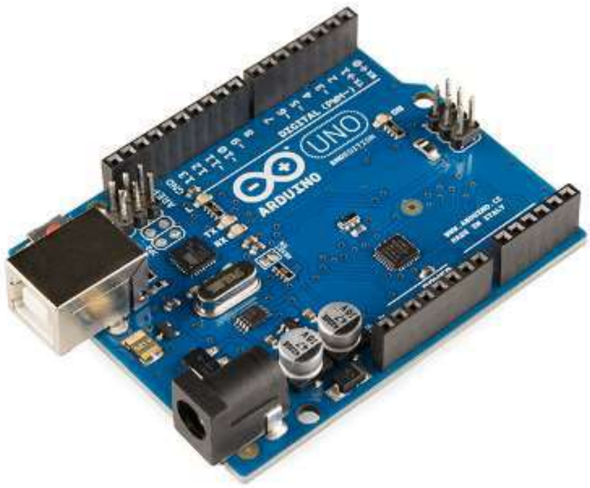

Figure 4.4: Arduino UNO R3.

4.3.1 Specifications of Arduino UNO R3

Table 4.2: Specifications of the Arduino UNO R3.

Parameters	Specifications
USB Connector USB	USB-Type B
Microcontroller	ATmega328P
I/O operating voltage	5Volts
Nominal Input Voltage	7 – 12Volts
USB port	Present
power jack(DC)	Present
Input/output pins(digital)	14
PWM pins	6
Analog Input Pins	6
Flash /EEPROM/SRAM Memory	32KB/1KB/2KB
Crystal Oscillator	ATmega328P 16 MHz
LED pins	13

Figure 4.5: Arduino UNO R3 Pin Description.

4.4 Sound Sensor

A sensor that detects sound waves in its environment and generates an electrical output is known as a sound sensor module. In general, the output signal will change in amplitude or frequency in response to changes in the sound level or frequency. The exact characteristics of the output signal depend on the sensor's design.

4.4.1 Types of Sound Sensors

There are four type of sound sensors which are used for specific purposes according to the needs of the task. These four types are following Dynamic microphone, Carbon microphone, Ribbon microphone, and piezoelectric microphone.

4.4.2 KY-038 Sound Sensor

The sound sensor KY-038 is a module designed to detect sound or volume in its environment. It is often used in various electronic projects that require audio-based input or interaction. The sound sensor module KY-038 usually consists of a small microphone or sound sensor element, an operational amplifier and additional components for signal processing. The module is designed for easy integration into electronic circuits or systems based on microcontrollers.

An operational amplifier amplifies the analog signal from the microphone, making it more suitable for processing or further analysis. This amplified signal can then be connected to an analog-to-digital converter (ADC) or connected directly to a microcontroller or other digital circuits for audio detection and processing. The sensitivity of the KY-038 sound sensor can often be adjusted with an internal potentiometer, allowing customization to meet specific project requirements. By adjusting the sensitivity, the module can be configured to detect sound levels that exceed a certain threshold.

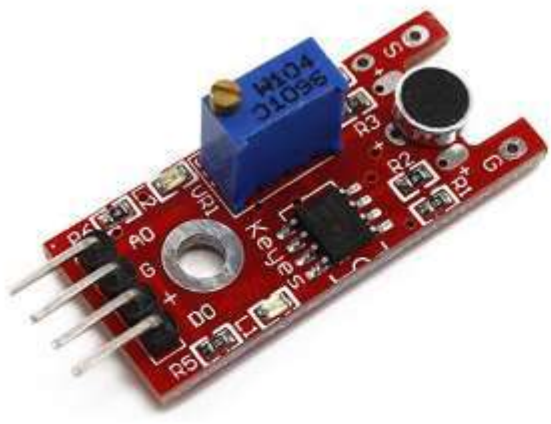

Figure 4.6: KY-038 Sound Sensor.

4.4.3 Specifications

Table 4.3: Specifications of KU-038.

Pins	Working
V_{cc}	5V
GND	Ground
A0	Analog Output
D0	Digital Output

4.5 Ultra-Sonic Sensor

It is a type of measuring instrument which measures the distance to an object with the help of ultrasonic sound waves. It uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

Figure 4.7: Ultra-Sonic Sensor.

4.5.1 Specifications of Ultra-Sonic Sensor

- The sensing range lies between 40 cm to 300 cm.
- The response time is between 50 milliseconds to 200 milliseconds.
- The Beam angle is around 50.
- It operates within the voltage range of 20 VDC to 30 VDC.
- Preciseness is ±5%
- The frequency of the ultrasound wave is 120 kHz.
- Resolution is 1mm.

4.6 Moisture Sensor

A moisture sensor is a type of sensor that is used to detect the level of moisture or water content in a substance, such as soil, air, or various materials. The moisture sensor works by measuring the electrical conductance or resistance of the substance, which is related to its water content.

Figure 4.8: Moisture Sensor.

4.6.1 Specifications of Moisture Sensor

Table 4.4: Specifications of Moisture Sensor.

Range	0 to 45% volumetric water content in soil
10-bit resolution (using CBL 2)	0.4%
Power	3 mA and 5V DC
Operating temperature	–40°C to +60°C
Dimensions	Dimensions: 8.9 cm × 1.8 cm × 0.7 cm (active sensor length 5 cm)

4.7 Led

A semiconductor device known as a light-emitting diode produces light when current passes through it. Recombining electrons and electron holes in the semiconductor results in the release of energy in the form of photons. The energy needed for electrons to cross the semiconductor band gap determines the color of the light.

