VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi – 590 018.

A PROJECT REPORT

on

"IOT BASED SMART CRADLE FOR BABY MONITORING SYSTEM"

Submitted in partial fulfillment of the requirement for the award of the degree

Bachelor of Engineering

in

Computer Science and Engineering

by

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Certificate

Certified that the project work entitled "**IOT BASED SMART CRADLE FOR BABY MONITORING SYSTEM**" carried out jointly by **Arpitha G (1VI20CS016), Chandrasekhar Kumar (1VI20CS029), Mohammed Amir Arsalan (1VI20CS068)** are bonafide students **of Vemana Institute of Technology** in partial fulfillment for the award of **Bachelor of Engineering** in **Computer Science and Engineering** of the **Visvesvaraya Technological University, Belagavi** during the year 2023-24. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements in respect of the project work prescribed for the said degree.

Supervisor	**HOD**	**Principal**
Dr. Rashmi R	Dr. M. Ramakrishna	Dr. Vijayasimha Reddy. B. G.

Submitted for the university examination (viva-voce) held on …………………

External Viva

Internal Examiner	**External Examiner**
1.__________________	__________________
2.__________________	__________________

DECLARATION BY THE CANDIDATES

We the undersigned solemnly declare that the project report “IOT BASED SMART CRADLE FOR BABY MONITORING SYSTEM” is based on our own work carried out during the course of our study under the supervision of ‘Dr. Rashmi R’.

We assert the statements made and conclusions drawn are an outcome of our project work. We further certify that,

a. The work contained in the report is original and has been done by us under the general supervision of my supervisor.

b. The work has not been submitted to any other Institution for any other degree/diploma/certificate in this university or any other University of India or abroad.

c. We have followed the guidelines provided by the university in writing the report.

d. Whenever we have used materials (data, theoretical analysis, and text) from other sources, we have given due credit to them in the text of the report and their details are provided in the references.

Date:

Place:

<u>Project Team Members:</u>

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ABSTRACT

This project proposes the idea of Smart Cradle for a baby. The main motive of this idea is to save time and energy of very busy parents. Working people are very busy these days. They do not have enough time to properly take care of their babies. So, the whole room is set up as it can sense the activities of the baby and work according to requirement. Parents can save their time and energy as they don't have to go and check their baby again and again until they don't get any information about baby.

The idea of this scenario is accomplished by using sensors and a microprocessor. The sensors attached to the microprocessor sense the room condition and also monitor the activity of the baby, It works based on the condition we apply to it, Entire data will be visible to the user and get notified about the status of the baby.

Key words: IoT, Machine Learning, Baby Cradle Monitoring System, Data Analysis

LIST OF ABBREVIATION

ABBREVIATION	DESCRIPTION
IoT	Internet of things
CSE	Computer Science and Engineering
PID	Proportional- Intergral- Derivative
RF	Radio Frequency
WAN	Wide Area Network
IP	Internet Protocol
SIDS	Sudden Infant Death Syndrome
LCD	Liquid Crystal Display
UNO	University of Nebraska
MCU	Microcontroller Unit
RFID	Radio- Frequency Identification
GPS	Global Positioning System
USB	Universal Serial Bus
LAN	Local Area Network
API	Application Programming Interface
GPL	General Public License
DIY	Do it Yourself

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CHAPTER 1

INTRODUCTION

Introduction

Many parents are unable to devote sufficient time to infants on account of office work or being short-handed. Additionally, there are also many first time parents, who lack experience in raising children. Infants, on the other hand, demand constant attention and care. Simple methods to immediately calm the agitated infants need to be devised. Hence, there is a need to assist parents in taking care of their infants by providing them with a single product which would monitor their infants at all times, send notifications in case attention is required, raise alerts in case of emergency situations and provide real time interaction between parents and infants.

In the dynamic landscape of parenting, where technology continuously shapes our daily lives, the IoT-based Smart Cradle emerges as a beacon of innovation, introducing a new paradigm in baby monitoring systems. This cutting-edge cradle offes parents an intelligent and connected solution to ensure the well-being of their precious little ones. TheIoT-based Smart Cradle is not just a bed, it's a guardian, a companion, and a source of invaluable insights into your baby's world.

Leveraging the capabilities of the Internet of Things, this advanced baby monitoring system is equipped with a sophisticated array of sensors, cameras, and connectivity features, transforming the act of caregiving into a seamless, data-driven experience.Imagine a cradle that goes beyond merely providing a secure and comfortable space for your baby. Picture a device that actively monitors your infant's vital signs, sleep patterns, and environmental conditions. Through real-time data collection and analysis, this smart cradle ensures that parents are always in the know, offering peace of mind and a heightened sense of connection with their child.

The IoT-based Smart Cradle redefines the boundaries of childcare, fusing technology and compassion to create a safer, smarter, and more responsive environment for the little one. There is a need to develop a new low cost indigenous electronic System because the existing mechanical systems are imported and costly The first verbal communication of newborn baby with the world is baby’s cry. This cutting-edge solution exemplifies the fusion of modern technology and traditional caregiving, offering peace of mind.

Infant crying is a biological alarm system. An infant crying signal is the attention call for parents or caregivers and motivates them to alleviate the distress. There is a need to develop a new low cost indigenous electronic System because the existing mechanical systems are imported and costly. Emotion based technique has been implemented. Based on the emotions nothing but the child is crying then a message is sent to the parents.

1.1 Scope

The scope of this project aims to create a comprehensive, intelligent, and user-friendly baby monitoring system that leverages IoT technologies to enhance the overall parenting experience. It not only focuses on essential health monitoring but also incorporates emotional aspects to create a nurturing and responsive environment for both the baby and the parents.

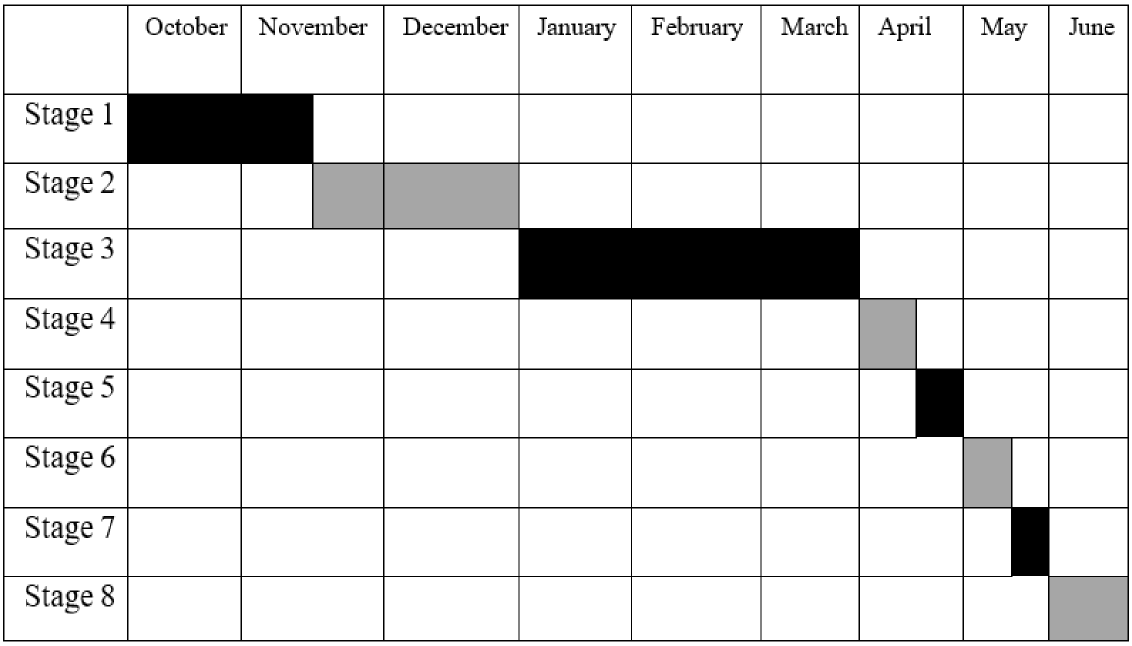
1.2 Objectives

The envisioned IoT-based Smart Cradle for our team’s baby monitoring system is designed to revolutionize the parenting experience with its innovative features. The system incorporates advanced sensors to monitor the baby's body temperature, dynamically adjusting the pillow temperature to ensure the infant's comfort. In response tothe baby's cry, the cradle not only initiates a gentle swing but also sends an immediate intimation to the parents' mobile phones, keeping them informed and connected at all times. Additionally, a wet sensor is integrated to detect dampness, providing timely alerts for diaper changes. The system goes beyond mere functionality by incorporating emotional cues – when the baby cries, a message is sent to the parents, fostering a deeper connection and responsiveness to the child's needs. This comprehensive approach aims to create a nurturing and intelligent environment, seamlessly blending technology with caregiving for an enhanced parenting experience.

1.3 PLAN OF ACTION FOR THE PROJECT

The table 1.1 describes that the first stage of the project started with identifying a relatively new problem for which a solution is needed. Then, after making a literature survey of papers published in journals, a solution was arrived at and a proposed system was presented. In the second stage, the system specification was made and the design methodology was spelt out in terms of system architecture and data flow diagram. The various modules of the system were design. The Plan of Action shown below shows the various months blocked down to different stages.

Table 1.1 Plan of Action for the Project (Timeline Chart)



1.4 CURRENT STATUS OF PROJECT

Table 1.2 Current Status of the Project

No	Task #	Start	Finish	Activity
1	Task 1	1-Oct-23	6-Oct-23	Topic Selection
2	Task 2	7-Oct-23	8-Oct-23	Arriving at the Methodology
3	Task 3	9-Oct-23	10-Oct-23	Zeroth review PPT preparation and submission
4	Task 4	11-Oct-23	13-Oct-23	Literature Survey
5	Task 5	14-Oct-23	14-Oct-23	Problem Statement
6	Task 6	15-Oct-23	17-Oct-23	Arriving at the Proposed System
7	Task 7	18-Nov-23	19-Nov-23	Review 1 PPT preparation and submission
8	Task 8	20-Nov-23	27-Nov-23	Arriving at the system specification
9	Task 9	28-Nov-23	5-Dec-23	Finalizing the design methodology
10	Task 10	6-Dec-23	12-Dec-23	Design of Modules
11	Task 11	13-Dec-23	14-Dec-23	Review 2 PPT preparation and submission
12	Task 12	15-Dec-23	15-Dec-23	Review 2 Presentation and End of Phase 1

The Table 1.2 describes the tasks and activities where the project follows a structured approach, commencing with Problem Formulation to define the research question and outline a detailed plan and timeline.

The subsequent Research on Existing Systems phase involves an extensive literature review and identification of similar systems, The analyzed data is then used to prepare for Phase-1 Review 0, then Literature Survey is conducting to search more on existing system and research done based on the problem. Then the problem statements are discussed based on the problem, literature survey conducted and existing system.

The proposed system is described after the problem statements are created. Information gained is used to prepare for review 1. The Research, Methodology, and System Architecture phase focuses on developing a research methodology and designing the system architecture. The research on the existing system and what can be implemented is done and the methodology that can be used is analyzed. Then the system architecture is described. Finally, preparation of review 2 is conducted in the project's development. This systematic progression ensures a well-planned and efficient execution, from problem identification to practical implementation, facilitating a comprehensive and organized research and development process.

1.5 PROPOSED PLAN FOR COMPLETION

Table 1.3 Proposed Plan for Completion

No	Task #	Start	Finish	Activity
1	Task 13	5-Feb-24	9-Feb-24	Module 1 Detailed Design, Coding, Testing
2	Task 14	12-Feb-24	16-Feb-24	Module 2 Detailed Design, Coding, Testing
3	Task 15	19-Feb-24	23-Feb-24	Module 3 Detailed Design, Coding, Testing
4	Task 16	26-Feb-24	1-Mar-24	Module 4 Detailed Design, Coding, Testing
5	Task 17	4-Mar-24	8-Mar-24	Module 5 Detailed Design, Coding, Testing
6	Task 18	11-Mar-24	15-Mar-24	Module 6 Detailed Design, Coding, Testing
7	Task 19	18-Mar-24	22-Mar-24	Module 7 Detailed Design, Coding, Testing
8	Task 20	25-Mar-24	29-Mar-24	Review 3 ppt Preparation and Submission
9	Task 21	1-Apr-24	5-Apr-24	Integration Testing
10	Task 22	8-Apr-24	12-Apr-24	System Testing
11	Task 23	15-Apr-24	29-Apr-24	Review 4 ppt Preparation and Submission
12	Task 24	30-Apr-24	30-Apr-24	Review 4 Presentation and Demo
13	Task 25	1-May-24	14-May-24	Modification After Review 4 and Demo
14	Task 26	15-May-24	29-May-24	Final Report Preparation, Submission
15	Task 27	3-June-24	7-June-24	Preparation for Exam Viva and Demo

The Table 1.3 describes that,

- From the month of February to march, we will design, learn Arduino coding andsimultaneously test the executed code.
- In the month of April, we will learn about the integration of the above modules and overall system testing.
- In the month of May, modification of Review 4 and the final presentation is done.
- In the month of June, preparation for final exam, viva and demo is implemented.

1.6 OUTINE OF THE CHAPTERS

- Chapter 1 Introduction: The IoT-based Baby Cradle Monitoring through real-time insights, advanced analytics, and proactive decision-making tools. Emphasizing energy efficiency, data privacy, and compliance, the project strives for sustainability and productivity in aquaculture. The primary objective is to elevate standards, enhancing productivity and environmental stewardship through precise management tools. The scope, objective, plan of actionfor the project with timeline chart, current status of the project, and proposed plan for completion are provided.
- Chapter 2 Literature Survey: The thorough survey of journal papers resulted in getting ten papers which were helpful in finalizing the proposed system. The detailsandabstracts of the ten papers are provided and comparative analysis of them is also given.
- Chapter 3 System Requirements: This chapter gives the functional requirements, non-functional requirements, hardware requirements and software requirements.
- Chapter 4 Design Methodology: The system architecture and data flow diagram are covered in this chapter.
- Chapter 5 Module description: This chapter lists the modules which have been identified and their description.
- Chapter 6 Summary: The work done so far is summarized in this chapter.

CHAPTER 2

LITERATURE SURVEY

[1] A SENSOR-BASED SYSTEM FOR INFANT SLEEP MONITORING.

Authors: PROF P REKHA, K SUGANYA

Publications: IEEE – 2020

Description: The Baby monitoring cradle system is a kind of alarm system which can detect baby's movements and activities and can convey the message about the condition of babies to the concerned authority via a radio or mobile or even a display. Nowadays parents are thinking about adopting the technological inventions for getting advantages and benefits to provide safety issues to their babies. Nowadays most of the parents are busy with their career, a modern baby monitoring system can be a solution for handling babies securely. Monitoring a baby continuously is really a tough job as well as it is arisky job for the parents to carry out their baby all the time with them especially while working. Since security of the baby plays a vital role in addition of a person monitoring a baby there is a need for continuous monitoring of the baby at all conditions and reporting the status of the baby to the parents. In this perspective, the authors have proposed the bestsolution to remove the anxiety and stress of the parents. In this project, the design of a baby monitoring system using Raspberry Pi whereas all the previous systems were developed using either Microcontroller or Arduino.

Advantages:

- Enhanced sleep quality for infants.
- The 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.

Limitations:

- Limited adaptability to diverse behaviors. The survey does not contain information about whether the Smart Baby Monitoring Cradle System can be customized to fit different types of cradles. Raspberry Pi is expensive.
- Without a stable internet connection, features such as real-time alerts, remote monitoring, and automatic updates can be compromised, potentially reducing the effectiveness of the system in ensuring timely response to the infant's needs.

[2] FUZZY LOGIC CONTROL FOR SMART BABY CRADLE

Authors: TUYISENGE JEAN CLAUDE, MUKANYILIGIRA DIDACIENNE, NIRERE GAUDENCE, NYAKURI JEAN PIERRE.

Publication: IEEE-2020

Description: This introduction covers the context of research project, the problem that the authors expect to solve, the relevance of the proposed project, approach/ proposed solution, as well as the report organization. Monitoring the baby's feeding sequence isthe major concern in this project. The proposed system comes to complete the existing baby's health monitoring systems since for the child, many health problems may be caused by Malnutrition, which is usually linked with maidservants' carelessness. In addition the health monitoring system, the fuzzy logic control is added for temperatureand humidity control on existing system for system enhancement. Therefore, through the use of IoT technology the parents need to take control of their baby's feeding activities. The proposed solution to the identified problem is about designing and implementing an IoT system where by the baby's smart cradle is designed with an IP (Internet Protocol) Camera, Fingerprint based access, room temperature and humidity control, an alert system to notify the maidservant the time to eat, and alert to notify the parents eating timeviolation. A mobile application was developed for parents to monitor the smart cradle activities. With this system, the maidservant will be noticed that it is time for the child to eat and take action accordingly.

