OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

Design of IoT Based Smart Cradle for Infants

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Abstract: This project aims to assist mothers who are overburdened and do not have a cleaning professional or sitter to care for their children. It includes a side-to-side rocking action that relaxes and soothes the infant. Parents must use considerable effort to physically rock the cradle in order to induce swinging motion. When the infant is kept in the cradle, the parents must constantly monitor him or her to keep track of the baby's activity. The suggested concept of this smart cradle prototype will allow the cradle to be efficiently integrated. All of the sensors and hardware components will be assembled using an Arduino microcontroller. The infant within the cradle will be constantly monitored. If any action occurs, such as urinating or a baby waking up from sleep, an SMS message will be sent to the parent's mobile.

The Smart cradle will also include other characteristics such as autonomously swaying the infant using a geared motor system. In addition, certain further features, such as a PCB for sensing moist conditions, will be included to improve the cradle's efficiency. The cradle is ideal for parents who are unable to spend their entire day at home sitting next to their new-born. This cradle may also be used in a maternity hospital as an aid to the workers who are in charge of the baby's care.

Keywords: IoT (Internet of Things), Smart Cradle, Infant Monitoring, Baby Safety, Remote Monitoring, Parental Control, Automation, Health Tracking.

I.Introduction to Smart Cradle

1.1 Introduction

The Internet of Things (IoT) is an emerging technology that enables physical devices to connect, communicate, and exchange data over the internet. By integrating sensors, microcontrollers, and wireless communication, IoT systems can monitor real-time conditions and respond intelligently without constant human intervention. An IoT-based Smart Cradle is a modern baby care system designed to assist parents and caregivers in monitoring and ensuring an infant's safety and comfort. Traditional cradles require continuous manual supervision, which can be challenging for working parents or caregivers. The smart cradle overcomes these limitations by using sensors to detect conditions such as baby movement, crying, temperature, and moisture. The system automatically performs actions like gentle rocking when the baby cries and sends real- time alerts to parents through a mobile application or web interface. It can also monitor environmental factors such as room temperature and humidity to maintain a comfortable sleeping environment for the baby.

By combining automation and remote monitoring, the IoT-based smart cradle enhances infant safety, reduces parental stress, and ensures timely care. This project demonstrates how IoT technology can be effectively applied in healthcare and child-care applications to improve quality of life. Moreover, in today, life it is very hard to even for the homemakers (mummy) to sit nearby their babies and sooth them whenever they feel uncomfortable. Though, it is automatic this application is very useful for the nurses in maternity units of hospital.

The rapid advancement of Internet of Things (IoT) technology has significantly transformed the healthcare sector, especially in the field of infant care. An IoT-based smart cradle is an innovative system designed to provide a safe, comfortable, and intelligent environment for newborns by integrating sensors, automation, and wireless communication. It continuously monitors a baby's vital parameters such as movement, temperature, and crying, and automatically responds to the baby's needs through soothing actions and alert mechanisms.

1.2 Overview of Smart Cradle

Generally, the baby cradle is used for to make sleep and soothe to baby. For example, guardian has to take care of their child till as they asleep. However, conventional cradle does not electronically equip such like battery or adapter to automate the cradle automatically. This kind of conventional cradle is used in villages areas or non-developed cities due to its low prices. But the problem of this kind of designated cradle is that you need manpower to take care of your child and your child may not be safe and feel comfortable in the conventional cradle. Thus, we need automatic cradle to take care of child which uses the battery or power source. Besides, there are extra features or function is provided by the newly automatic cradle that is beneficial for parents. Because in the present world people are very busy in their professional life so they do not get ample time to take care of their infants.

It will be very difficult control the babies and if someone is hiring professional to take care of their infants. It may increase your expenses from monthly expenditure. Moreover, in today, life it is very hard to even for the homemakers (mummy) to sit nearby their babies and sooth them whenever they feel uncomfortable. Though, it is automatic this application is very useful for the nurses in maternity units of hospital.

The cradle can be connected to a mobile app or web platform, allowing parents or caregivers to monitor their baby remotely and receive instant notifications. This not only offers peace of mind but also supports timely intervention, improving the safety and comfort of infants.