Figure 4.9: LED.

4.8 IBT-2 Motor Driver

A type of electronic device called the IBT-2 motor driver is used to regulate the motion of DC motors or stepper motors. A dual H-bridge module called the IBT-2 motor driver allows for the bidirectional control of up to two DC motors or one stepper motor. A microcontroller or other control device sends control signals to the IBT-2 motor driver, indicating the desired direction and speed of the motor. The motor driver then supplies the motor with the proper voltage and current to produce the desired motion.

Figure 4.10: IBT-2 Motor Driver.

4.8.1 Key Features of IBT-2 Motor Driver

- **Dual H-bridge configuration:** The IBT-2 motor driver has two H-bridges, allowing it to independently control either two DC motors or one stepper motor.
- **High current handling capacity:** The IBT-2 motor driver can drive high-current motors with a maximum current of up to 43A per channel.
- **Low voltage drop:** The IBT-2 motor driver has a low voltage drop of approximately 0.7V, which aids in cutting down on power losses and maximizing motor effectiveness.
- **Built-in safety features:** The IBT-2 motor driver has a number of built-in safety features, including over-temperature protection, over-current protection, and short-circuit protection, which help to shield the motor driver and connected motor from harm.

4.9 Arduino Nano

A powerful and small microcontroller board called the Arduino Nano is made for projects that need a small form factor without sacrificing functionality. It uses the same ATmega328P microcontroller chip as the well-known Arduino Uno but is substantially smaller in size. The Arduino Nano offers a wide range of features and capabilities that make it an excellent choice for both beginners and advanced users. It has 14 digital input/output pins, 8 analog inputs, and 6 Pulse Width Modulation (PWM) pins, allowing you to connect a variety of sensors, actuators, and other components. The Arduino Nano is powered either via USB or an external power supply.

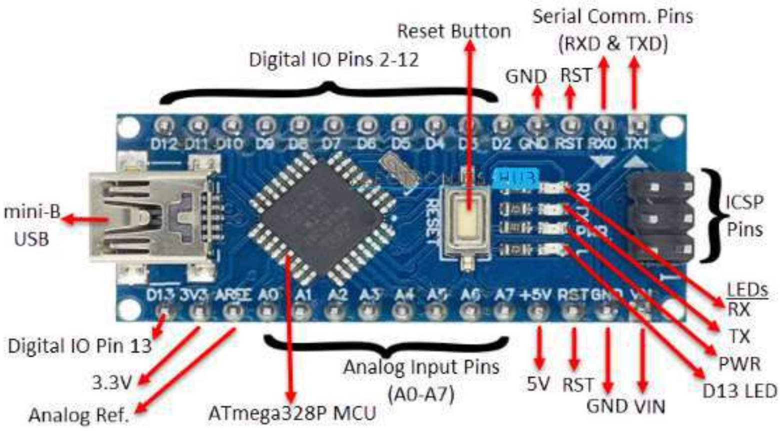

Figure 4.11: Arduino Nano & Pin Configuration.

4.9.1 Specifications of Arduino Nano

Table 4.5: Specification of Arduino Nano.

MCU	ATmega328P
Architecture	AVR
Operating Voltage	5V
Input Voltage	7V – 12V
Clock Speed	16 MHz
Flash Memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Digital IO Pins	22 (of which 6 can produce PWM)
Analog Input Pins	8

4.10 12C (16x2) LCD Display

A form of liquid crystal display known as a 16x2 LCD display has a display area that is 16 characters wide and 2 lines tall. Up to 16 alphanumeric letters or symbols can fit on a single line. The LCD display is made up of a grid of pixels, each of which can display a character or symbol. Each character normally occupies a fixed space determined by the display size and is shown in a grid pattern. The 16x2 LCD display is commonly used in applications like digital clocks, temperature displays, and menu navigation systems and etc. due to its small size and simplicity.

Figure 4.12: 12C (16x2) LCD Display.

4.10.1 I2C (Inter-Integrated Circuit) Display Module

This module connects LCD display to microcontrollers or other devices using the I2C communication protocol. The I2C backpack acts as a bridge between the LCD and the microcontroller, allowing for easier and more efficient communication.

In order to create communication between the microcontroller and the display module, the I2C display module uses a standardized I2C bus, which only needs two wires (SCL - Serial Clock Line and SDA - Serial Data Line) and this reduces the wiring process and make it simple enough.

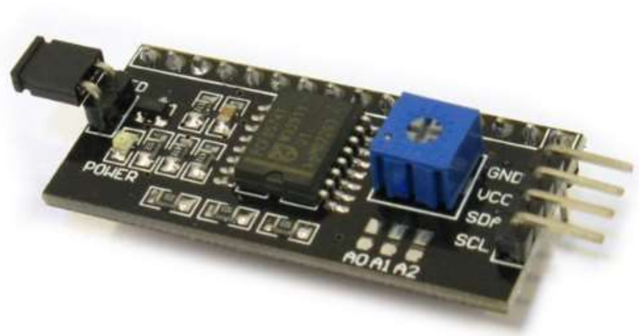

Figure 4.13: I2C Display Module.

4.10.2 Specifications of I2C LCD Display

Table 4.6: Specifications of I2C LCD Display.

Items	Specification
Display capacity	16 character x 2 row.
Display color	Blue backlit
Character size	2.95 mm wide x 4.35 mm high
Character pixels	5 W x 7 H
Voltage requirements	5 VDC +/- 0.5V
Current requirements	2 mA @ 5 VDC
Connection	4-pin male header with 0.1″ spacing
Communication	I2C
Overall dimensions	3.15 x 1.42 x 0.51 in (80 x 36 x 13 mm).
Operating temperature range	32 to +131 °F (0 to +55 °C).