Advantages:

- The fuzzy inference system takes into account the current temperature and humidity levels, as well as the desired temperature and humidity ranges, and uses fuzzy logic rules to determine the appropriate action to take.
- The output of the fuzzy inference system is a control signal that is sent to the heating and cooling systems to adjust the room temperature and humidity.

Limitations:

- Higher computational requirements, financially infeasible because of biometrics.

[3] MACHINE LEARNING APPROACHES FOR AUTOMATED BABY CRADLE

Authors: HINA ALAM, MUHAMMAD BURHAN, ANUSHA GILLANI, IHTISHAM UL HAQ, MUHAMMAD ASAD ARSHED, MUHAMMAD SHAFI, AND SAEED AHMAD.

Publications: IEEE – 2023

Description: Nowadays, childcare challenges have become a hurdle to work, especially for working mothers. Child care is necessary for parents, but parents cannot always take care of their babies and can spend time monitoring their babies because of their other responsibilities. Raising a child with care these days where both parents are working is a difficult task. It has become a challenge for many families to keep an eye on their children with everyday routines. Many parents are not satisfied with the daycare facilities provided in many countries. Babies need care and monitoring 24 hours a day which is difficult for working parents because they cannot always carry their babies with them at the time. Hiring a caregiver to watch infants is an option when parents are busy or the nursery is an alternative solution.

The IoT connects billions of smart objects and sensors to the Internet, to collect data from the physical environment. These smart objects and sensors are aimed at reducing human intervention and expand automation to daily life. Moreover, these smart objects and sensors lead to various smart industries, such as smart homes, smart cities, intelligent transport systems, smart healthcare, and smart agriculture. Therefore, proposing the idea of a smart baby monitoring system, which is a kind of notification system that can detect the activities of the babies in real-time and send the message about the status of the babies to only the registered parents. In particular, focusing on the vital parameters that are important in maintaining the comfort of the baby. The camera is also attached for live streaming and live updates of the baby using real-time facial expressions. By using the mobile application, the registered parents can control the hardware remotely, get the live stream of the baby, detect the crying sound, and monitor the humidity and temperature of the surroundings. The control system of the proposed system is equipped with a NodeMCU, a Raspberry Pi with a camera, a DC motor, a mic, and a DHT11 sensor for reading vital parameters to monitor the condition of the infant. These connected sensors send the values tothe controllers and immediately notify the parents about abnormal conditions. The proposed system also identifies the unknown face and detects the real-time emotion of a baby using the (SVM) classifier.The camera is also attached for live streaming and live updates of the baby using real-time facial expressions.

Advantages:

- Adaptive motion based on baby behavior and controlling the degree of swinging.

Limitations:

- Privacy concerns with data collection and the accuracy of the sensors and machine learning model used is less.

[4] ADAPTIVE SWAY FOR BABY BASSINET

Authors: YANG HU, WEIHUA GUI

Publications: IEEE – 2020

Description: Along with development of time and accelerating of life rhythm, more and more young parents have no much time to give consideration to their babies. At the same time good nurses are hard to find. The old manpower sway bassinet is hard to fit the society need. A kind of new baby bassinet is presented in the paper. Some sensors are under the bassinet. Baby status can be perceived by these sensors. The bassinet is made up of an adaptive swaying device and other sensors network. While baby crying, the sensors network can judge the reason according to detecting parameters. At the same time, the bassinet starts to sway slightly. The swaying rhythm can be adjusted according to parameters from baby status . A kind of artificial metabolic algorithm is proposed in the paper. It simulates the biology metabolism. The optimization object can be seen a metabolic process. The optimization process can be realized after the substrate concentration and product concentration can reach balance. The total process is adjustedby enzyme. According to the above principle, the idea of artificial metabolic algorithm isto balance the flows in metabolic network by metabolic operators. While the metabolic ratereaches stability, the optimization result can be gained. The problem of looking after babiesis hard problem worldwide. Babies are society future. The intelligent bassinet could alleviate parents' pressure but not obligation. Along with information technology development, more and more work can be deal with by machines. But should not ignore parent-child communication. After all, caring from his (or her) parents may be best bassinet for every baby.

Advantages:

- Improved Household Management: The new baby bassinet aims to improve household management and decrease the labor intensity of young parents by providingan adaptive swaying mechanism based on the baby's status.

Limitations:

- Lack of Detailed Evaluation: The paper does not provide a detailed evaluation of the effectiveness of the adaptive sway control and the artificial metabolic algorithm in real-world scenarios.
- This financial barrier may limit accessibility, preventing some parents from benefiting from the enhanced safety and convenience that the Smart Cradle System offers.

[5] MONITORING & CONTROLLING A BABY CRADLE WITH ADAPTIVE FEATURES.

Authors: DR. R JOSEPHINE, N DIVYA PREETHA.

Publication: IEEE-2021

Description: As familiar with the hurdles faced by parents to nurture their baby and especially in case of both working parents. Thus, a requirement system that can help parents to have a continuous surveillance of their baby and can notify about the same whenever needed. The sudden infant death syndrome (SIDS), which is characterized by the sudden death of a healthy infant while sleeping, has long been considered one of the most mysterious disorders in medicine. SIDS occurs when three factors are present simultaneously which are vulnerability of the infant, a critical developmental period and an exogenous stressor (During the first year of life, rapid changes in maturation of cardio respiratory control and in cycling between sleeping and waking occur). Thus, have come up with an idea to design a Smart Cradle System using IOT that helps the parents to monitor their baby even if they are away from home and detect every activity of the baby from any distant corner of the world.

Internet of things simply refers to a network of objects that is connected to the internet. here the IoT is integrated into the baby monitoring system to achieve a rapid response time and to provide a greater sense of security for parents. The research paper proposes a system that utilizes a wireless webcam and various sensors to monitor and control a baby cradle. The authors have proposed an efficient system which shows live footage of the baby and updates on body temperature and moisture content using a web cam, temperature sensor and humidity sensor. A sound sensor is also fixed to the cradle in order to sense a baby’s cry and accordingly the cradle automatically swings slowly usinga motor. If the child continues to cry a notification is sent to the parents. And the caretaker can also view all these data through LCD display, which is also connected to theArduino UNO. All the sensors are connected to Arduino UNO which collects data from the sensors and sends it to the server via Node MCU. An android application is used to control all the features mentioned above. This provides a safe environment to the baby. These sensors continue to collect data and these data are compared with the threshold values, so as to send any notification when required. The server is interfaces with the mobile application. The parents are able to view the baby’s status through the android application and the advanced technology and sophisticated features integrated into the system often result in accurate results.

Advantages:

- Continuous Surveillance: The system enables continuous live footage streaming of the baby, providing parents with real-time monitoring capabilities.

Limitations:

- Reliance on Technology: The system's effectiveness is dependent on the proper functioning of the technology involved, which may pose a drawback in case of malfunctions.

[6] IOT BASED SMART BABY CRADLE WITH ROBOTIC PARENTS VOICE TOYS USING MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE.

Authors: PRIYANKA SHINDE, DR. SHUBHANGI D.C, PROF BASWARAJ GADGAY

Publication: IEEE-2018

Description: With the new IoT based smart cradle and baby monitoring system, the authors have made many advancements to the traditional cradle. The smart baby cradle helps working women balance their work and domestic chores. It creates a positive impact on society as women can continue their studies or job without worrying about their children and can take part in development of the nation. There are a lot of accidents such as SIDS(Sudden infant death syndrome)which occur when the child suffocates after crying in the cradle and if it is not attended there is risk of SIDS, so as soon as the baby starts crying the care taker can recognize and take the appropriate action the new advanced and the prototype that the authors have made many advancements wherein they have basically added DHT11 sensor which is also known as humidity sensor, to detect the humidity in the cradle, a sound sensor to detect if the baby wakes up and cries, the sound senses it and the tempo audio plays the music and ON, and turns on the Fan if thehumidity increases in the cradle. So basically, to make a few advancements and improvisations in the traditional cradle and the authors have added ESP8266 IC and made it IoT compatible so that it can be monitor the baby with a PC or mobile remotely as well, have implemented an automated swing where the authors have fixed a DC motor to the cradle, whenever the baby wakes up the microphone senses the crying sound of the baby and activates the DC motor and swings the cradle. Along with DC motor the melody tune will start to play to relax a crying baby and then the authors are providing button feeds in the IoT server so that parents can go control the motion of the swing as well and if the humidity increases to a certain pre-set level, then automatically the fan will turn On. Utilizing sensors and IoT connectivity, it monitors vital signs, sleep patterns, and environmental conditions, ensuring optimal comfort and health for the baby.

There is also a wet detection sensor that the owners have added which will be placed at the bottom of the bedding, so if the baby makes the bed wet, then the water sensor senses the wetness send real time feed to the IoT monitoring system, so that the guardians or parents can change the diaper. added an independent camera where it will have a real timefeed to the guardian or the parents to check if the baby is asleep. So basically, whenever the baby is crying then the cradle swing goes on automatically or even the guardianscan turn on the cradle manually on the IoT feed buttons. The authors are using two relays to trigger the Fan and DC motor, temperature or the humidity level goes beyond the presetlevel the relay connected to the fan gets activated, and the DC motor relay gets triggered. The fan also works on the same principle, if the humidity goes above the preset level the fan turns on automatically or even the fan can be activated manually with IoT feed button.All these functions can be seen on the LCD display what exactly is the status going on. **Advantages:**

- Enhanced safety and comfort for the baby through automated features such as swinging motion, lullaby activation, and environmental monitoring.

Limitations:

- High maintenance cost and maintenance.

[7] DESIGN OF SMART CRADLE FOR INFANT HEALTH MONITORING SYSTEM USING IOT

Authors: MEGHA DANGI, SHRADDHA SARNA, VINOD KUMAR AHUJA

Publication: IEEE-2017

Description: Working parents make an enormous proportion of the workforce. Infants need round the clock care, which is practically impossible, particularly where both the parents are working. In such cases, there is a desire of a sheltered and secure mechanism for the consideration of infants. This issue is genuine and inescapable and for parents whoare adapting to it every day, it might appear to be overwhelming. It expects them to deal with an unending stream of todays, issues and circumstances. At the point when this issue comes out as a matter of great concern today and as the authors see the strains that the parents are confronting, it straightaway brings the sense of being in charge which at that point opens the entryway for some concrete, practical fixes. The smart cradle system is a boon for parents. It is an innovative cradle system that is designed to nurture an infant in aviable and productive manner. It considers all the minute subtleties engaged with child-care. Thus, where parents feel difficult to accomplish both the commitments of work and parenting, the framework is planned to such extent that they take care of infants without being present.

This system uses IOT for an intelligible and coherent child-care that has the ability to monitor the factors like humidity and body temperature, cry detection mechanism and live video surveillance. An instant mobile alert will likewise be sent to the parent if any irregular action is recognized. Thus, where parents feel difficult to accomplish both the commitments of work and parenting, the framework is planned to such an extent that they can take care of infants even without being genuinely present. A smart cradle system for infant care is proposed using the Internet of Things. It fulfills the requirements of working parents who probably will not be available with the infant consistently. The framework assures the parents that the baby is secure. Various features that are integrated with the cradle helps the parents to effectively monitor all the prospective parameters remotely. They will likewise receive an instant notification in case there is any anomaly or irregularity. Hence, the smart cradle system comes as an aid to parents and emerge as a reliable system for infant care.

Advantages:

- The smart cradle system offers a solution to the challenges faced by working parents and provides a sense of security for the well-being of their infants.

Limitations:

- The study does not discuss the cost of implementing the smart cradle system. The study also does not address the potential risks associated with using IoT technology in infant health monitoring.

[8] IOT BASED SMART CRADLE SYSTEM FOR BABY MONITORING

Authors: SURESH GARE, BHUSHAN KIRAN SHAHANE, KAVITA SURESH JORI, SWEETY G

Publication: IEEE-2020

Description: Many of IOT devices are being develop in the IT sector. There are some cradles also, which are built with integration of IOT, but still there are some less feature which could be threat to the health of the babies. As the statistics seen in India or any other industrializing nation that both parents need to go to work and also look after the baby which increases workload on both the parent, it could also affect their professional life and their babies' life. Due to less featured cradle systems and parents busy schedule that are implementing modern day cradle system. 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 baby is crying and simultaneously there is wetness detected then alert will send baby is crying due to wetness.

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 anykind of movement detected by the PIR sensor then alert SMS will send to the parent through the GSM module. If baby is crying and simultaneously there is wetness detected then alert will send as baby is crying due to wetness. Even after the cradle swing to thefive minutes and baby is still crying then there will be high alert will send to the parent. Arduino Uno is one of the most commonly used hardware in the Arduino series. It is low cost, easily available and is quite compact. It has an on-board USB to serial chip so easily load code into the on-board at mega328 controller. This GSM modem has a SIM800A chip and RS232 interface while enables easy connection with the computer or laptop using the USB to Serial connector. SMS can send and receive using AT command. **Advantages:**

- The smart cradle system provides a convenient and efficient way for working mothers to monitor their babies' activities and ensure their safety and well-being.

Limitations:

- The authors have not discussed the cost and feasibility of implementing the smart cradle system. The system may require a significant investment in terms of hardware and software, which may not be affordable for all parents

[9] DESIGN OF SMART CRADLE SYSTEM USING IOT

Authors: GULAM SARWAR, MOHD AMIR, NIKHIL YADAV, PRINCE MEENIA.

Publication: IEEE-2020

Description: From last few decades there is a large migration of people in metro cities in search of better job opportunities (specially women workforce). At present couples who both are working may find it difficult to give proper time and care to their baby. In corona times many people were working from home and it was difficult for them to balance workload and parenting, This put extra burden on parent, Situation aggravates when baby is ill where it require a constant monitoring which results in taking leave from works.This not only affect the career of parent but also put a stress on them so there is a need to reduce burden of monitoring and nurturing on parents. This project is an innovative idea to resolve this problem by developing an automated smart cradle system using IOT to monitor and nurture child in an efficient way. So ought to create an IOT based smart cradle system to assist parent in monitoring of their child regardless of their presence whether they are at work or in home. This cradle system is equipped with an automated swing mechanism which will swing automatically on detection of baby crying sound also it has an certain time limit is to send an notification to the parent if the baby don’t stop crying.

Along with it has a wetness detector to detect the wetness of mattress and send SMS to parent’s phone. A camera is attached at top of the cradle so that parent can have continuous surveillance on their baby. To detect the sound of baby during author need a sound sensor to detect the noise. A sound sensor is a electrical component used to detect the sound present in the near environment. A sound sensor have a microphone(50KHz- 100KHz) and a processing circuitry which converts analog sound waves into electrical signals. This electrical signal act as input to LM393 which is a High Precision Comparator that converts electrical signal into digital signal and send it to output pin. A sound sensor have 3 Pin. When no noise is detected voltage across this pin is High and when noise is detected voltage across this pin becomes low. This pin can be connected to any of the 14 digital pin in arduino. Connect VCC pin of sound sensor to 5V on the arduino and GND pin to ground on arduino, OUT pin to digital pin 7 on the arduino. To detect the sound of baby accurately the authors need to calibrate the sensor by rotating knob or screw present at the top of the sensor, rotating screw in clockwise direction will decrease the sensitivity and rotating in anti clockwise will increase the sensitivity. Once sensor become calibrate to measure the sound of baby when crying accurately connection is done as mentioned above and sound sensor isready to use.

Advantages:

- Efficient monitoring and nurturing of the child, regardless of the parent's presence. Reduction of the burden on working parents by providing continuous surveillance and automated responses to the baby's needs.

Limitations:

- Potential limitations in the accuracy of sensors and automated responses and requiring careful calibration and testing.

[10] INTERNET OF THINGS-BASED BABY MONITORING SYSTEM FOR SMART CRADLE

Author: WAHEB A. JABBAR, HIEW KUET SHANG, SAIDATUL N. I. S. HAMID, AKRAM, A. ALMOHAMMED, ROSAHLIZA M. RAMLI, MOHAMMED A. H. ALI.