By combining technology with infant care, IoT- based smart cradles aim to reduce parental stress, ensure continuous baby monitoring, and contribute to healthier developmental environments for infants. This intelligent cradle system incorporates

sensors and microcontrollers to monitor vital parameters such as baby movement, crying.

1.3 Objectives

1.Offer peace of mind by constantly monitoring the baby and alerting parents to any issues, bridging the gap for busy or working parents.

2.Prevent hazards like SIDS by monitoring movement, position, and environmental factors (temp/humidity).

3.Automatically swing the cradle or activate fans/air fresheners based on sensor data (e.g., crying, high temp).

4.Allow parents to check on their baby via a mobile app using integrated cameras and sensor data from anywhere.

5.Detect wet diapers or poor air quality (methane/smoke) and alert parents to change/clean the environment.

1.4 Importance of Smart Cradle in healthcare

A smart cradle is important in healthcare because it enhances infant safety and supports continuous monitoring of a baby's condition. By using sensors to track movement, breathing, sleep patterns, and crying, it helps in the early detection of health issues and reduces the risk of conditions such as sudden infant death syndrome (SIDS). Smart cradles can automatically soothe babies through gentle rocking or calming sounds, which improves sleep quality and reduces stress for caregivers and parents. In hospitals and neonatal care units, they minimize unnecessary handling of infants, lowering the risk of infection while ensuring constant observation. Additionally, the data collected by smart cradles can assist healthcare professionals in understanding an infant's growth and behavior patterns, enabling timely medical intervention and better overall neonatal care.

A smart cradle plays a significant role in healthcare by combining technology with infant care to ensure safety, comfort, and continuous monitoring of newborns. It uses sensors to track vital signs such as movement, breathing patterns, temperature, and crying, which helps in the early detection of abnormalities and reduces the risk of serious conditions like sudden infant death syndrome (SIDS). The cradle can automatically respond to a baby's needs through gentle rocking, vibration, or soothing sounds, promoting better sleep and healthy growth. This automation reduces the physical and emotional burden on parents, nurses, and caregivers, especially during night hours. In hospitals, particularly in neonatal intensive care units, smart cradles allow constant observation with minimal handling, decreasing the chances of infection. The health data collected over time can be shared with healthcare professionals for better diagnosis, tracking development, and planning personalized care. Overall, smart cradles improve the quality of infant care, support caregivers, and contribute to better health outcomes in both home and clinical settings.

1.5 Problem Definition:

We are fully aware of the difficulties parents encounter while caring for their young kids. Especially, when both the parents are working. It is impossible for a parent to give 100% attention to the infant. Thus, to overcome problems like this we need to develop a system which could help parents to have a watch on the Baby and can get message alerts about the same. Thus, we have proposed a system to design called Smart Cradle System which would help a parent to look after the infant by monitoring continuously from any place. It is a simple but effective prototype for child care. Infant care requires constant attention, particularly during sleep, when issues like excessive crying, discomfort, or environmental disturbances can go unnoticed. Traditional cradles lack intelligent monitoring and automated soothing mechanisms, placing stress on caregivers and potentially affecting infant well-being.

There is a need for an IoT-based smart cradle system that can monitor vital conditions such as crying, motion, temperature, and humidity in real-time, and respond with soothing actions like gentle rocking or lullabies while alerting caregivers through a mobile application. This solution aims to improve infant care, reduce caregiver workload, and enhance response time to the baby's needs.

2.Literature Review

The Smart Cradle System proposed in the paper leverages a combination of cutting-edge technologies to redefine infant care. Central to this innovation is the Internet of Things (IoT), which facilitates real-time data collection and remote monitoring. The modularity and integration of these technologies make the cradle not only intelligent but also responsive and adaptable to infant needs. The modelling process outlined in the study is systematic and event-driven. It begins with the setup and calibration of the sensors to establish threshold values for moisture, sound, and temperature. A pseudo-code algorithm is used to structure this sequence, ensuring that each input triggers an appropriate and timely response [1].