4.11 Temperature Sensor (LM 35)

The LM35 is a temperature sensor also known as thermometer with an analogue output voltage that varies with temperature. It offers output voltage in Celsius (Celsius), not Fahrenheit. No additional calibrating circuitry is needed. The LM35 is 10 mV/degree Celsius sensitive. Output voltage increases along with temperature.

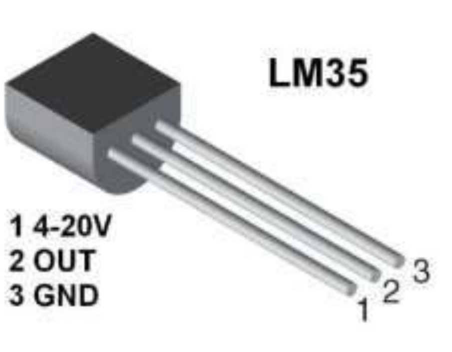

Figure 4.14: LM35 Sensor.

4.12 Load Cell

A load cell is a type of force transducer. It transforms an input mechanical force, such as a load, weight, tension, or compression, into another physical variable, in this case, an electrical output signal that can be measured, converted, and standardized. An increase in force acting on the force sensor causes a proportionate change in the electrical signal.

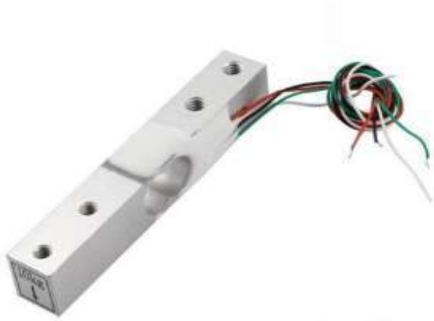

Figure 4.15: Load Cell.

4.12.1 HX 711 Module for Load Cell

A breakout board called the HX711 amplifier makes it simple to read load cells and measure weight. The microcontroller is wired on one side, while the load cell wires are wired on the other. The HX711 uses a two-wire interface (Clock and Data) to connect with the microcontroller and measure the weight.

Figure 4.16: HX 711 Module.

4.12.2 Specifications of Load Cell

- **Rated Output:** 1.2 ±0.1mV/V.
- **Overall Precision:** 0.02%F.S.
- **Input Resistance:** 1066 ± 20 Ohm.
- **Output Resistance:** 1000 ± 20 Ohm.

4.13 Fan

A mechanical device called a fan rotates its blades to produce airflow. It is frequently used for cooling, ventilation, and air circulation reasons and is made to move air or gases.

Figure 4.17: DC Fan.

4.13.1 Working Principle of Fan

The basic principle of a fan involves the rotation of blades, which creates a difference in air pressure. As the blades spin, they push air forward, causing a flow of air in the desired direction. This movement of air helps to disperse heat, improve air quality, and provide comfort in indoor or enclosed spaces.

4.14 12V D.C 1-Channel Relay

12V 1-channel relay is an electromechanical device commonly used in electronic circuits and projects to control high-power loads with a low-power signal. The 12V indicates the operating voltage required to activate the relay coil. It means that the relay needs a 12-volt power supply to function properly. A relay consists of several key components, including a coil, a set of contacts, and a mechanical switching mechanism. When a voltage of 12 V is applied to the coil, it creates a magnetic field that activates the switching mechanism.

Relay contacts are typically designed to handle large currents and voltages that may be unsafe or impractical to drive directly through low-power electronics. These contacts are usually separate normally open (**NO**) and normally closed (**NC**) terminals.

4.14.1 Working mechanism of 12V D.C 1-Channel Relay

In default mode, when the relay is de-energized (no voltage), the NO contact is open and the NC contact is closed. When the relay pulls, applying 12 V to the coil, the switching mechanism is activated, causing the NO contact to close and the NC contact to open.

Figure 4.18: 12V D.C 1-Channel Relay.

4.14.2 Specifications of 12V D.C 1-Channel Relay

Table 4.7: Specification of 12V D.C 1-Channel Relay

Power supply	12V
Coil voltage	12V
Max switching voltage	250VAC / 30VDC
Max switching current	10A
Logic	5V

4.15 Push Button

A button is a type of switch designed to be activated or deactivated by pressing it with a finger or other suitable object. It is a simple but widespread component in various electronic devices and systems. A button usually consists of a button or plunger made of a durable material such as plastic or metal. The button is connected to the switch mechanism inside the case. When the button is pressed, it activates the switch, making or breaking an electrical connection.

Push buttons are often categorized based on their action type, including momentary and latching.

4.15.1 Momentary Push Button

A momentary push button, also known as a normally open (NO) button, is designed to be in the open position when not pressed. When you press the button, it momentarily closes the electrical circuit and allows current to flow. When the button is released, it returns to the open state and breaks.

4.15.2 Lock button

The lock button, also known as a toggle button or bitable button, remains in the depressed position until pressed again. It has two stable states, usually ON and OFF. Pressing the button changes its state and it remains in that state until it is pressed again to change to the opposite state.

Figure 4.19: Push Button.

4.16 Battery

A battery is a device that uses chemical reactions to both store and release electrical energy. It is a portable, self-sufficient power source that has a wide range of uses, from supplying backup power for bigger systems to small electronic items. It provides a current of 1-4A and output voltage 12-14V.