Publication: IEEE 2017

Description: At present, female participation in the work force in the industrializednations has greatly increased, thereby affecting infant care in many families. Both parents are required to work due to the high cost of living. However, they still need to look after their babies, thereby increasing workload and stress, especially of the mother. They either send their babies to their parents or hire a baby caregiver while they are working.

Working parents cannot always care for their babies. They either send their babies to their parents or hire a baby caregiver while they are working. Some parents worry about the safety of their babies in the care of others. Thus, they go home to check on their babies during their free time, such as lunch or tea break. A baby monitoring system that can monitor the babies' condition real time is proposed to solve these problems. A baby monitoring system consisting of a video camera and microphone without limitations of coverage. It can send data and immediately notify the parents about urgent situations, thereby shortening the timeneeded to handle such scenarios.

Generally, babies cry because they are hungry, tired, unwell, or need their diaper changed. Sudden Infant Death Syndrome (SIDS) is also known as crib death, because many babies who die of SIDS, are found in their cribs. It occurs to infants younger than 12 months old. Most SIDS deaths younger than 6 months old. Professionals still do not know the causes of SIDS, but risk can be reduced by letting the baby sleep on a firm surface (crib mattress). In addition, the baby should not sleep on a pillow or another a soft surface. The researchers do not know why sleeping on such surfaces increase the risk of SIDS, but they warn that it could be dangerous. For instance, in 2003, a showed that placing an infant to sleep on soft bedding rather than on firm bedding appeared to pose five times the risk of SIDS. Moreover, overheating should be avoided during sleep. Babies should be kept warm during sleep, but the temperature should not be extremely warm. In winter or cold weather, the risk of SIDS increases, because the parents overdress their babies or place them under heavier blanket, thereby overheating them. Therefore, if the room temperature is comfortable for an adult, then it is also appropriate for the baby. Internet of Things (IoT) simply refers to a network of objects that are connected to the internet.

Advantages:

- Real-time monitoring of the baby's vital parameters such as ambient temperature, moisture, and crying.

Limitations:

- The wireless camera used is limited to local network connectivity, restricting remote monitoring when not connected to the same network.

2.1 Comparative Analysis

Table 2.1 Comparative Analysis of Literature Survey

REF. NO	ALGORITHM/ TECHNIQUE	PLATFORM USED	PERFORMANCE METRICS	ADVANTAGE	DRAWBACK
[1]	Smart Cradle: A Sensor-based System for Infant Sleep Monitoring	PID Controller	Stability, Power Consumption	Enhanced sleep quality for infants	Limited adaptability to diverse behaviors
[2]	Fuzzy Logic Control for Smart Baby Cradles	Fuzzy Logic	Comfort, Safety	Customizable Cradle Motion	Higher Computation Power
[3]	Machine Learning Approaches for baby Cradle	Machine Learning	Sleep Quality, User Satisfaction	Adaptive motion based on baby behavior	Privacy concerns with data collection
[4]	Adaptive sway control for baby bassinet.	Artificial metabolic algorithm	Easy sway of the cradle	Control of sway in any situation	Not easy controlled
[5]	Neural Network-Based Adaptive Cradle for Infant Comfort	Neural Network	Heart Rate, Sleep Patterns	Adapts to individual baby needs	Complex training and tuning process.
[6]	Smart baby cradle with robotic parents voice	Sound sensors and pre recorded voice	Stability, Power Consumption	Enhanced safety and comfort	High maintenance cost
[7]	Infant health monitoring system	All health sensors and temperature sensor.	Comfort, Safety	Sense of security	Risk associated with using IoT
[8]	IoT based smart cradle system for baby monitoring	Internet of things for smart monitoring.	Time management of the working parents.	Comfort of the working mother or parents	Cost and feasibility of implementin g the smart cradle.
[9]	Design of smart cradle system using IoT	Sensors fixature for no risk of child.	Easy design for comfort and control of child.	Efficient monitoring and nurturing of child	Potential limitation to accuracy of sensors
[10]	Baby monitoring system.	Neural Network and camera.	Heart Rate, Sleep Patterns, temperature	Real time monitoring of baby vitals.	The wireless camera used is limited.

2.2 Summary of Literature Survey

The literature delves into various aspects of speech processing, including automatic summarization, speaker recognition, real-time meeting analysis, and speech-based life logging, all contributing to the broader field of natural language understanding and human- computer interaction. Speech summarization methods aim to distill key information from spoken content, facilitating efficient review and retrieval, particularly in scenarios where written text is impractical. Speaker recognition techniques leverage speech intelligibility to enhance identification accuracy, benefiting security authentication, forensic analysis, and human computer interaction. Real-time meeting analysis systems employ advanced techniques for speech enhancement, speaker diarization, and topic tracking, facilitating effective communication and collaboration during meetings. Speech-based life logging systems capture and store audio data from daily experiences, creating a rich repository of personal memories and contextual information accessible through searchable text. These advancements drive innovation across domains, enabling more natural and intuitiveinteractions between humans and machines.

CHAPTER 3

SYSTEM ANALYSIS

3.1 Existing system

Existing systems provides a comprehensive analysis of similar systems and technologies that are currently available in the market or have been previously developed. This phase involves conducting a literature review to identify existing systems related to smart cradles, safety devices, and implementable technology. The data gathered from this review is used to understand the current landscape of smart cradle solutions and to identify areas for improvement and innovation. The analysis of existing systems helps in benchmarking the proposed smart cradle project against established products or technologies. By studying the strengths and weaknesses of existing systems, the project team can leverage best practices and address any shortcomings in their design and implementation. Additionally, the review of existing systems aids in identifying potential features, functionalities, or technologies that can be integrated into the new smart cradle to enhance its performance and user experience. Overall, the examination of the existing system is a crucial step in the research and development process of the smart helmet project. It provides valuable insights, informs decision-making, and guides the team in designing a solution that is innovative, effective, and competitive in the market.

3.1.1 Drawbacks

Historically, hardware and software used for baby monitoring systems have faced several drawbacks:

1. **Limited Connectivity**: Previous systems often relied on limited connectivity options, such as traditional radio frequencies or dedicated monitors, which could have range limitations or interference issues, restricting parents' mobility and flexibility.
2. **Lack of Integration**: Many older systems lacked integration with other smart home devices or platforms, limiting their ability to provide a holistic view of the baby's environment or to seamlessly fit into the parents' daily routines.
3. **Inaccurate Sensors**: Earlier sensors might have been less precise or reliable, leading to false alarms or missed events. For example, temperature sensors may not have been as sensitive orresponsive, leading to discomfort for the baby or unnecessary interventions.
4. **Limited Data Analysis**: Historical systems may have lacked sophisticated data analysis capabilities, providing parents with basic alerts but lacking deeper insights into the

Baby’s patterns or trends over time. This could hinder parents' ability to track developmentalmilestones or detect subtle changes in the baby's behavior or health.

5. **High Maintenance**: Some older systems required frequent maintenance or calibration, adding to the burden on parents and increasing the risk of malfunctions or downtime
6. **Privacy and Security Concerns**: Early IoT devices may have had vulnerabilities in terms of data security and privacy, potentially exposing sensitive information about the baby or thefamily to unauthorized access or hacking.
7. **Complexity and User Interface**: Previous systems might have been overly complex to set up or use, with cumbersome user interfaces that could be intimidating or confusing for parents,especially during periods of sleep deprivation or stress.
8. **Cost**: Historically, advanced baby monitoring systems with IoT capabilities may have been prohibitively expensive for many parents, limiting their accessibility and adoption. Addressing these drawbacks is crucial for ensuring the success and widespread adoption of the envisioned IoT-based Smart Cradle.

3.2 Proposed System:

Using new hardware devices such as Arduino Uno and different sensors like DC motors, temperature sensors, and sound sensors, coupled with developing software using embedded C programming and leveraging Telegram for sending alert messages to parents, offers several advantages over historical systems:

1. **Enhanced Connectivity**: Utilizing modern IoT technology allows for more robust and versatile connectivity options, enabling parents to receive alerts and monitor their baby remotely from anywhere with internet access.
2. **Improved Sensor Accuracy**: Newer sensors tend to be more accurate and reliable, providing precise measurements of parameters like temperature and sound levels. This enhances the system's ability to detect changes in the baby's environment and promptly alert parents as needed.
3. **Customizability and Expandability**: With Arduino Uno and embedded C programming, the system can be highly customizable and easily expandable. Parents can tailor the system to their specific needs and preferences, and additional features or sensorscan be integrated as desired.
4. **Real-Time Monitoring and Alerts**: By leveraging Telegram for alert messages, parents can receive real-time notifications on their mobile devices, ensuring they stay informed abouttheir baby's well-being no matter where they are.

5. **Cost-Effectiveness**: Arduino Uno and open-source software tools offer a cost-effective solution compared to proprietary hardware and software options. This makes the system moreaccessible to a wider range of parents, regardless of their budget constraints.
6. **Ease of Use**: Despite the advanced technology involved, the system can be designed with a user-friendly interface, making it intuitive and easy for parents to set up and use without requiring extensive technical knowledge.
7. **Increased Security**: Utilizing modern encryption protocols and secure communication channels, such as Telegram's encryption, helps safeguard sensitive information and protect against unauthorized access or hacking attempts.
8. **Energy Efficiency**: Arduino Uno and other modern microcontroller platforms are designed for energy efficiency, prolonging the system's battery life and reducing the need forfrequent recharging or replacement of batteries.
9. **Community Support and Resources**: Arduino and embedded C programminghave vibrant communities with extensive resources, tutorials, and support forums available.This can facilitate development, troubleshooting, and ongoing maintenance of the system.

Overall, the combination of new hardware devices, advanced sensors, embedded programming, and modern communication platforms offers a powerful and versatile solution for baby monitoring, providing parents with peace of mind and greater convenience in caring for their infant.

3.3 Feasibility Study

A feasibility study is necessary to determine whether the proposed system for Smart cradle system with IoT is feasible in terms of technical, economic, and operational aspects.

3.3.1 Technical Feasibility

1. **Component Availability**: Assess the availability of required components such as Arduino boards, various sensors, hardware modules, software modules, and power suppliesin the market to ensure the feasibility of sourcing necessary hardware for cradle system.
2. **Compatibility Testing**: Conduct compatibility testing to ensure seamless integration and communication between different components of the smart cradle, such as verifying the Arduino's compatibility with the Node MCU module for efficient data processing.
3. **Power Consumption Analysis**: Evaluate the power consumption of the smart cradle system components to determine the feasibility of long-term operation using the specified ensuring that the system can function effectively without frequent replacement.

4. **Signal Strength Assessment**: Test the signal strength and reliability of wireless communication modules like the telegram module to confirm that distress messages can be transmitted successfully to parents in regular and emergency situations, ensuring the system'seffectiveness in critical scenarios.

5. **Sensor Calibration**: Calibrate sensors like the temperature sensor and microprocessor module to optimize their accuracy and responsiveness in detecting various cases and conditions of the baby monitoring ensuring the reliability and precision of the smartcradle’s functionalities.

6. **Software Development**: Evaluate the feasibility of developing and implementing the required software algorithms on the Arduino board for temperature detection, audio tracking, and message generation, ensuring that the system can execute these functions efficiently and accurately.

3.3.2 Operational Feasibility

1. **User Training and Adoption**: Assess the feasibility of providing adequate training and support to users for effectively utilizing the smart cradle system, ensuring that users can easilyunderstand and operate the device to maximize its benefits.

2. **Response Protocols**: Evaluate the feasibility of establishing clear and efficient response protocols for users, responders, and relevant authorities to ensure timely and coordinated actions in case of change in condition or distress situations.

3. **Maintenance and Support**: Determine the feasibility of implementing maintenance procedures and support services for the smart cradle system, including regular checks, software updates, and technical assistance to address any issues and ensure continuous functionality.

4. **Integration with Existing Systems**: Assess the feasibility of integrating the smart cradle system with existing emergency response systems with caregivers, and communication networks to streamline information sharing and response coordination.

5. **Compliance with Regulations**: Evaluate the feasibility of ensuring compliance with relevant safety standards, regulations, and data privacy laws governing the use of smart cradle systems, to mitigate legal risks and ensure ethical responsible operation of the technology.

6. **Scalability and Expansion**: Assess the feasibility of scaling up the smart cradle system to accommodate future enhancements, features, and technological advancements.

7. **User Feedback and Iterative Improvements**: Determine the feasibility of collecting user feedback, conducting usability tests, and implementing iterative improvements based on userexperiences and suggestions to enhance the operational effectiveness, user satisfaction, and overall performance of the smart cradle system.

8. **Sensor Calibration**: Calibrate sensors like the temperature sensor and WiFi module to optimize their accuracy and responsiveness in detecting falls, impacts, and tracking location data, ensuring the reliability and precision of the smart cradle’s functionalities.

3.3.3 Economic Feasibility

Economic feasibility is to check whether the system can be implemented within the budget and the benefits provided by the system justify the costs.

1. **Cost of Hardware and Software**: The cost of the hardware and software components of the system should be reasonable and affordable. The components should be of good quality and provide the necessary functionality for the system.
2. **Installation and Maintenance Costs**: The installation and maintenance costs of the system should be reasonable and affordable. The installation process should be designed to minimize downtime and prevent any damage to the existing infrastructure. Themaintenance costs should be reasonable and should not require excessive resources or expertise.
3. **Operating Costs:** The operating costs of the system should be reasonable and affordable. The costs of electricity, internet connectivity, and other operational expenses should be accounted for.
4. **Life Cycle Costs**: The life cycle costs of the system should be considered. The system should be designed to last for a reasonable amount of time, and the costs of replacement or upgrade should be accounted while determining life cycle costs.
5. **Cost-Benefit Analysis**: A cost-benefit analysis should be conducted to assess the economic feasibility of the system. The costs and benefits of the system should be quantified and compared to determine whether the system is economically feasible.
6. **Return on Investment**: The benefits provided by the system should justify the costs. The return on investment should be reasonable and should provide a clear financial benefit to thefacility.

CHAPTER 4
SYSTEM REQUIREMENT

4.1 Functional Requirements

The functional requirements of the Smart Helmet encompass the features and capabilities necessary for its primary objective – prompt detection and communication of working conditions. These include:

1. **Real-time Data Collection:** The system should collect real-time data on parameters like temperature, wetness, audio etc. using IoT sensors.
2. **Alerts & Notifications:** The system should be capable of generating alerts and notifications when any parameter exceeds threshold limits. These alerts can be sent via telegram bots.
3. **Remote Monitoring & Control:** Web and mobile apps should allow parents/guardianto monitor the controls remotely.
4. **Sensor Management:** The system should facilitate plug-n-play addition of new sensors and calibration, configuration of sensors.
5. **Security**: Access control mechanisms and data activity audits are required to ensure data privacy and system security.
6. **Scalability & Availability:** The system architecture must support scaling up for large hospitalized facilities with high availability.

4.2 NON - FUNCTIONAL REQUIREMENTS

The non-functional requirements define the performance, reliability, and usability aspects of the Smart Cradle. Key non-functional requirements include:

1. **Performance**: The system should demonstrate high performance, ensuring rapid data processing, real-time responsiveness, and minimal latency in delivering insights tousers.
2. **Scalability**: The architecture must be scalable to accommodate the potential growth of cradle operations, allowing for the seamless addition of new sensors and devices without compromising system performance.
3. **Reliability**: The system should be highly reliable, minimizing downtime and ensuring continuous operation. It should withstand potential disruptions and quickly recover from failures to maintain consistent monitoring capabilities.

4. **Availability**: The system must maintain high availability to ensure uninterrupted monitoring. This involves minimizing planned downtime for maintenance and implementing redundancy measures to handle unexpected outages.

5. **Security**: Robust security measures must be in place to safeguard the system against unauthorized access, data breaches, and cyber threats. This includes, secure communication protocols, and authentication mechanisms.

6. **Usability**: The user interface should be intuitive, ensuring ease of use for first time users with varying technical expertise. Usability considerations should be prioritized in the design to enhance user acceptance.

7. **Compatibility**: Works with various other sensors, and common mobile devices.

4.3 HARDWARE REQUIREMENTS

1. Arduino
2. Motor Driver
3. DC Motor
4. Temperature Sensor
5. Sound Sensor
6. Vibration Sensor

4.4 SOFTWARE REQUIREMENTS

1. Arduino IDE
2. Embedded C

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control both physically and digitally. Its products are licensed under the GNU Lesser General Public License (LGPL) or the GNU. General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form or as do-it-yourself (DIY) kits. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

When designing software for a smaller embedded system with the 8051, it is very common place to develop the entire product using assembly code. With many projects, this is a feasible approach since the amount of code that must be generated is typically less than 8 kilobytes and is relatively simple in nature. If a hardware engineer is tasked with designing both the hardware and the software, he or she will frequently be tempted to write the software in assembly language.