Figure 4.20: Dry Battery

4.17 Smart PTZ Camera

It is a smart camera which have the ability to monitor the things around it and record those things in the SD card. It is able to pan, tilt and zoom according to the requirement and can also be controlled through its app VicoHome. The monitoring can also be seen live from anywhere where the Wi-Fi is present.

It is very useful device for safety purposes and help people to keep real timetrack of activities.

Figure 4.21: Smart PTZ Camera.

4.17.1 Specifications of Smart PTZ Camera

Table 4.8: Smart PTZ Camera specifications.

Item	Specification
Horizontal angle	355^{o}
Vertical angle	110^{o}
Camera lens	Field of view 100^{o}
Image Resolution	1080P
Video bit rate	Adaptive
Image Coding standard	H.265
Audio	Duplex two-way audio intercom
Storage Media	Micro SD card

Night Vision light source	Infrared Light
Network	Wi-Fi
Power	DC 5V/1A
Operating Temperature	-10ºC – 45ºC
Size (LxWxH)	72.0mm x 72.0mm x 115.5mm

4.18 Summary

This chapter comprises of all the details and working principles of the hardware components that are being used in the project and also the specifications of these components are enlisted within the chapter using tables. The figures of the components are also included in this chapter which help to recognize the components.

Chapter 5
SOFTWARE SIMULATIONS and HARDWARE WORKING

Hardware and software components form the essential pillars of any project and work together to bring ideas to life and achieve desired results. In this chapter, we will explore the worlds of hardware working and software simulations and explore their interrelationships and their importance in the context of our project. By understanding the complex relationship between hardware and software, we gain insight into a holistic approach that contributes to the success of our business. The purpose of this chapter is to provide a comprehensive overview of the hardware and software aspects of our project. We look at aspects of hardware working and explore the selection and specifications of key components such as microcontroller, sensors, and communication interfaces. Through careful planning and thoughtful design, we strive to create a strong and efficient hardware foundation that meets design requirements while ensuring scalability and flexibility for future enhancements.

5.1 Proteus Professional and Arduino IDE

Proteus is a special type of software designed to perform the circuit operations in soft form before compiling the hardware of circuit completely. It helps to connect different components in its library in the sketch and to find out their working according to the need of the results. It popups the errors when the simulation of the circuits is compiled and run in it and helps to remove the bugs if present in the wiring or in the properties of the components used.

The **Arduino IDE** is a software which helps in writing the codes for the task and is useful in loading the compiled codes in the Arduino Board to perform the tasks.

These both are a very useful software for the beginners as well as the professionals and have a variety of scope in field of electronics and electrical engineering.

5.2 Simulation of Phase-1

The simulation done for the first phase of the project is shown by the figure 5.1 and the connections done are also explained in detail.

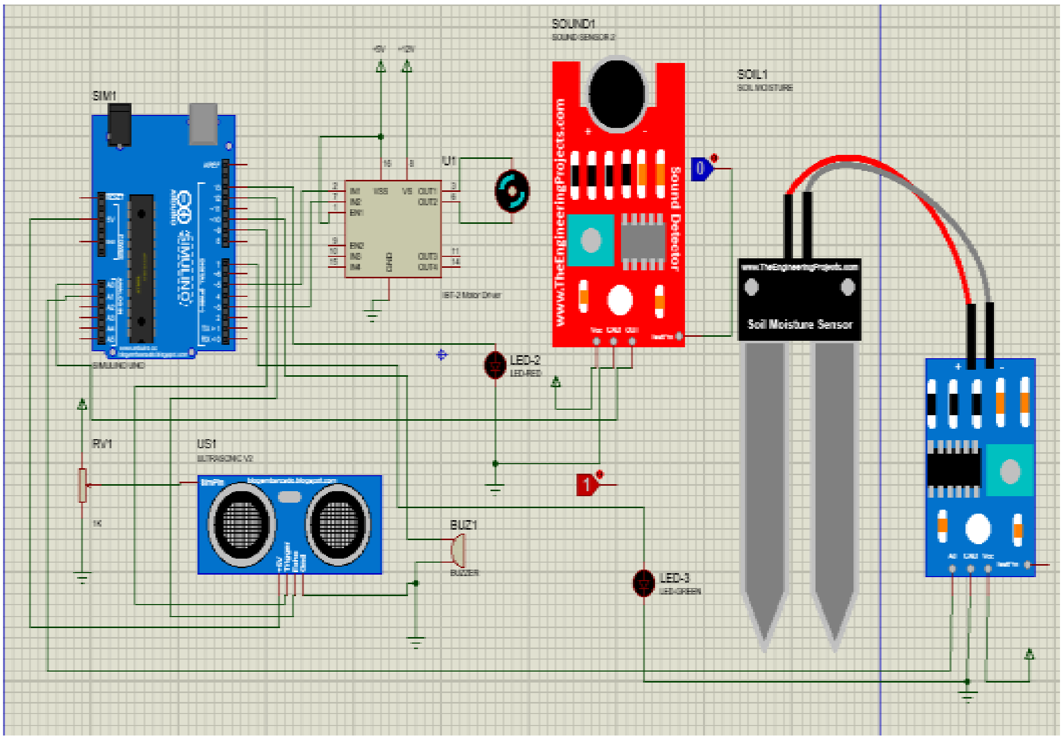

Figure 5.1: Proteus Simulation Phase-1.

5.2.1 Interfacing of Sound Sensor with Arduino UNO

The Vcc of sound sensor is connected with 5V power pin of Arduino Board. Ground of sound sensor is connected with ground of Arduino Board. Output pin is connected with analog IN pin i.e. A0 of Arduino Board to transfer the signal as analog input.

5.2.2 Interfacing of Ultra-Sonic Sensor with Arduino UNO

The 5V pin of ultra-sonic sensor is connected with 5V power pin of Arduino Board. Trigger Pin is connected with PWM pin 9 of Arduino Board. Echo pin is connected with PWM pin 12 of Arduino Board. Ground pin is connected with ground pin of Arduino Board.

5.2.3 Interfacing of Moisture Sensor with Arduino UNO

The Vcc pin of moisture sensor is connected with 5V power pin of Arduino Board. Analog output pin of moisture sensor is connected with analog input pin A1 of Arduino Board. Ground pin is connected with ground pin of Arduino Board.

5.2.4 Interfacing of D.C Motor and Motor Driver with Arduino UNO

The Input pin 1 of driver is connected with PWM pin 5 of Arduino Board. Input pin 7 of driver is connected with PWM pin 3 of Arduino Board. EN 1 pin of Driver is power with 5V. Output pin 3 of motor Driver is connected with Positive pin of Motor. Output pin 6 of motor Driver is connected with Negative pin of Motor.

5.1.5 Interfacing of Buzzer and LED's

Buzzer is connected with PWM 10 pin of Arduino Board and start beeping with any obstacle is detected through ultrasonic sensor. LED 2 is connected with PWM 13 pin of Arduino Board and start glow when sound is detected through sound sensor. LED 3 is connected with PWM 7 pin of Arduino Board and start glow when moisture is detected through moisture sensor.

5.3 Simulation of Phase-2

The simulation done for the second phase of the project is shown by the figure 5.2 and the connections done are also explained in detail.

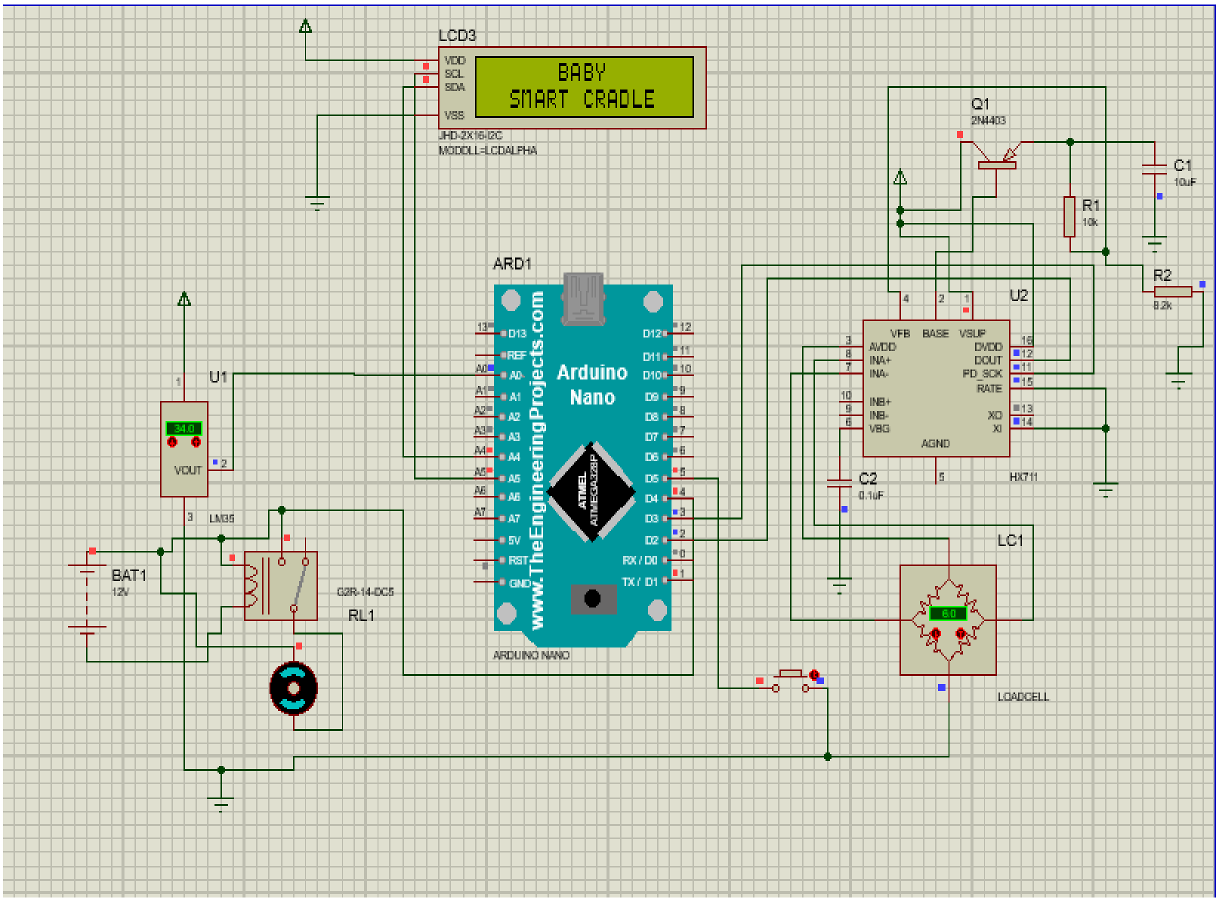

Figure 5.2: Proteus Simulation Phase-2.

5.3.1 Interfacing of Motor and Relay with Arduino Nano

Relay and Motor is powered with 12 V battery supply. Positive pin of relay is connected with digital 4 pin of Arduino Nano. Motor is connected on the output of relay. When the relay switches ON motor will start running and vice versa.