Since a C program possesses greater structure, it is easier to understand and maintain. Because of its modularity, a C program can better lend itself to reuse of code from project to project. The division of code into functions will force better structure of the software and lead to functions that can be taken from one project and used in another, thus reducing overall development time. A high order language such as C allows a developer to write code, which resembles a human’s thought process more closely than does the equivalent assembly code. The developer can focus more time on designing the algorithms of the system rather than having to concentrate on their individual implementation. This will greatly reduce development time and lower debugging time since the code is more understandable.

CHAPTER 5

PROJECT DESCRIPTION

5.1 Problem Statement:

In today's fast-paced world, the demands of modern life often collide with the responsibilities of parenthood, leaving many single and working parents overwhelmed and stretched thin. Single parents face the monumental task of raising children solo, shouldering the emotional, financial, and practical burdens of childcare without the support of a partner. Meanwhile, working parents, striving to maintain a delicate balance between career aspirations and family commitments, find themselves caught in a perpetual struggle to juggle competing priorities. Amidst this whirlwind of responsibilities, the care and well-being of infants often become a source of immense stress and worry for parents. The constant need to monitor their baby's safetyand comfort can disrupt the flow of daily life, forcing parents to repeatedly interrupt their tasksto check on their little ones. This relentless cycle of vigilance not only drains their time and energy but also takes a toll on their mental and emotional well-being, leaving them feeling exhausted, anxious, and disconnected from their children.

5.2 Proposed Solution:

Our proposed solution offers a beacon of hope for overwhelmed parents in the form of an Automatic Caretaker Cradle designed to revolutionize the childcare experience. This innovative system harnesses the power of cutting-edge sensor technology and intelligent automation to create a nurturing and responsive environment for infants, providing parents with the peace of mind they crave and the support they desperately need.

At the heart of our solution lies a sophisticated network of sensors strategically positioned throughout the baby's Cradle, capable of monitoring a myriad of environmental variables and infant activities in real-time. These sensors, ranging from temperature and humidity detectors to sound and motion sensors, continuously collect data and relay it to a central microprocessor, which acts as the brain of the system, orchestrating a symphony of responses tailored to the baby's needs and parental preferences.

For single parents, our Automatic Caretaker Room serves as a tireless ally, offering unwavering support and assistance around the clock, without the need for physical presence. Working parents, too, reap the benefits of this ingenious system, as it seamlessly integrates into their busy schedules, alleviating the burden of constant worry and enabling them to focus thereby providing parents with the peace of mind they crave and the support they desperately need.

Key Features and Benefits:

1. **Unprecedented Monitoring**: Parents gain unprecedented insight into their baby's world, with the ability to remotely monitor vital signs, room conditions, and infant activities in real-time, all from the convenience of their mobile devices.

2. **Intelligent Automation**: The system employs advanced algorithms to analyze sensor data and trigger automated responses tailored to the baby's needs, such as adjusting room temperature and humidity levels, activating soothing sounds or lights, and initiating gentle rocking motions to lull the baby to sleep.

3. **Customizable Alerts**: Parents receive customizable alerts and notifications, allowing them to stay informed about their baby's status and intervene promptly if needed, whether they are at home, at work, or on the go.

4. **Time and Energy Efficiency**: By eliminating the need for constant physical checks, the system saves parents valuable time and energy, enabling them to reclaim precious moments for themselves and their families, while still ensuring the highest standard of care for their infants.

5. **Strengthened Parent-Child Bonding**: By providing caregivers with deeper insights into their baby's behavior and needs, the system fosters a stronger bond between parents and children, promoting trust, communication, and emotional connection.

In conclusion, our Automatic Caretaker Room represents a paradigm shift in childcare, offering a lifeline to single and working parents struggling to navigate the complexities of modern parenthood. With its blend of cutting-edge technology and compassionate design, we aim to empower parents to embrace their roles with confidence and grace.

5.3 Overview of the project:

This project is centered around a sophisticated baby monitoring system that leverages the versatility of Telegram Bots to provide real-time updates to caregivers about their baby's condition. The system utilizes a suite of sensors that continuously measure various environmental and physiological parameters such as temperature, humidity, and noise levels within the baby's vicinity. Audio sensors are employed to monitor sounds, and when crying is detected, the system triggers a gentle swaying motion of the cradle to soothe the baby. If the crying persists despite the cradle's motion, the system sends an alert through a Telegram Bot directly to the parents or caregivers' mobile devices, informing them of the baby’s distress. A temperature sensor is provided in the cradle which tell the wellbeing of the baby.

The temperature regulation feature of the system adds another layer of monitoring, where the sensors compare the baby's body temperature with the ambient room temperature. If a discrepancy is found, and the baby's body temperature does not align with the room temperature, the system assesses the situation and either activates a DC fan to cool the environment or turns on a heater to provide warmth, depending on the need.

The Telegram Bot plays a crucial role in this ecosystem by acting as a bridge between the sensor system and the caregiver. It facilitates seamless communication and instant notification, making it easier for caregivers to monitor the baby’s environment remotely and respond more quickly to changes. This is particularly beneficial in scenarios where direct observation is not always possible, providing caregivers peace of mind knowing that they will be promptly alerted to any issues.

Overall, this smart monitoring system is designed to enhance infant care through automated technological solutions, using real-time data and responsive actions to maintain optimal conditions. The use of Telegram Bot for notifications ensures that caregivers are always in the loop and can intervene when necessary, thereby potentially reducing the risk of discomfort or health issues for the baby. This project not only highlights the integration of IoT in daily life but also showcases how technology can be used to improve the quality of care in sensitive environments such as those involving infants and young children. The potential for future enhancements could include features like video streaming, more nuanced environmental controls, or even AI-driven predictions about the baby's needs based on behavioral patterns, making it a scalable and evolving tool in the realm of childcare technology.

5.4 Design Methodology

The process of design involves “conceiving and planning out in mind and making a drawing, pattern or a sketch”. The system design transforms the logical representation of what a given system is required to do into the physical reality during development. Design factors and design constraints such as reliability ,cost, hardware limitations should be taken into account. The task as to provide complete specification of the workable system

5.4.1 SYSTEM ARCHITECTURE

System architecture for an IoT-based baby cradle monitoring system encompasses a network of interconnected devices and components designed to ensure the safety and well-being of infants while providing peace of mind for parents or caregivers.

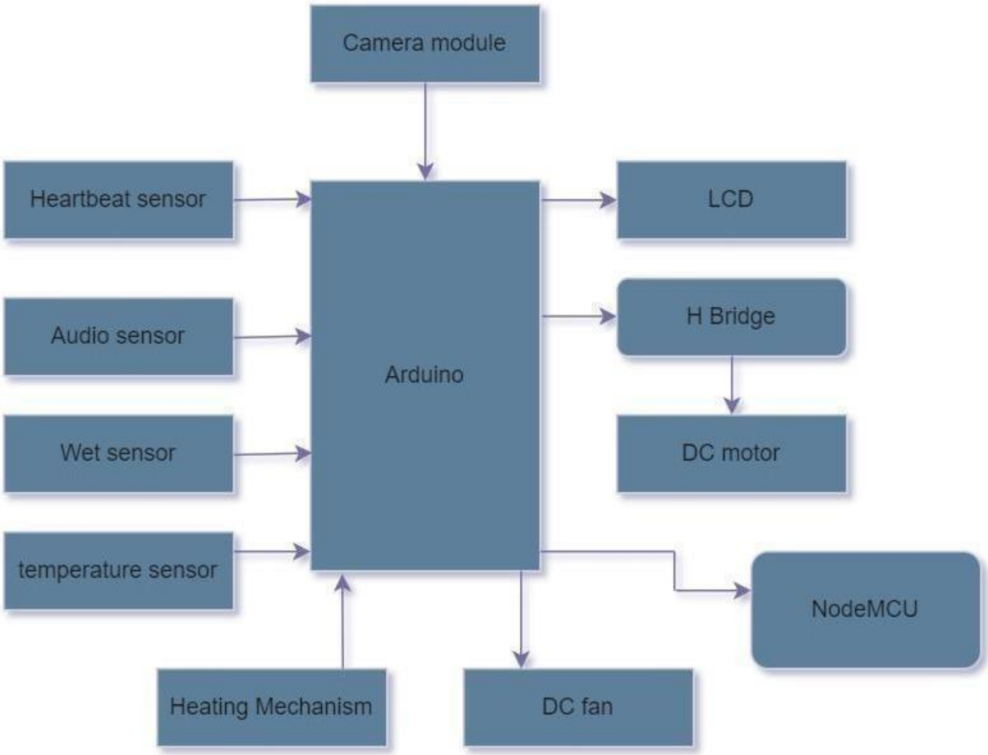


Fig 5.1 System Architecture

Fig 5.1 describes the system architecture as follows:

1. The system is microcontroller based that is being designed is aimed to help parents and nurses in infant care.
2. System starts playing mothers voice automatically when baby cry and stops till the baby stops crying.
3. A sound detector is interfaced to the controller which senses sound when baby cries and activates the controller with its digital output.
4. A temperature sensor kept under the bottom cover where the baby sleeps can sense the temperature all time and sends analog signals to the inbuilt ADC of the Arduino controller.
5. The digital data can be continuously monitored. A reduction in temperature indicates the wetness in the cover. The controller can be made to activate an alarm, so that his/her cover be changed.
6. Sounds an alarm if baby cries for more than a stipulated time indicating that baby needs attention.

5.4.2 DATA FLOW DIAGRAM

The data flow diagram illustrates the flow of information within the Smart Cradle system, showcasing how data is processed, transmitted, and utilized. The diagram outlines the sequential steps from detection to emergency response:

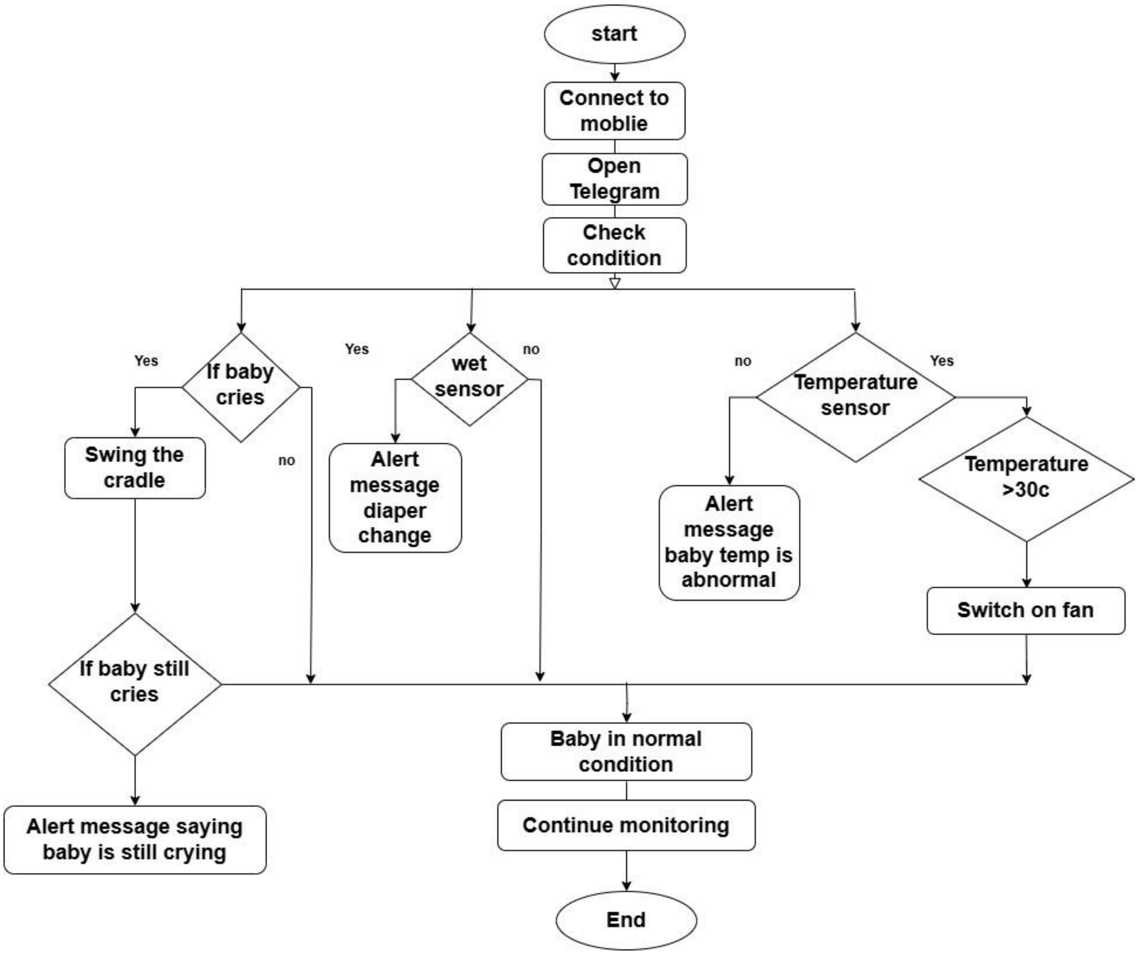


Fig 5.2 Data flow diagram for working condition

Fig 5.2 describes that the process begins by reading data from various sensors, which measure parameters such as temperature, wetness level etc. This data is then transmitted to Telegram Cloud, a platform for data acquisition and analysis. The audio sensor will constantly check if the baby is crying or not. If the condition is true then the swaying motion of the cradle will be the process, else if the baby still cries after the swaying after a period of time a temporary message is sent via telegram to alert the parents. The wet sensor is used to check the dampness, if moisture of certain level exist then the parents are alerted for necessary condition. The sensor also monitors the temperature of the baby. If the body temperature is not same as the room temperature then alert is sent and condition of baby surrounding condition is checked.

5.4.3 USE CASE DIAGRAM:

To create a use case diagram for the scenario describing a smart cradle, which involves an intelligent baby monitoring and cradle swaying system, we need to identify the primary actors and the use cases based on the interactions you've outlined. Here's a breakdown before we draw the diagram:

Actors

1. **Parent**: Receives alerts and monitors the baby remotely.
2. **Baby**: The one whose conditions (crying, temperature, wetness) are monitored.
3. **System (Automated Cradle)**: Monitors the baby and performs actions based onsensor input.

Use Cases

1. **Monitor Temperature**: System checks baby’s body temperature against room temperature.
2. **Adjust Temperature**: System activates either the heater or the fan based on the temperature difference.
3. **Monitor Crying**: Audio sensors detect if the baby is crying.
4. **Sway Cradle**: Activate the cradle's swaying motion if the baby is crying.
5. **Monitor Wetness**: Wet sensors check the dampness of the baby's environment.
6. **Send Alerts**: Send notifications to parents via Telegram if the baby cries beyond a set period, the temperature is inappropriate, or wetness is detected.
7. **Receive Alerts**: Parents receive updates and alerts about the baby's condition.

The Use Case Diagram shows a simplified visual form showing the actors, use cases, and their interactions and the diagram will visually depict the system (cradle) as the central actor interfaced withsensors.

1. The Parent and the Baby as external actors who interact with the system.
2. Connections will show which actor initiates which use cases and how the system responds.
3. Sensors capture environmental data and send it to the Arduino UNO.
4. The Arduino processes the data and sends relevant alerts to the Telegram application.
5. The Telegram application authenticates users, generates message IDs with timestamps, and notifies the parents. Parents can interact with the system, receiving alerts and monitor.