5.3.2 Interfacing LCD (16x2) with Arduino Nano

VCD pin of LCD is powered. SCL pin of LCD is connected with analog A5 pin of Arduino Nano. SDA pin of LCD is connected with analog A4 of Arduino Nano. VSS pin of LCD is grounded.

5.3.3 Interfacing of LOAD Cell with Arduino Nano

DOUT pin of load cell module is connected with digital pin 2 of Arduino Nano. PD SCK pin of load cell module is connected with digital pin 3 of Arduino Nano. Output of load cell is shown on LCD display.

5.4 Hardware Working Algorithm

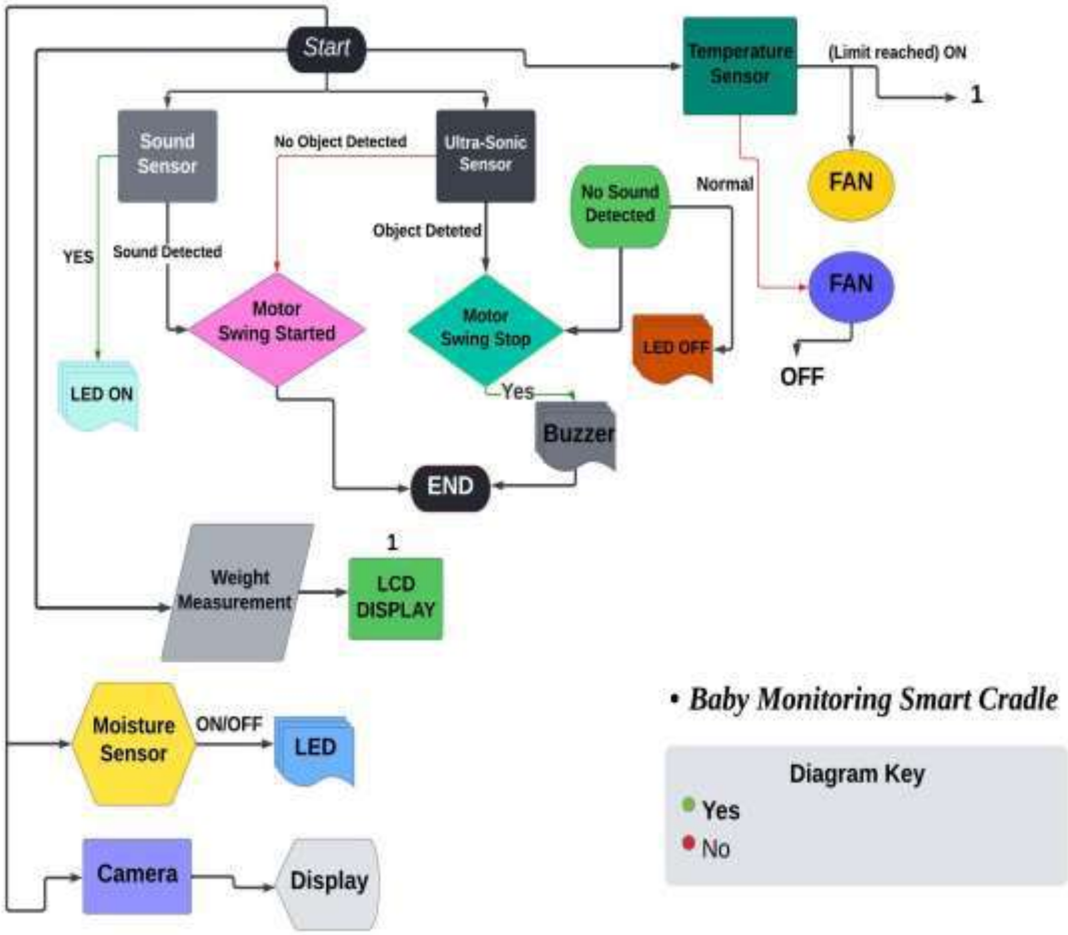

Figure 5.3: Hardware Working Algorithm.

The information of hardware working algorithm through this flowchart obtained is explained below.

The framework of smart cradle consists of Arduino UNO and Arduino Nano and Battery supply. All other components including different sensors are interfaced with Arduino Boards.

The sound sensor when detect the baby cry sound then it sends the signal to Arduino Uno and on the output the motor start swing and LED remain on till the detection of sound. On the other hand, when any obstacle is detected through ultrasonic sensor it triggers the Arduino Uno and stops the motor swing but at the same time when object or any obstacle is removed it again start the swing while detecting the baby cry sound.

When moisture is detected through moisture sensor then it sends the signals to Arduino Uno as a result LED start glowing on the output until and unless moisture is removed.

The load cell and LCD (16x2) is interfaced with Arduino Nano, in order to measure the weight (g) using load cell, and display output on the LCD. In the same manner the temperature sensor LM35 sense the room temperature of the surroundings and also show the temperature on the LCD display.

The fan is connected with temperature sensor, when temperature rises beyond the set limit as a result the fan will turn **ON**, when the temperature drops below the defined limit the fan turns **OFF** automatically.

The camera is installed for the live monitoring of all the activities happening in the cradle as well as surroundings.

5.5 3D Design of Cradle

The 3D designs help to visualize anything that how it would look in real and what steps are required to make out the specific thing. The 3D design of the "Baby Monitoring Smart Cradle" helps to visualize its size, working, placement of the sensors and components.

Figure 5.4: 3D Cradle Front View.