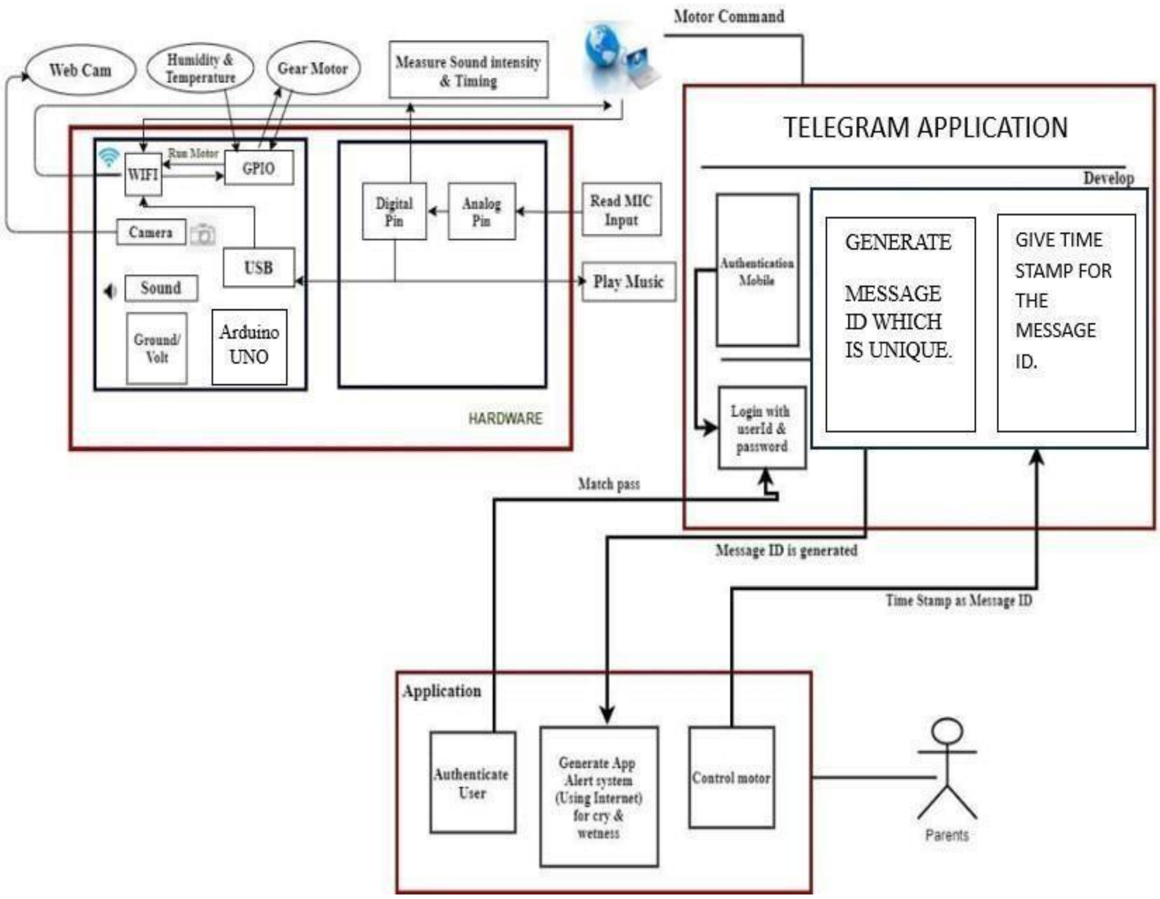


Fig 5.3 Use case diagram for the entire system.

Fig 5.3 gives the use case diagram for the actors and use cases and shows an overall working for the cradle.

The use case diagram illustrates the functionality of an IoT-based smart cradle system tailored for baby monitoring. Acting as the central component, the Automated Cradle System integrates sensors to monitor environmental factors and vital signs, enabling continuous assessment of the baby's well-being. Through Telegram integration, the system promptly alerts parents of any abnormalities, ensuring timely intervention. Additional features such as adjusting temperature, detecting crying, and remote monitoring further enhance the system's capacity to provide comprehensive care, facilitating peace of mind for caregivers while optimizing infant comfort and safety.

The use case diagram showcases the sophisticated capabilities of the IoT-based smart cradle system, emphasizing its ability to monitor various aspects of the baby's environment and health while enabling remote monitoring and timely interventions. By leveraging advanced technology and seamless communication channels like Telegram, this system enhances parental care and ensures the well-being of infants with efficiency and convenience.

CHAPTER 6
MODULE DESCRIPTION

6.1 SOFTWARE MODULE:

A program written in C is easier to read than an assembly program. By using a language like C, the programmer does not have to be intimately familiar with the architecture of the processor. This means that someone new to a given processor can get a project up and running quicker, since the internals and organization of the target processor do not have to be learned. Additionally, code developed in C will be more portable to other systems than code developed in assembly. Many target processors have C compilers available, which support ANSI C. All of this is not to say that assembly language does not have its place. In fact, many embedded systems (particularly real time systems) have a combination of C and assembly code. For time critical operations, assembly code is frequently the only way to go. One of the great things about the C language is that it allows you to perform low-level manipulations of the hardware if need be, yet provides you the functionality and abstraction of a higher order language. Embedded C Programming Language, which is widely used in the development of Embedded Systems, is an extension of C Program Language. The Embedded C Programming Language uses the same syntax and semantics of the C Programming Language like main function, declaration of datatypes, defining variables, loops, functions, statements, etc. The extension in Embedded C from standard C Programming Language include I/O Hardware Addressing, fixed point arithmetic operations, accessing address spaces, etc. There is actually not much difference between C and Embedded C apart from few extensions and the operating environment. Both C and Embedded C are ISO Standards that have almost same syntax, datatypes, functions, etc. Embedded C is basically an extension to the Standard C Programming Language with additional features like Addressing I/O, multiple memory addressing and fixed-point arithmetic, etc. C Programming Language is generally used for developing desktop applications whereas Embedded C is used in the development of Microcontroller based applications.

6.2 APPLICATION MODULE:

Application module uses Bots as third-party applications that run inside Telegram. Users can interact with bots by sending them messages, commands and inline requests. You control your bots using HTTPS requests to our Bot API. To name just a few things, you could use bots to do the following:

1. Get customized notifications and news. A bot can act as a smart newspaper, sending relevant content as soon as it's published.
2. Integrate with other services. A bot can enrich Telegram chats with content from external services.
3. Gmail Bot, GIF bot, IMDB bot, Wiki bot, Music bot, Youtube bot, GitHub bot.
4. Accept inputs from Telegram users. A bot can offer paid services or work as a virtual storefront.
5. Create custom tools. A bot may provide you with alerts, weather forecasts, translations, formatting or other services.
6. Markdown bot, Sticker bot, Vote bot, Like bot are a few examples.
7. Build single- and multiplayer games. A bot can offer rich HTML5 experiences, from simple arcades and puzzles to 3D-shooters and real-time strategy games.
8. Build social services. A bot could connect people looking for conversation partners based on common interests or proximity.

At the core, Telegram Bots are special accounts that do not require an additional phone number to set up. Users can interact with bots in two ways:

1. Send messages and commands to bots by opening a chat with them or by adding them to groups. This is useful for chat bots or news bots like the official TechCrunch bot.
2. Send requests directly from the input field by typing the bot's @username and a query. This allows sending content from inline bots directly into any chat, group or channel.

Messages, commands and requests sent by users are passed to the software running on your servers. Our intermediary server handles all encryption and communication with the Telegram API for you. You communicate with this server via a simple HTTPS-interface that offers a simplified version of the Telegram API. We call that interface our Bot API.

6.3 SENSOR MODULE:

In the realm of IoT, sensors play a crucial role in collecting data from the physical world and transmitting it to IoT devices or platforms for analysis and decision-making. Various types of sensors are employed in IoT applications, each designed to measure specific physical or environmental parameters.

6.3.1 Node MCU:

Node MCU is an open source LUA based firmware developed for ESP8266 wifi chip.The ESP8266 is a low-cost Wi-Fi chip developed by Espress if Systems with TCP/IP protocol.

For more information about ESP8266, you can refer ESP8266 WiFi Module. There is Version2 (V2) available for NodeMCU Dev Kit i.e. NodeMCU Development Board v1.0 (Version2), which usually comes in black colored PCB.

The NodeMCU is a low-cost, open-source IoT platform that incorporates an ESP8266 WiFi module, making it ideal for connecting various devices to the internet, including an Arduino board. In projects like the baby monitoring system where messages need to be sent through Telegram, the NodeMCU serves as the communication bridge between the Arduino and the internet. Here's how the NodeMCU can be used to connect an Arduino board to send messages through Telegram:

1. Connecting NodeMCU with Arduino:

- Hardware Setup: Connect the NodeMCU to the Arduino via serial communication (using UART) or through digital I/O pins if a more complex interaction is needed. The connection allows the Arduino to send commands to the NodeMCU and receive data from it.
- Power Supply: Ensure both the Arduino and the NodeMCU are powered appropriately, keeping in mind that NodeMCU operates at 3.3V, unlike some Arduino boards which operateat 5V

2. Setting Up the WiFi Connection:

- Programming the NodeMCU: Use the Arduino IDE or other development environments compatible with the ESP8266. Program the NodeMCU to connect to a WiFi network by incorporating the SSID and password into the code.
- Network Communication: Once connected to the WiFi, the NodeMCU can communicate over the internet. It can send HTTP requests or use other communication protocols required by the application.

3. Integrating with Telegram:

- Telegram Bot: Create a Telegram bot using BotFather on Telegram. This bot will provide an API token that is used to send messages.
- Programming for Telegram: Write code on the NodeMCU that uses the Telegram Bot API to send messages. This typically involves making HTTPS requests to the Telegram API with the bot token and the message content.
- Bot Commands: The NodeMCU can be programmed to listen for commands from the Telegram API and perform actions or send alerts accordingly.

4. Communicating with Arduino:

- Sending Commands: Based on the sensor data and the programmed conditions (e.g., if the baby cries or the temperature deviates from a set range), the Arduino sends specific commandsto the NodeMCU.
- Sensor Data: The Arduino, equipped with various sensors (like temperature, humidity, audio), gathers environmental data and processes it.
- NodeMCU Actions: Upon receiving commands from the Arduino, the NodeMCU triggerspredefined actions like sending alert messages through the Telegram bot

5. Running the System:

- Continuous Monitoring: The system operates continuously, with the Arduino monitoring sensors and the NodeMCU maintaining a WiFi connection to send alerts via Telegram.
- Feedback Loop: Optionally, caregivers can send commands back through Telegram to control the system or request real-time updates, which the NodeMCU relays back to the Arduino for any required actions.

This setup leverages the strengths of both the Arduino and the NodeMCU, where Arduino excels in handling sensor interactions and NodeMCU in handling network communications and protocols, creating a powerful and interactive IoT system for baby monitoring or similar applications.

Fig 6.1 Node MCU

In Fig 6.1 by exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. NodeMCU Dev Kit/board consist of ESP8266 wifi enabled chip.

6.3.2 Temperature sensor

Measure ambient temperature and are used in applications like smart homes, agriculture, and industrial processes. The LM35 does not require any external calibration or trimming to provide typical accuracies.

Integrating an LM35 temperature sensor with an Arduino is a straightforward process that allows you to measure ambient temperature with reasonable accuracy. The LM35 sensor is an analog temperature sensor that outputs a voltage linearly proportional to the Celsius temperature. Here’s how to connect and program an LM35 temperature sensor with an Arduino:

Wiring the LM35 to Arduino

1. Identify the Pins: The LM35 has three pins:

- VCC (connected to 5V on Arduino)
- Output (connected to an analog input on Arduino)
- GND (connected to ground on Arduino)

2. Connect the LM35 to Arduino:

- Connect the VCC pin of the LM35 to the 5V output on the Arduino.
- Connect the GND pin of the LM35 to one of the GND pins on the Arduino.
- Connect the Output pin of the LM35 to an analog input pin on the Arduino (e.g., A0).

Fig 6.2 Temperature Sensor

Fig 6.2 shows the LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

6.3.3 Wet detection sensor:

Soil moisture sensor consist of two conducting plates which function as a probe and acting as a variable resistor together. When the sensor is inserted into the water, the resistance will decrease and get better conductivity between plates. Soil moisture sensor has two conducting plates. First plate is connected to the +5Volt supplythrough series resistance of 10K ohm and second plate is connected directly to the ground. It simply acts as a voltage divider bias network, and output is taken directly from the first terminal of the sensor pin, which is shown in figure above. The output will change in the range of 0 – 5 Volt, in proportion with change in content of water in the soil. Ideally, when there is zero moisture in soil, the sensor acts as open circuit i.e. infinite resistance. For this condition, we get 5V at the output.

Specification of Moisture Sensor

- Operating Voltage: The voltage range is 3.3V to 5V.
- Operating Current: 15mA
- Output Type: The type of output that the sensor generates, such as analog voltage ordigital signals.
- Connectivity: The type of connector or interface that the sensor uses to connect to thecontroller or computer.
- IC Used: LM393 IC is used as a comparator.
- Indicator: Two LED Indicators are used one for Power and one for Output

This is an easy to use digital moisture sensor. In Fig 6.3 it gives a digital output of 5V when moisture level is high and 0V when the moisture level. In this project this sensor is used for detecting baby bed wet condition. The sensor includes a potentiometer to set the desired moisture threshold. When the sensor measures more moisture than the set threshold, the digital output goes high and an LED indicates the output. When the moisture in the soil is less then the set threshold, the output remains low.The digital output can be connected to a micro controller to sense the moisture level. The sensor also outputs an analog output which can be connected to the ADC of a micro controller to get the exact moisture level in the solid.

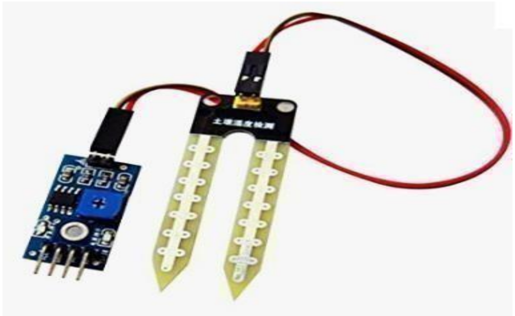


Fig 6.3 Wet detection sensor

Fig 6.3 Shows the wet detection sensor which helps in detecting the wetness level of the baby in the cradle

6.3.4 Audio sensor

A sound sensor is a simple, easy-to-use, and low-cost device that is used to detect sound waves traveling through the air. Not only this but it can also measure its intensity and most importantly it can convert it to an electrical signal which we can read through a microcontroller.

The Sound sensor module has 4 pins VCC, GND, Digital Out, and Analog Out. We can either use the AO pin as an output for analog reading or the DO pin as an output for digital readout. The Sound sensor pinout is as follows:

- VCC: It is the power supply pin of the Sound Sensor that can be connected to 3.3V or 5V of the supply. But note that the analog output will vary depending upon the provided supply voltage.
- GND : It is the ground pin of the Sound Sensor module and it should be connected to the ground pin of the Arduino.
- DOUT: It is the Digital output pin of the board, low output indicates that no sound is detectedby the sensor, and high indicates that the sensor has detected sound.
- AOUT: It is the Analog output pin of the board that will give us an analog reading directly from the Sound sensor.

The main component of a sound sensor is a microphone. There are many different types of microphones, like Carbon Microphone, Fiber Optic Microphone, Ribbon Microphone, and Laser Microphone, but the sound sensor module we are using has a condenser microphone. An image of the sound sensor module is shown below,

Fig 6.4 Sound sensor

Fig 6.4 displays the sound sensor which helps to turn on the speaker after a specific decibel of sound is produced.

The condenser microphone consists of two charged metal plates. The first plate is called the diaphragm and the second plate is the backplate of the microphone. These two plates together form a capacitor. When a sound wave hits the diaphragm of the microphone the diaphragm starts to vibrate, and the distance between the two plates changes. The movement of the diaphragm and the change in spacing produces the electrical signal that corresponds to the sound that's picked up by the microphone and this signal then gets processed by the onboard op-amp. This module also has two built-in onboard LEDs, one of which lights up when power is applied to the board and the other one lights up when the incoming audio signal exceeds the threshold value set by the potentiometer.

Connecting the Sound Sensor to the arduino microcontroller is really simple. The sensor outputs an analog signal and it's easy to process the signal. We can use the ADC of the Arduino to process the signal and we can light up some LEDs to show the intensity of the sound received by the microcontroller. The connection of the circuit is also very simple, we have just connected the VCC and ground from the Arduino board to the sensor module and we have used GPIO2 to GPIO6 to connect the LEDs. The ground is common in between LEDS and the Sensor.

6.3.5 Arduino Uno

The Arduino Uno is a compact yet powerful microcontroller board designed for electronics prototyping and DIY projects. Featuring the Atmega328P microcontroller, it boasts 14 digital input/output pins, 6 analog input pins, and various communication interfaces, including USB, UART, SPI, and I2C.

It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board. Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

Fig 6.5 Arduino Uno

Fig 6.5 gives an visualization of Arduino uno which controls the main aspect of the system.

Key Components

- ATmega328 Microcontroller- It is a single chip Microcontroller of the ATmel family. The processor code inside it is of 8-bit. It combines Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internalinterrupts, and oscillator.

- ICSP pin - The In-Circuit Serial Programming pin allows the user to program using the firmware of the Arduino board.

- Power LED Indicator- The ON status of LED shows the power is activated. When the poweris OFF, the LED will not light up.

- Digital I/O pins- The digital pins have the value HIGH or LOW. The pins numbered from D0 to D13 are digital pins.

- TX and RX LED's- The successful flow of data is represented by the lighting of these LED's.

- AREF- The Analog Reference (AREF) pin is used to feed a reference voltage.

- Reset button- It is used to add a Reset button to the connection.
- USB- It allows the board to connect to the computer. It is essential for the programming of the Arduino UNO board.
- Crystal Oscillator- The Crystal oscillator has a frequency of 16MHz, which makes the Arduino UNO a powerful board.
- Voltage Regulator- The voltage regulator converts the input voltage to 5V.
- GND- Ground pins. The ground pin acts as a pin with zero voltage.
- Vin- It is the input voltage.
- Analog Pins- The pins numbered from A0 to A5 are analog pins. The function of Analog pins is to read the analog sensor used in the connection. It can also act as GPIO (General Purpose Input Output) pins.

Technical specifications of the Arduino UNO:

- There are 20 Input/Output pins present on the Arduino UNO board. These 20 pins include 6PWM pins, 6 analog pins, and 8 digital I/O pins.
- The PWM pins are Pulse Width Modulation capable pins.
- The crystal oscillator present in Arduino UNO comes with a frequency of 16MHz.
- It also has a Arduino integrated WiFi module. Such Arduino UNO board is based on the Integrated WiFi ESP8266 Module and ATmega328P microcontroller.
- The input voltage of the UNO board varies from 7V to 20V.
- Arduino UNO automatically draws power from the external power supply. It can also drawpower from the USB.

Integration with arduino:

The integration of sensors and modules with Arduino Uno involves establishing a seamless connection between the microcontroller and the various input/output devices. Arduino Uno, a popular open-source platform, facilitates this integration through its versatile pin configuration.

CHAPTER 7

SYSTEM IMPLEMENTATION

7.1 Introduction

The implementation of the IoT-based Smart Cradle for Baby Monitoring System represents a comprehensive endeavour that seamlessly integrates cutting-edge technologies to revolutionize cradle operations. This system leverages the power of the Internet of Things (IoT), sensor networks, and machine learning algorithms, creating a robust and intelligent solution for monitoring, and optimizing Smart Cradle.

The implementation process commences with the strategic deployment and integration of specialized sensors capable of measuring critical parameters such as temperature, wetness, crying, and humidity. The Arduino UNO efficiently transmits data from the sensor nodes to the telegram platform while implementing secure communication protocols and gateways to safeguard data privacy and integrity.

At the core of the system lies a scalable and secure platform, responsible for data processing, storage, and analysis. This platform seamlessly integrates machine learning models and predictive algorithms, enabling sophisticated analysis of incoming data and generating actionable insights. The development and training of these machine learning models leverage historical data, enabling the identification of patterns, detection of anomalies, and forecasting of potential changes.

The system's implementation also involves the design and development of a user-friendly interface accessible through web and mobile applications. Intuitive dashboards and visualizations are meticulously crafted to facilitate real-time monitoring of parameters and system status, empowering parents with a comprehensiveunderstanding of their child condition. Furthermore, the integration of alert and notification systems ensures thatparents are promptly informed of potential issues or deviations from optimal conditions, enabling timely interventions.

Scalability and flexibility are paramount considerations in the implementation process, ensuring that the IoT-based Smart Cradle for Baby Monitoring System can seamlessly integrate with existing Cradle management systems or third-party applications, while accommodating future growth and expansion of Smart Cradle operations. Rigorous testing of the system components is conducted to ensure optimal performance reliability.

The successful deployment of the system in the target parents facilities is accompanied by the establishment of comprehensive maintenance protocols and procedures, encompassing system updates, sensor calibration, and troubleshooting measures. Throughout the implementation process, adherence to best practices, industry standards, and regulatory requirements is paramount, ensuring the system's reliability, security, and compliance.

By leveraging the synergistic integration of IoT, sensor networks, cloud computing, and machine learning algorithms, the IoT-based Smart Cradle for Baby Monitoring System empowers parents with real-time data, predictive analytics, and intelligent decision support, enabling them to optimize environmental conditions, enhance operational efficiency, and promote sustainable practices in their Smart Cradle operations.

Table 7.1 Threshold Value of The Parameter

Parameter	Threshold Value
Temperature	25°C -35°C
Humidity	1023 NTU
DC Motor	30 RPM
Sound	80 db(A)

Table 7.1 outlines the threshold values for key parameters in the Baby Cradle monitoring system. These values serve as reference points to assess the health and condition of the child. For temperature, the acceptable range falls between 25°C to 35°C, ensuring optimal conditions for aquatic organisms. Wetness, indicating wetness level, should ideally remain within the range of 1023 NTU. DC motor , a measure of rotation speed, is deemed suitable when it ranges from 30 RPM . Sound levels, are considered balanced within the range of 80 decibels. These threshold values provide a basis for monitoring and managing baby condition in Smart Cradle management systems.

7.2 Hardware Implementation

Cradle monitoring is crucial for various applications, including infant safety, health monitoring, and ensuring a comfortable environment for babies. Ensuring the well-being and safety of infants requires continuous monitoring of various parameters that can affect their health and comfort. This project aims to develop a comprehensive baby monitoring system that can measure and analyze multiple parameters in real-time.

The proposed system incorporates a network of sensors designed to monitor various parameters essential for ensuring the safety and well-being of infants in smart cradles. These sensors are equipped to measure crucial metrics such as temperature, humidity, motion, and sound levels within the vicinity of the cradle. By continuously monitoring these parameters, caregivers can gain valuable insights into the environmental conditions surrounding the baby.

The hardware setup for this project consists of the following main components:

- Sensors (Temperature, sound, wetness)
- Arduino UNO
- Node MCU
- Power Supply
- Wifi Module
- Speaker and recorder.
- Camera
- DC Fan

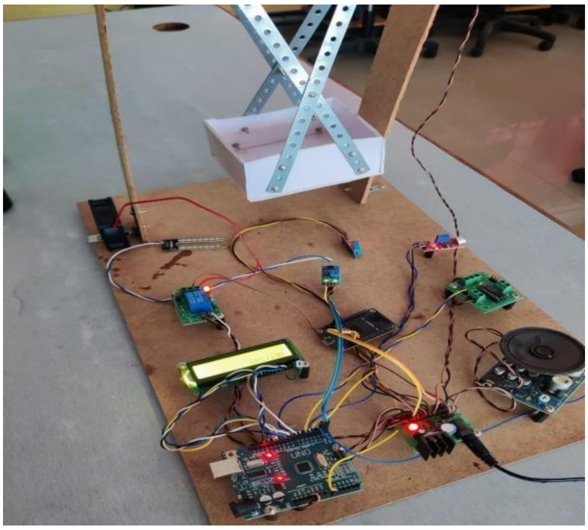


Fig 7.1 Hardware Setup for IoT based Smart Cradle for Baby Monitoring System

The Fig 7.1 shows a hardware setup for IoT based Smart Cradle for Baby monitoring system. The setup consistsof various sensors connected to a microcontroller board (likely an Arduino UNO) through wires. The sensors include temperature, sound, and wetness sensors, which are designed to measure different parameters of cradle.

The temperature sensor constantly monitors the ambient temperature around the baby. This data is crucial for ensuring the baby's comfort and safety. Whereas the sound sensor detects and measures the noise levels in the vicinity of the cradle.

The wetness sensor is designed to detect moisture or wetness in the baby's diaper or surrounding area. It helps caregivers monitor the baby's diaper status and prevent discomfort or skin irritation caused by prolonged exposure to wetness.

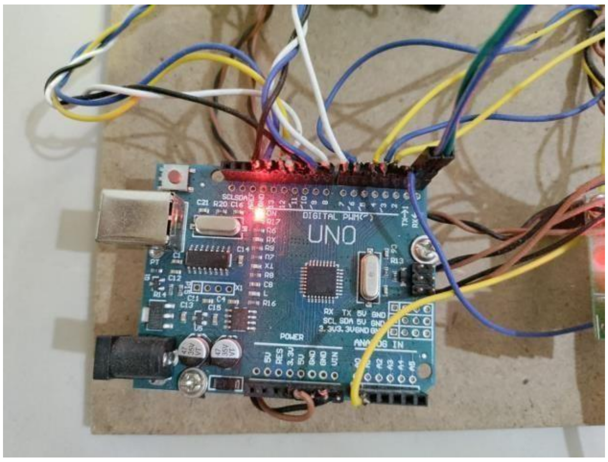


Fig 7.2 Arduino UNO

The data collected by these sensors is sent to the Arduino UNO in Fig 7.2 microcontroller board, which can process and transmit the data wirelessly or to a connected device for further analysis or display. The setup also includes a power supply unit to provide the necessary power to the components.

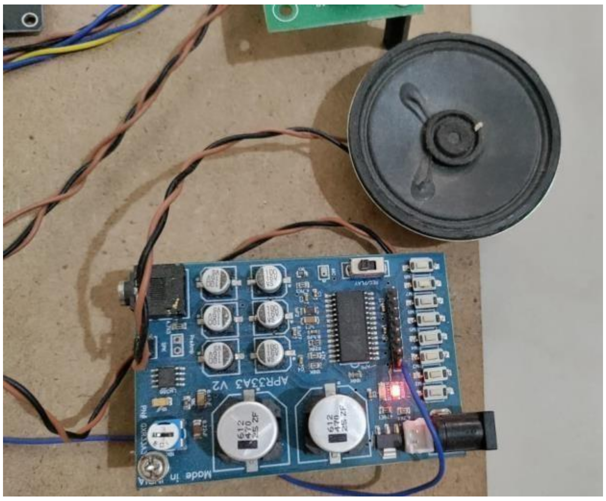


Fig 7.3 Speaker and Recorder

The speaker and recorder in Fig 7.3 enhance the cradle's functionality significantly. The speaker plays soothing sounds, lullabies, enabling parents to comfort their baby remotely. The recorder captures audio, that is to be played. This integration provides a comprehensive monitoring system, ensuring the baby's comfort, safety, and well-being through continuous audio interaction and data analysis.

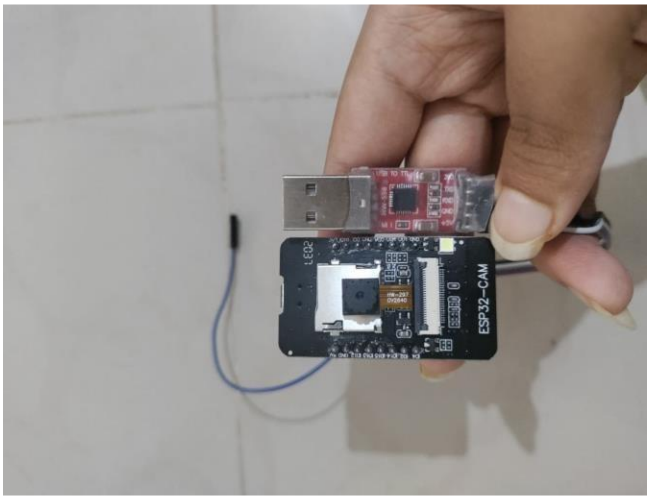


Fig 7.4 ESP32 Camera Module

The ESP32 camera module in Fig 7.4 plays a crucial role. It provides real-time video streaming, allowing parents to visually monitor their baby’s activities and well-being from anywhere through a mobile or web application. Additionally, recorded footage can be stored and reviewed to analyze sleep patterns and ensure the baby's safety. This integration offers parents peace of mind with continuous visual monitoring and enhanced security for their baby.

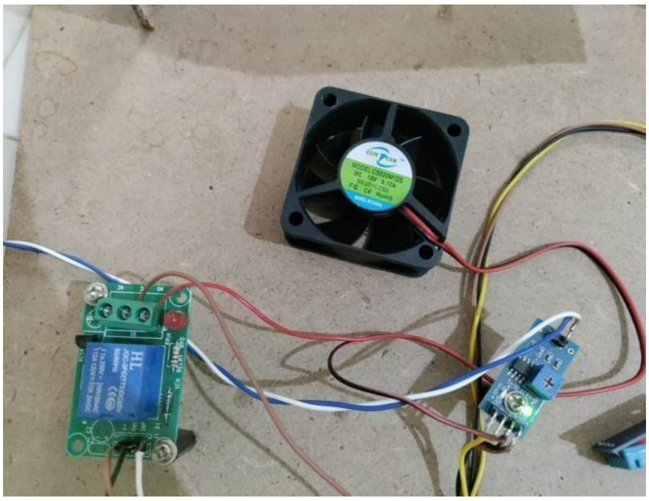


Fig 7.5 DC Fan

Fig 7.5 represents a DC fan that serves a vital purpose. It regulates the cradle’s temperature, ensuring the baby remains comfortable and safe during sleep. Integrated with temperature sensors, the fan activates automatically to maintain optimal conditions, preventing overheating or discomfort. Moreover, it improves air circulation, reducing the risk of suffocation and promoting better sleep quality for the baby. This feature enhances the overall functionality of the smart cradle.

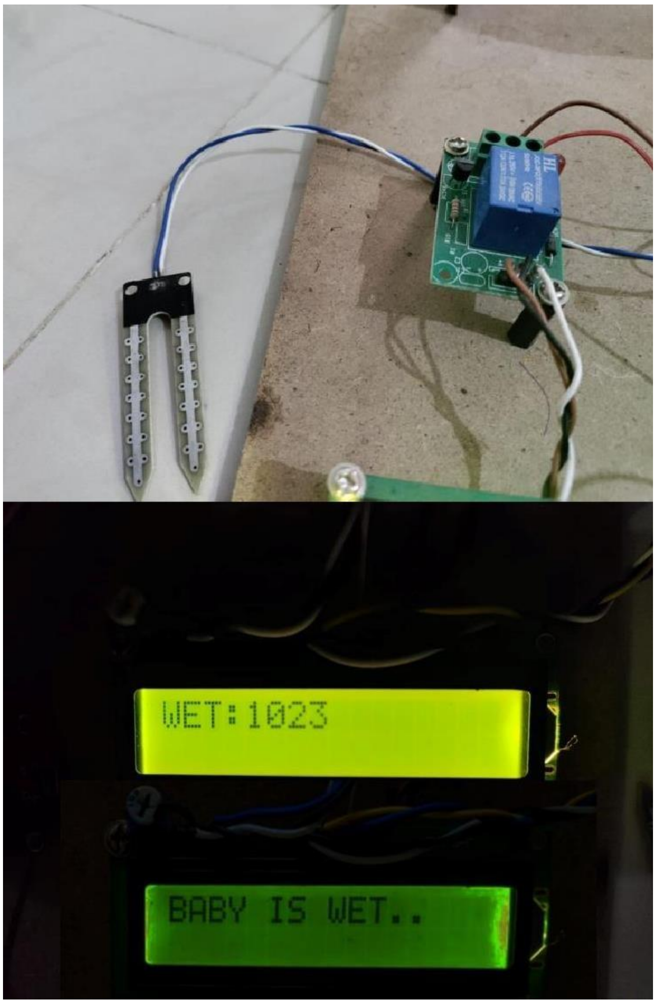


Fig 7.6 Wetness Detection Sensor

The wetness detection sensor in Fig 7.6 plays a critical role in ensuring the baby's comfort and hygiene. Integrated into the cradle's mattress, the sensor detects moisture levels, alerting parents when the baby's diaper needs changing.

By providing timely notifications like “Baby is wet” as shown in the second Figure the wetness sensor enables Parents to attend to the baby's needs promptly, maintaining a clean and dry environment essential for the baby's well-being. The Wet: 1023 is the threshold amount of the sensor, if the value is below that level than a notification is sent via telegram to the parents.

This feature helps prevent discomfort, irritation, and potential skin problems caused by prolonged exposure to wetness. This integration enhances the functionality of the smart cradle, offering convenience and peace of mind for parents while prioritizing the baby's comfort and hygiene.