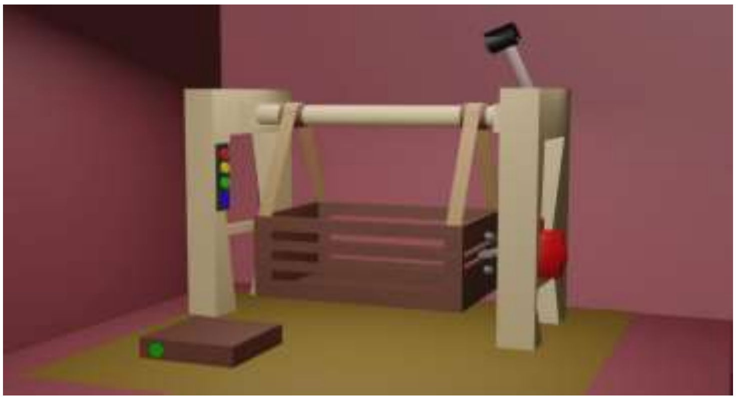

Figure 5.5: 3D Cradle Side View.

These two figures [5.4-5.4] shows the 3D designs of cradle from both the angles and help to understand where the components will be best fitted to get maximum output from them and how the cradle will look like when all the components will be connected on the frame of the cradle. However this 3D design is just a computerized designed model and the actual cradle will be looking little bit different in frame size and other aspects.

5.6 Summary

This chapter consist all the details of the components and software's used to complete the project. Arduino UNO and Nano are the main components which carry out all the tasks.

The sound sensor makes the motor to swing and ultra-sonic sensor help to avoid any collision with cradle. Also the moisture sensor detects the wet conditions and the temperature sensor is used to turn ON fan when required and weight sensor is used to help parents to keep check whether baby weight is normal or not. Camera helps to monitor the activities of baby from anywhere. The **3D** model helps to visualize how the prototype will be in real-time.

Chapter 6

PROJECT RESULTS and EVALUATION

The culmination of any project is its results and evaluation of the results. In this chapter, we begin an in-depth examination of the results of our project. With the help of a comprehensive evaluation, we want to give an objective assessment of the success and possible progress of the project. Throughout this chapter, we present a synthesis of data, providing a holistic perspective on the results and evaluation of our project. A detailed examination of these findings not only reinforces the efforts invested, but also fosters a continuous cycle of improvement and innovation.

6.1 Testing

6.1.1 Crying Sound Detection evaluation

The detection of crying sound was evaluated using the sound of baby crying with its output shown at the LED display board. Its threshold value of intensity was set about 22.

When the sound of crying was detected the LED turned ON successfully.

6.1.2 Auto Swing evaluation

The evaluation of auto swing was performed upon the detection of crying sound and the motor driver IBT-2 helped to drive the motor when the crying sound was detected.

6.1.3 Collision Avoidance evaluation

The collision avoidance was evaluated by placing an object within the range of ultra-sonic sensor which was set about 50 mm and upon the detection the buzzer generates the alarm.

6.1.4 Moisture Detection evaluation

The moisture or wet surface was detected using the wet sensor and by applying water on it the condition was checked using the LED on display board.

6.2 Additional Features Testing

6.2.1 Temperature sensor evaluation

The temperature sensing was evaluated by heating up the temperature around the sensor and the temperature value was checked on the 16x2 LCD display in (^{o}C).

6.2.2 Automatic Fan evaluation

The automatic fan working was evaluated in correspondence to the temperature sensor and when the temperature rises to 33^{o}C the fan started automatically.

6.2.3 Weight Measurement evaluation

The weight measurement was evaluated by placing weight upon the load cell (measures up to 20kg) and the weight was displayed on the 16x2 LCD display in grams (g) and by pressing the push button the weight was reset to zero.

6.2.4 Live Monitoring Evaluation

The live monitoring was evaluated using the Smart PTZ Camera and the app VicoHome is used to check out the activity of the things going around and in the cradle.

6.3 Experimental Results

The experimental results of working of the different components were obtained and these results are shown out using the table which makes it easy to understand the experimental results and the accuracy of the system. The accuracy factor was checked by taking out the trials of the system for four time of each component and successful and un-successful trial results are also shown using the Table 6.1.

The percentage ratio helps to get the performance of every component. The equation 6.1 shows how the performance is determined.

$$\frac{Successful\ attempts}{Total\ Attempts} \text{ X } 100. \qquad (6.1)$$

Table 6.1: Experimental Results of Baby Monitoring Smart Cradle.

	Baby Monitoring Smart Cradle						
Sr. No		50 Attempts	50 Attempts	10 Attempts	50 Attempts	50 Attempts	Performance
	Sound & Motor						
1	Detection and Swing	✓	×	✓	✓	✓	76%
	Ultra-Sonic & Motor						
2	Collision Avoidance	✓	✓	✓	✓	✓	100%
	Moisture Detection						
3	Wet or Not-Wet	✓	✓	×	✓	✓	94%
	Temperature & Weight						
4	Accurate or Not , Fan On/OFF	✓	✓	✓	✓	✓	100%
	Live Monitoring						
5	Accurate View	✓	✓	✓	✓	✓	100%

The table 6.1 provides the performance result obtained in different attempts and 76% accuracy in Sound Detection and Auto Swing of motor also 100% accuracy is obtained in Collision Avoidance. The accuracy of Moisture Sensor is 94%, Temperature Sensor and Weight Sensor is 100% and Live Monitoring accuracy is 100%.

6.4 Actual Prototype

The actual prototype that consist of all the components fitted upon it can be seen in the figure 6.1 which has its resemblance with the 3D design of the cradle and it is the finalize prototype of the "Baby Monitoring Smart Cradle".