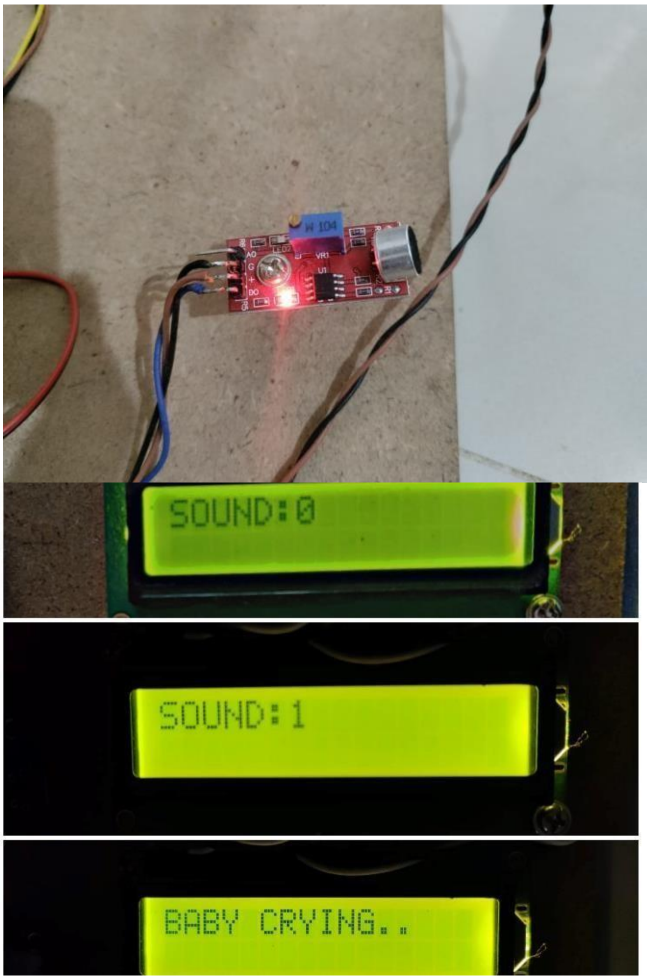


Fig 7.7 Sound Detection Sensor

As represented in Fig 7.7 the sound detection sensor is a key component for ensuring the baby's safety and well-being. Positioned within the cradle, it continuously monitors the surrounding environment for sounds, particularly the baby's cries or distress signals.

Upon detecting such sounds, the sensor triggers alerts to notify parents or caregivers, the notification received is “Baby Crying” enabling them to promptly attend to the baby's needs. The Sound 0 is the default condition, whereas the Sound:1 is the condition when an sound is detected. This feature provides reassurance to parents, allowing them to monitor their baby's status even from a distance.

By offering real-time monitoring and alerts, the sound detection sensor enhances the functionality of the smart cradle, fostering a safer and more responsive caregiving experience.

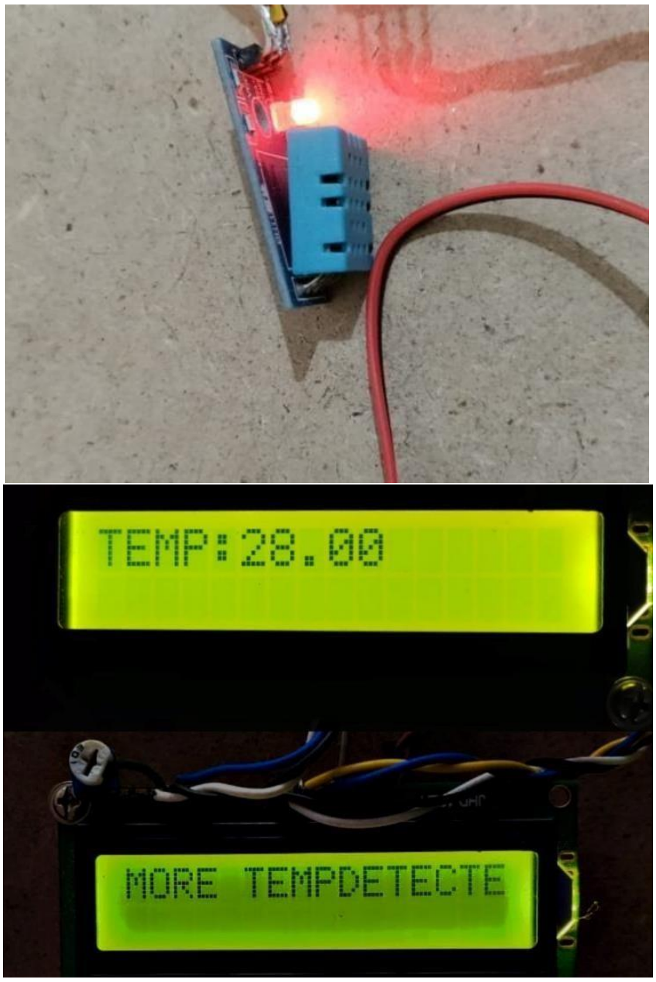


Fig 7.8 Temperature Sensor

The temperature sensor as shown in Fig 7.8 is a critical component for ensuring the baby's comfort and safety. Integrated into the cradle, it continuously monitors the ambient temperature, ensuring it remains within a safe and comfortable range for the baby.

If the temperature deviates from the preset threshold, the sensor triggers alerts to notify parents or caregivers as a message “More Temperature”, prompting them to take necessary actions such as adjusting the room temperature or clothing the baby accordingly. This feature provides peace of mind to parents, knowing that their baby's environment is constantly monitored, and enables timely interventions to maintain optimal conditions.

By offering real-time temperature monitoring and alerts, the temperature sensor enhances the functionality of the smart cradle, creating a safer and more comfortable sleeping environment for the baby.

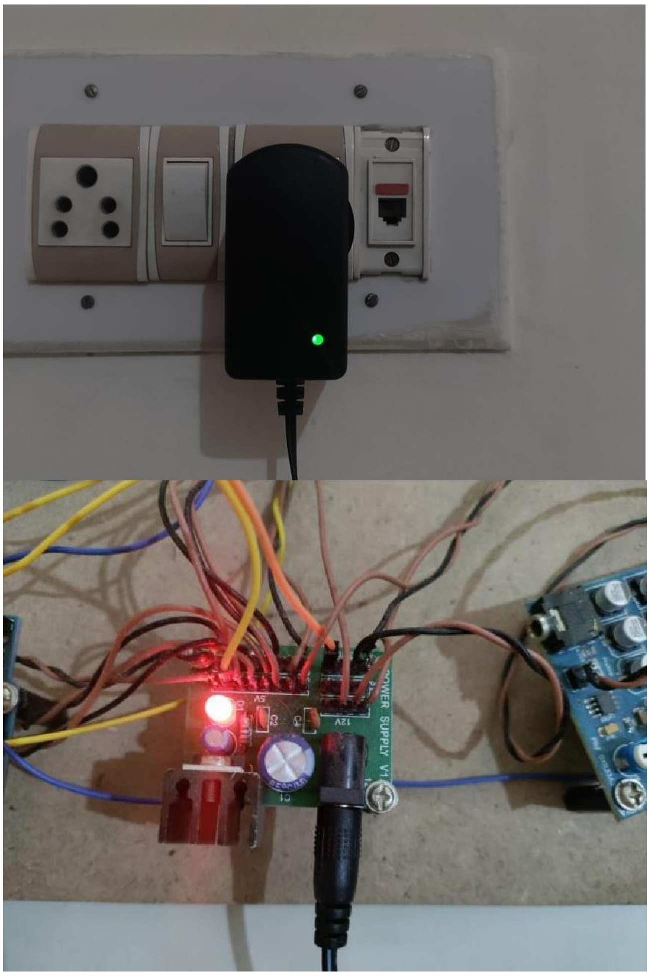


Fig 7.9 Power Supply

As represented in Fig 7.9 the power supply serves as the backbone, ensuring continuous operation of the system. It provides reliable electrical power to all components, including sensors, actuators, and communication modules, ensuring uninterrupted monitoring and functionality.

This power supply is often designed with safety features such as surge protection and backup batteries to mitigate potential risks of power fluctuations or outages. By maintaining a stable power source, the system ensures constant monitoring of the baby's environment, enabling caregivers to respond promptly to any changes or emergencies. This integral component ensures the reliability and effectiveness of the smart cradle, supporting its role in enhancing baby care and parental peace of mind.

7.3 Software Implementation

The IoT based Smart Cradle for Baby monitoring system leverages Telegram, a popular messaging platform, for real-time data visualization and analysis. Telegram acts as an interface for displaying the sensor data collected from the cradle.

Within the Telegram platform, dedicated channels or bots have been created for each critical parameter, such as temperature, sound, and wetness. These channels/bots display real-time data in the form of interactive messages, photos, and videos, enabling users to monitor the trends and fluctuations in these parameters over time.

Fig 7.10 Telegram Dashboard for Smart Cradle Monitoring

Fig 7.10 displays two separate messages showing the real-time monitoring of different notification in an Smart Cradle setup using Telegram, an IoT platform. Each image represents the variation of a specific work.

- Field 1 Shows the different notifications and alert the parent receive whenever there is any changes in the smart cradle or condition of the baby.
- Field 2 presents the live streaming and live photo of the child when the parents need or notification is received.

These notification provide real-time visualization of the parameters essential formaintaining optimal conditions in an Smart Cradle. Such continuous monitoring enables parents to quickly identify any deviations from desired levels and take necessary actions to ensure the health and productivity of the baby

The web application seamlessly integrates with Telegram, allowing users to access and visualize the sensor data directly from the application's interface. This integration ensures a seamless experience, enabling users to monitor the baby conditions without the need to navigate between multiple platforms.

The IoT-based Smart Cradle for Baby monitoring System features a comprehensive web application designed to provide parents with a centralized platform for monitoring and managing their operations. Developed using modern web technologies, including HTML and CSS the web application offers a responsive and intuitive user experience across various devices and platforms.

A key feature of the web application is the real-time sensor data visualization interface which displays live data from various sensors monitoring critical parameters such as temperature, sound, and wetness. Furthermore, The IoT-based Smart Cradle for Baby Monitoring System incorporates a comprehensive baby wellness assessment feature. This feature presents key health and environmental parameters measured in the baby’s surroundings. Based on these values, the system provides an overall assessment of whether the conditions are suitable for the baby. This empowers parents and caregivers to take timely actions to maintain optimal conditions, ensuring the baby's health and comfort.

CHAPTER 8

SYSTEM TESTING

System testing is a crucial part of any project to ensure that it meets the desired requirements and functions correctly. For IoT-based Smart Cradle for Baby Monitoring System, there are several components that need to be tested to ensure their proper functioning.

8.1 Tests Conducted

8.1.1 Hardware Testing

Hardware testing for the IoT-based Smart Cradle for Baby Monitoring System involves testing the individual components and the system to ensure that they are functioning correctly and as intended.

The testing process involves the following steps:

- **Testing Temperature sensor:** Testing the temperature sensor in the smart cradle is essential to ensure accurate and reliable monitoring of the baby's conditions. To validate its performance, the temperature sensor undergoes rigorous testing procedures.Firstly, the sensor is immersed in water baths set to known temperatures, covering the expected operating range of the cradle environment. This allows for comprehensive testing across various temperature levels. The measured values from the sensor are thencompared against those obtained from high-precision reference thermometers, serving as benchmarks for accuracy assessment. Any disparities between the sensor readings and the reference values are carefully analyzed to identify potential calibration requirements. By conducting thorough testing procedures, the smart cradle's temperature sensor can be verified to deliver precise and dependable temperaturemonitoring, ensuring optimal comfort and safety for the baby.
- **Testing Wetness Detection Sensor:** Testing the wetness detection sensor in the smart cradle is vital to ensure accurate and reliable monitoring of the baby's hygiene and comfort. To validate its performance, the wetness sensor undergoes rigorous testing procedures. Initially, the sensor is exposed to simulated wet conditions, mimicking scenarios where the baby's diaper may become moist. Various moisture levels are introduced to the sensor, covering a range of potential wetness levels the cradle may encounter. The sensor's response to these simulated conditions is carefully monitored and recorded. Next, the sensor is tested in real-world scenarios,

where it detects wetness from actual diaper usage. The sensor's performance in these practical situations is evaluated to assess its reliability and responsiveness. Any discrepancies between the sensor's readings and expected outcomes are thoroughly investigated to identify potential calibration needs or sensitivity adjustments

- **Testing Sound Sensor:** Testing the sound sensor in the smart cradle is essential to ensure accurate and reliable detection of the baby's cries and environmental noises. The testing process involves several key steps to validate its performance. Initially, the sensor undergoes controlled testing in a controlled environment with calibrated sound sources emitting various frequencies and amplitudes. This allows for assessing the sensor's sensitivity and response across different sound levels. Additionally, the sensor is tested in realistic scenarios, where it detects the baby's cries and other relevant sounds within the cradle environment. The sensor's ability to distinguish between different sound types and its responsiveness to sudden changes in sound levels are carefully evaluated. Furthermore, the sensor is subjected to noise interference tests to determine its immunity to external disturbances.
- **Testing ESP32 Camera Module:** Testing the ESP32 camera module in the smart cradle is crucial to ensure reliable and high-quality video streaming for monitoring the baby's activities. The testing process involves several key steps to validate its performance. Initially, the camera module undergoes functionality testing to ensure that it can capture and transmit video footage effectively. This includes verifying its ability to initialize, capture images or video, and transmit data over the network. Next, the camera module is tested for image quality and resolution across various lighting conditions to ensure clear and sharp video output.
- **Testing DC Motor**: Testing the DC motor in the smart cradle is essential to ensure smooth and safe operation, providing gentle rocking motions to soothe the baby. The testing process involves several critical steps to validate its performance. Initially, the motor undergoes functionality testing to ensure it can start, stop, and change direction as intended. This includes verifying its responsiveness to control signals from the cradle's central system. Next, the motor is tested for torque and speed across various voltage levels to determine its capacity to provide gentle rocking movements without causing discomfort to the baby. Additionally, the motor's power consumption and heat dissipation are monitored to ensure efficient energy usage and prevent overheating. Integration testing is then conducted to ensure seamless communication between the motor and the cradle's control system.

8.1.2 Software Testing

Software testing is an important part of the development process to ensure that the software functions as expected and meets the user requirements. In the case of the Smart Cradle Baby monitoring system, the software includes the code that runs on the Arduino UNO microcontroller and the application that the user interacts with.

The software testing process typically involves the following steps:

- **Unit Testing**: Individual units or modules of the software, such as sensor data acquisition, data processing, prediction algorithms, and user interface components, can be tested independently to verify their correct functionality and behaviour.
- **Integration Testing:** After unit testing, the different modules and components can be integrated and tested together to ensure proper communication and data flow between them, as well as to identify any interface-related issues or compatibility problems.
- **System Testing:** The complete Smart Cradle monitoring system, including hardware(sensors) and software components, can be tested as a whole to validate its end-to- end functionality, performance, and compliance with the specified requirements.
- **User Acceptance Testing (UAT):** Potential end-users or stakeholders can be involved in testing the system to ensure that it meets their expectations and requirements, and to identify any usability or user experience issues.
- **Load and Performance Testing:** The system can be subjected to simulated real-world load conditions to assess its performance, response times, and ability to handle multiple concurrent users or data streams.
- **Security Testing:** Depending on the system's architecture and deployment, security testing can be conducted to identify and mitigate potential vulnerabilities, ensuring data privacy and system integrity.
- **Regression Testing**: After making changes or enhancements to the system, regression testing can be performed to ensure that previously working features or functionalities have not been adversely affected by the modifications.
- **Compatibility Testing:** The Smart Cradle monitoring system can be tested on different hardware platforms, operating systems, and web browsers (for the user interface) to ensure compatibility and consistent behavior across various environments.

8.2 Test Cases

Table 8.1 Test cases for Smart Cradle Baby Monitoring System

ID	Description	Expected Output	Actual Output	Remarks
1	Data Collection	Temperature, sound and Moisture data is collected from the sensors	Same as expected	Pass
2	Transfer Data	Collected data is sent to telegram	Same as expected	Pass
3	Obtain Output	Arduino collects the status of the baby and specifies the condition	Same as expected	Pass
4	Send alert	If baby condition is not optimal, user receives the message	Same as expected	Pass
5	Temperature Sensor	Baby temperature ranges from 25°C -35°C	Less than 25°C and more than 35°C	Pass - Baby temperature is beyond threshold Range. Send alert
6	Sound Sensor	Crying sound level ranges from 40dB-80dB	More than 80dB	Pass– Audio level beyond threshold range. Send alert
7	Fan	To be turned on when the temperature exceeds the threshold	Greater than threshold value	Pass-turns off after 10 seconds
8	DC motor	Run the motor at certain rotations per minute	25 rpm to 30 rpm	Pass – Motor works in the threshold range.

9	Moisture sensor	Substrate detects the presence of wetness	1023 NTU	Fail- Sensor does not detect wetness below threshold value
10	Lullaby recording	Record music and generate sound on speaker	Range between 30dB to 40 db	Fail- Speaker generates noise beyond threshold
11	NodeMCU	Real-time monitoring and updating messages	Range between 0 feet to 50 feet	Fail- Wifi connectivity gets disabled beyond threshold

Table 8.1 provide the analysis regarding the test cases. It provides a comparison between the actual and expected outputs. It can be said that the IOT based Smart Cradle for Baby Monitoring system performed reasonably well on the test cases.

Each step corresponds to a specific task, such as data collection, data transfer to the cloud, data processing, prediction of status, sending alerts to the user and sensors. For each task, the expected output is compared with the actual output, and a remark is provided to indicate whether the task has passed or failed. The table serves as a systematic evaluation framework for assessing the functionality and reliability of the system.

By systematically evaluating each step in the workflow and comparing expected versus actual outcomes, users can gain insights into the system's reliability, efficiency, and functionality. It enables users to identify areas of improvement, troubleshoot issues, and ensure that the system operates effectively under different conditions.

CHAPTER 9

SUMMARY

The IoT-based baby cradle monitoring system is a revolutionary solution that leverages smart technology to enhance the safety and well-being of infants during sleep. Integrating a range of sensors such as accelerometers and temperature sensors, the system captures vital data regarding the baby's movements and the surrounding environment. This information is transmitted wirelessly to a central hub or cloud platform, facilitating real- time monitoring for parents or caregivers through an intuitive mobile app or web interface. One of the system's standout features is its intelligent alert system, which promptly notifies caregivers of any anomalies or potential risks, ensuring a quick response to the baby's needs. Moreover, the system enables remote control of the cradle, allowing adjustments to rocking speed and other settings, enhancing convenience for parents. With its emphasis on real-time monitoring, alerts, and user-friendly controls, the IoT-based baby cradle monitoring system presents a comprehensive and secure solution for modern parents, providing them with valuable insights into their baby's sleep patterns and fostering a sense of confidence in their experience. Concluding the development of an intelligent baby monitoring and cradle swaying system encompasses reflecting on the achievements, challenges, and the overall impact of the project

9.1 Achievements of the smart cradle project:

1. **Innovative Integration of Technology**: The project successfully integrates multiple sensors and systems to monitor and respond to a baby's needs in real-time, offering a high degree of automation in baby care.

2. **Enhanced Safety and Comfort for Infants**: By monitoring temperature, wetness, and crying, and by automatically adjusting the environment or alerting parents, the system enhances the safety and comfort of infants.

3. **Remote Monitoring Capability**: The use of the Telegram Cloud for alerts allows parents to stay informed about their baby’s condition from anywhere, providing peace of mind.

4. **Complexity in Integration**: Combining hardware and software components into a seamless and reliable system posed significant challenges, especially concerning real-time data processing and response.

5. **Ensuring Reliability and Safety**: Developing a system that is consistently reliable and safe for use with infants required rigorous testing and validation to meet safety standards.

9.2 Impacts of the Smart cradle:

1. **On Parents**: The system offers parents a new level of interaction with and monitoring of their baby’s well-being, potentially reducing anxiety for new parents and those with special-needs infants.
2. **On Market**: The introduction of such a technology-driven solution in the baby care market could lead to higher standards of care and innovation, pushing further advancements in infant care technologies.
3. **Safety and Security**: IoT-based smart cradle systems can provide parents with real-time updates on their baby's vital signs, sleep patterns, and environment conditions, enhancing the safety and security of infants. Alerts can be sent to parents' smartphones or other devices in case of any abnormalities, such as irregular breathing or sudden changes in temperature, allowing for immediate intervention if necessary.
4. **Convenience and Peace of Mind**: These systems enable parents to remotely monitor their baby from anywhere with internet access, offering convenience and peace of mind. Whether they are at work, traveling, or simply in another room of the house, parents can check on their baby's well-being without physically being present, reducing stress and enabling them to focus on other tasks or responsibilities.
5. **Data-Driven Insights**: By collecting and analyzing data on the baby's sleep patterns, feeding habits, and other relevant metrics, IoT-based smart cradles can provide valuable insights to parents and healthcare professionals. These insights can help identify trends, detect potential health issues early on, and inform decisions regarding the baby's care and development.
6. **Parental Engagement and Bonding**: The ability to interact with the smart cradle system, such as adjusting settings, playing soothing music, or remotely comforting the baby through built-in cameras or speakers, fosters parental engagement and bonding. Parents feel more connected to their baby's daily routine and development, strengthening the parent-child relationship.

CHAPTER 10

CONCLUSION AND FUTURE WORK

10.1 CONCLUSION

Baby monitoring system helps in monitoring the baby without direct help from any human in the times of busy working schedule for both the parents. The baby monitoring system is equipped with live video relay to the parents, so that, in case of exceptions, the parents or the guardian can act accordingly. The baby monitoring system utilized the entire proximity of the room cradle space to ensure that the baby is safe from any external elements. This system is equipped with the various sensor to endure the safety of the baby and make the parents aware of what happening around the baby. This system overcomes from the drawbacks faced in the existing system and also given additional features. If anything happens message will be sent to the parents. By this parent will be stay updated about the baby. This helped to stop baby from crying and prevented from getting scared. Room temperature and humidity is also get monitored and displayed. Which ensure that room is ideal for the baby to feel comfort and relaxed. If baby cries it is detected and plays a song or any audio clip, this helped baby to calm down. Web camera helps us to monitor the activity of the baby. This makes us stay connected to the baby. The room condition is checked for the comfortable for the baby. All the sensors attached in the system is checks the room condition and the detect condition of the room and baby. This helps the baby from getting any problem and also helps the parents to stay updated about the baby and its condition. This makes the working parents to feel free and stress free. The project's success lays the foundation for a promising future where wearable technology plays a pivotal role in shaping a more efficient and responsive emergency healthcare system.

10.2 FUTURE ENHANCEMENTS

- **Integration with AI**: Applying machine learning algorithms to predict the baby's needs based on behavior patterns could enhance the system's responsiveness and personalize care.

- **Expansion of Monitoring Capabilities**: Future versions could include additional sensors for health metrics like heart rate or oxygen saturation, providing a more comprehensive health monitoring system.

- **On Future Developments**: This project lays the groundwork for future integrations with more advanced technologies like AI and machine learning, which could offer predictive insights into baby health and development patterns.

To further enhance the intelligent baby monitoring and cradle swaying system, several future improvements can be considered. These enhancements focus on expanding capabilities, improving user experience, and integrating cutting-edge technologies to offer more comprehensive care and insights. Here are some potential future enhancements:

1. Advanced Health Monitoring

- Integration of Additional Sensors: Incorporate sensors to monitor the baby's heart rate, oxygen levels, or breathing patterns. This can provide early detection of potential health issues.

2. Improved User Interface and Interaction

- Customizable Mobile App: Develop a more intuitive and customizable app that allows parents to set preferences, receive tailored advice, and interact more effectively with the monitoring system.
- Voice-Control Integration: Integrate voice-controlled assistants like Amazon Alexa or Google Assistant to allow hands-free operation and updates, making it easier for parents to interact with the system during busy times.

3. Data Security and Privacy Enhancement

-Enhanced Encryption Methods: Implement state-of-the-art encryption techniques for transmitting and storing data to ensure privacy and security.

4. Global Standard Compliance

- International Certification: Pursue certifications like CE, FCC, and others necessary for international markets to ensure compliance with global safety and operational standards.
- Multi-language Support: Provide support for multiple languages in the system’s user interface to cater to a global customer base.

5. Eco-Friendly and Sustainable Design

- Sustainable Materials: Use environmentally friendly materials in the manufacturing of the cradle and monitoring devices.
- Energy Efficiency Improvements: Enhance the system’s energy efficiency to minimize its environmental impact and reduce operational costs.

Implementing these enhancements would significantly increase the value of the baby monitoring system, providing deeper insights into infant care, greater ease of use, and improved adaptability to various environments and user needs.

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APPENDIX A

A1. SOURCE CODE 1

```
#include <LiquidCrystal.h>
const int rs = 13, en = 12, d4 = 10, d5 = 11, d6 = 9, d7 = 8;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
#include<dht.h>
#define dht_dpin 3
dht DHT;
int fan=7;
int sound=4;
int Voice=2;
#define IN1 6      // left motor
#define IN2 5    // left motor
int i=0;
void setup()
{
  Serial.begin(9600);
  lcd.begin(16,2);
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(sound,INPUT);
  pinMode(A0,INPUT);
  pinMode(fan, OUTPUT);
  pinMode(Voice,OUTPUT);
  digitalWrite(Voice,HIGH);
  digitalWrite(fan,LOW);
  digitalWrite(IN1,LOW);
  digitalWrite(IN2,LOW);
      Serial.begin(9600);
//      lcd.begin(16, 2);
      lcd.print("BABY CRADLE..");
      delay(1000);
      while(1)
```

```
      {
        digitalWrite(Voice,LOW);
        delay(1500);
        digitalWrite(Voice,HIGH);
        delay(1000);
      }
}
void loop()
{
   SOUND_MONITOR();
   delay(1000);
   TEMP_MONITOR();
   delay(1000);
   WET_MONITOR();
   delay(1000);
 }
void TEMP_MONITOR()
{
      DHT.read11(dht_dpin);
  Serial.print("Temperature");
  Serial.print(DHT.temperature);
  Serial.print("C");
  Serial.println(" ");
  lcd.clear();
  lcd.print("TEMP:");
  lcd.print(DHT.temperature);
  delay(1000);
  if(DHT.temperature>32)
  {
  digitalWrite(fan,HIGH);
  lcd.clear();
  lcd.print("MORE TEMP");
  lcd.print("DETECTED..");
  Serial.print("$More Temperature#");
  Serial.println();
```

```
  delay(1000);
 }
 else
 {
  digitalWrite(fan,LOW);
 }
}
void WET_MONITOR()
{
  int WET_val=analogRead(A0);
// WET_val=1023-WET_val;
  lcd.clear();
  lcd.print("WET:");
  lcd.print(WET_val);
  Serial.print("WET:");
  Serial.println(WET_val);
  delay(1000);
  if(WET_val<700)
  {
    lcd.clear();
    lcd.print("BABY IS WET..");
    Serial.println("$Baby is Wet#");
//    CRADLE_START();
  }
}
void SOUND_MONITOR()
{
  int Sound_val=digitalRead(sound);
  lcd.clear();
  lcd.print("SOUND:");
  lcd.print(Sound_val);
  Serial.print("SOUND:");
  Serial.println(Sound_val);
  delay(1000);
  if(Sound_val==HIGH)
```

```
  {
    lcd.clear();
    lcd.print("BABY CRYING..");
    Serial.println("$Baby Crying...#");
    CRADLE_START();
  }
}
void CRADLE_START()
{
   digitalWrite(Voice,LOW);
  for(i=0;i<2;i++)
  {
    digitalWrite(IN1,HIGH);
    digitalWrite(IN2,LOW);
    delay(300);
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,LOW);
    delay(300);
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,HIGH);
    delay(300);
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,LOW);
    delay(300);
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,HIGH);
    delay(300);
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,LOW);
    delay(300);
    digitalWrite(IN1,HIGH);
    digitalWrite(IN2,LOW);
    delay(300);
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,LOW);
```

```
delay(300);
  }
  digitalWrite(Voice,HIGH);
  STOP();
}
void STOP()
{

    digitalWrite(IN1,LOW);
    digitalWrite(IN2,LOW);

}
```

A2. SOURCE CODE 2

```
#include<ESP8266WiFi.h>
#include<WiFiClientSecure.h>
#include<UniversalTelegramBot.h>
#include<ArduinoJson.h>
const char* ssid = "PROJECT";
const char* password ="123456789";
//  with your network credentials
// Initialize Telegram BOT
#define BOTtoken "7078922754:AAHKuVEUxkUrDlt88TQeOzXZBoBVCtAyGlA" //
your Bot Token (Get from Botfather)
// Use @myidbot to find out the c"hat ID of an individual or a group
// Also note that you need to click "start" on a bot before it can
// message you
#define CHAT_ID "2042845213"
X509List cert(TELEGRAM_CERTIFICATE_ROOT);
WiFiClientSecure client;
UniversalTelegramBot bot(BOTtoken, client);
char Start_buff[70];
int i,z;
char ch;
```

```
int str_len;
 char textmessage[20];
 String text;
void MESSAGE_SEND();
void WAITING();
void setup()
{
   // initialize the Serial
   Serial.begin(9600);
   Serial.println("Starting TelegramBot...");
   configTime(0, 0, "pool.ntp.org");      // get UTC time via NTP
  client.setTrustAnchors(&cert); // Add root certificate for api.telegram.org
  // Attempt to connect to Wifi network:
  Serial.print("Connecting Wifi: ");
  Serial.println(ssid);
  WiFi.mode(WIFI_STA);
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
   Serial.print(".");
   delay(500);
  }
  Serial.println("");
  Serial.println("WiFi connected");
  Serial.print("IP address: ");
  Serial.println(WiFi.localIP());
//  bot.sendMessage(CHAT_ID, "Bot started up", "");
   bot.sendMessage(CHAT_ID, "Baby Craddle");
}
void loop()
{
  WAITING();
}
void MESSAGE_SEND()
{
```

```
  bot.sendMessage(CHAT_ID, "SEND START TO CONTINUE");
  // myBot.sendMessage(msg_sender_id1, "WELCOME TO ATM");


}
char Serial_read(void)
{
      char ch;
      while(Serial.available() == 0);
      ch = Serial.read();
      return ch;
}
void WAITING()
{
   Serial.println("WAIT");
  buffer_clear();
// msg.text[0]='\0';
//       msg.text[1]='\0';
//        msg.text[2]='\0' ;
//        msg.text[3]='\0';
//         msg.text[4]='\0';
//          msg.text[5]='\0';
 while(1)
 {
      if (Serial.available() > 0)
      {
         //Serial.println("halo")
          while(Serial_read()!='$');
          i=0;
          while((ch=Serial_read())!='#')
          {
            Start_buff[i] = ch;
             i++;
          }
          Start_buff[i]='\0';
```

```
 }
      Serial.println(Start_buff);
      bot.sendMessage(CHAT_ID, Start_buff);

delay(100);
   //      if((Start_buff[0]=='F'))
   //      {
   //       //Serial.println(Start_buff);
   //            bot.sendMessage(CHAT_ID, Start_buff);
   //           delay(100);
   //           Waiting_for_Response();
   //      }
   //       if((Start_buff[0]=='A'))
   // {
   //  String one = "Accident Occured AT:https://www.google.com/maps/?q=";
   //      String two = "," ;
   //      String message = one +"12.9219513" +two + "77.564949";

   // // Convert String to char array
   // int str_len = message.length() + 1;
   // char textmessage[str_len];
   // message.toCharArray(textmessage,str_len);
   // Serial.println(textmessage);
   // bot.sendMessage(CHAT_ID,textmessage);
   // delay(100);
    // }
      }
   }
   void buffer_clear()
   {
     for(z=0;z<60;z++)
     {
       Start_buff[z]='\0';
   //    textmessage[z]='\0'
```

```
  }
}
void buffer1_clear()
{
  for(z=0;z<5;z++)
  {
   text[z]='\0';
  }
}
void Waiting_for_Response()
{
  buffer1_clear();
  while(1)
  {
      int numNewMessages = bot.getUpdates(bot.last_message_received + 1);

      while (numNewMessages)
      {
        Serial.println("got response");
       handleNewMessages(numNewMessages);
        numNewMessages = bot.getUpdates(bot.last_message_received + 1);
      }
  }

}
void handleNewMessages(int numNewMessages)
{
  Serial.print("handleNewMessages ");
  Serial.println(numNewMessages);
  for (int i = 0; i < numNewMessages; i++)
  {
    String chat_id = bot.messages[i].chat_id;
    String text = bot.messages[i].text;
Serial.print(text);
```

```
//    if (text == "1234")
//    {
//
////      Serial.println("*1234#");
////      delay(1000);

////      WAITING();
//    }
  }
// numNewMessages=0;
// buffer1_clear();
}
```