Figure 6.1: Baby Monitoring Smart Cradle Prototype.

6.5 Comparison

As compared to the ideas of the Smart Cradle [1]–[4] our prototype is easy and feasible to carry anywhere and also the system van be fixed on any cradle which has a same frame according to our prototype. The live monitoring system helps to reduce the cost of GSM module[4] and helps to monitor all the alarms displayed in front of the camera and can also monitor the activities going around the cradle and in the cradle. The new add on features of temperature and weight sensor are also very helpful in handling the baby.

6.6 Applications

The major advantage and benefit of this Smart Cradle is that it is user friendly for parents to operate it and also for the baby. It helps to minimize the efforts of the parents in handling babies and to reduce stress of the parents especially at night. This cradle have its applications in house hold, day-care centers and hospitals and targets the Health Care Industry.

6.7 Future Recommendations

Although the Baby Monitoring Smart Cradle is equipped with a number of features but further in the future some more things can be included in it like more advanced sound detection technology can be implemented to get maximum accuracy. As we have used Arduino which is slower in data processing and in other terms but more advanced microcontroller can be used in future to get more fast response. A hybrid source of power can more improve its backup time working. Also, in future a Smart Cradle application can make it possible to measure and watch all the values and alarms generated by the sensors installed in the cradle.

6.8 Summary

This chapter comprises of project results and evaluation data in which different type of testing's are performed to check out the accuracy of the system. It also contains the actual picture of the prototype which is being designed and implemented. The applications of the cradle are also discussed and recommendations are being made that can be carried out further in the future.

Chapter 7
CONCLUSION

This paper presents the work done on Baby Monitoring Smart Cradle which will help the parents to reduce their efforts in handling their babies in daily routine and also in the night especially it is a very useful innovation for the mothers to enhance their capabilities in their job life despite of taking stress of handling their babies back at home. Also it will help efficiently to sooth and nurture the baby in his starting age of growing.

This project intends to target the Health Care industry and will have substantial effects of its use in life of different people including parents, staff of day-care centers also in the hospitals. The results and other things when compared with different models of the smart cradles our cradle is low-cost and comprises all of the features like the other models. Different factors like safe angle of swing, comfort of the baby, safety of the baby and budget of the project were considered during the designing and implementation of the project.

The Baby Monitoring Smart Cradle project also implies upon the Sustainable Development Goals (SDG’s) and it holds a bright future in light of innovation. In future with more advanced technology it can be improved more to get maximum of results from this innovation.

The main goal of this project is to empower the ladies in different areas of their life and to bring up a new way of handling babies with a change in conventional ways being used from past till now.

REFERENCES

[1] O. Access, G. Sarwar, M. Amir, N. Yadav, and P. Meenia, "DESIGN OF SMART CRADLE SYSTEM USING IOT," no. 05, pp. 3654–3658, 2022.

[2] A. Kumaravel, S. Ramesh, M. Ramya, and J. Ranjani, "Smart Cradle for Baby Monitoring Using IOT," vol. 10, no. 5, pp. 370–374, 2021, doi: 10.17148/IJARCCE.2021.10575.

[3] Kannan P, A. Devaraj, B.Pradheep T Rajan, Swathira P K, Subhikshaa Jayaranim, and Shebna V, "IoT Based Smart Cradle Using PI," pp. 716–720, 2021, doi: 10.3233/apc210268.

[4] M. P. Joshi and D. C. Mehetre, "IoT Based Smart Cradle System with an Android App for Baby Monitoring," *2017 Int. Conf. Comput. Commun. Control Autom. ICCUBEA 2017*, pp. 1–4, 2018, doi: 10.1109/ICCUBEA.2017.8463676.

APPENDICES

CONTACT INFORMATION

- **Supervisor**

Name: Dr. Muhammad Shahid Iqbal.
Email ID: shahid.iqbal@nutech.edu.pk
Mobile No: +92344-1844275.

- **Group Members**

1) Name: Adil Ahmed Satti.
Email ID: adilahmedf19@nutech.edu.pk
Mobile No: +92300-8358827.

2) Name: Muhammad Fawaq Azhar.
Email ID: muhammadfawaqf19@nutech.edu.pk
Mobile No: +92335-9983251.

3) Name: Mehran Ali
Email ID: mehranalif19@nutech.edu.pk
Mobile No: +92335-1980205.

ORIGINALITY CERTIFICATE

We, the undersigned members of the capstone design project group, hereby confirm that the group project titled "**Design and Implementation of Baby Monitoring Smart Cradle**" has been undertaken and completed by us as a collaborative effort. The project report is prepared by the undersigned group members. Any external sources, including published or unpublished works, have been appropriately acknowledged and referenced in accordance with the guidelines provided by NUTECH University.

As a group, we understand the severity of plagiarism and its consequences, and we assure you that the level of plagiarism in this project report is below 20 percent. To ensure the originality of our project report, we have utilized anti-plagiarism (Turnitin) software to verify the uniqueness of the content.

By signing this undertaking certificate, we affirm that our project work adheres to the principles of academic integrity. We are committed to upholding the values and standards of NUTECH University.

Signatures of Group Members:

1. ______________________________

[Muhammad Fawaq Azhar - Group Member 1]

2. ______________________________

[Adil Ahmed Satti - Group Member 2]

3. ______________________________

[Mehran Ali - Group Member 3]

Supervisor Name & Signature: Dr. Muhammad Shahid Iqbal

Date: ____________________________