The ―SmartCare Baby‖ cradle integrates an impressive array of modern technologies that collectively redefine infant care. Most notably, the system introduces an auto-cleaning mechanism—a first in smart cradle innovations—which utilizes a plastic sheet roll driven by a motorized winch, inspired by public toilet cleaning systems. The modeling process involves a systematic integration of sensors, actuators, and controllers into a unified IoT framework. The Arduino Uno interfaces directly with sound, humidity, and ultrasonic sensors, as well as servo motors responsible for cradle rocking and the auto- cleaning mechanism.The experimental outcomes validate the cradle's design objectives through measurable performance indicators. The sound sensor demonstrated high sensitivity and responsiveness, activating the cradle's rocking mechanism within 2 milliseconds in over 95% of test cases when the cry intensity exceeded 400 Hertz [2].

The SmartNest system introduces an advanced integration of IoT and machine learning technologies in infant care, focusing on real-time monitoring and intelligent decision-making. A key innovation in the system is the use of emotion classification and intruder detection—features rarely seen in prior smart cradle implementations. These are realized through a web camera connected to a Raspberry Pi 3 B+, which streams real-time video for processing.The development of SmartNest involved a well-structured modeling approach combining sensor integration, data communication, ML algorithm deployment, and real-time alert mechanisms [3].

The system architecture centers around Raspberry Pi 3 B+ as the processing unit, interfacing with various sensors through an Arduino Uno. SmartNest is designed for modern working parents who need constant yet non intrusive monitoring of their infants. Core applications include automated cradle rocking, emotion-based alerts, live video monitoring, environmental sensing, and intruder detection. These features collectively offer both comfort and security for infants while reducing the caregiver's manual burden [4].

This paper presents an innovative fusion of Internet of Things (IoT) technologies and mobile application interfaces to enhance infant care through a smart cradle system. The system stands out with its ability to remotely monitor and interact with infants using multiple sensors and actuators, all connected via a microcontroller- based network. The modeling process begins with the integration of sensor nodes and actuators into a centralized microcontroller, most likely an Arduino or equivalent IoT-compatible board. The cradle is designed to detect baby cries via a sound sensor, and based on the input, the system triggers the servo motor to rock the cradle and can also play a soothing pre-recorded voice or music. Although specific datasets or extensive statistical results are not provided, the paper presents a functionalprototype with clearly defined sensor thresholds. The moisture sensor triggers alerts when mattress wetness exceeds resistance thresholds, and the temperature sensor activates alerts when body temperature surpasses a predefined safe range (commonly 98.6°F) [5].

The paper introduces a smart baby cradle system integrating several modern technologies from the Internet of Things (IoT) and embedded systems domain. At the heart of the system lies the Raspberry Pi B+, chosen for its low power consumption, compact form factor, and sufficient computational capability to manage sensor data and actuate hardware components. The system employs ultrasonic sensors to monitor the presence and movement of the baby, ensuring real-time detection of wakefulness or distress.

The modelling of the smart cradle system was executed in a structured, modular approach. The authors first designed the hardware architecture, comprising the Raspberry Pi controller, sensors (ultrasonic and sound), motor drivers, and camera modules. Each sensor was interfaced with the Raspberry Pi using its GPIO pins [6].

The paper showcases the integration of several cutting-edge technologies in the design of an intelligent, IoT-based smart baby cradle system. At the core of the system is the Arduino Uno R3, a versatile microcontroller responsible for coordinating all system operations. Various sensors are embedded to enhance functionality—most notably, a moisture sensor detects diaper wetness, and a sound sensor identifies baby cries. The development of the smart cradle follows a well-structured modelling process involving both hardware configuration and software implementation. Hardware modelling starts with setting up the Arduino Uno, which interfaces with sensors and actuators, such as the sound and moisture sensors, servo motor, buzzer, and camera.

The moisture detection system demonstrated high reliability, with minimal false positives and negatives when tested across different wetness levels. The system's wetness detection accuracy exceeded 95%, ensuring timely diaper alerts. The servo motor provided stable and smooth oscillations, with adjustable speed and angles tailored for infant comfort [7].

The paper presents a sophisticated implementation of IoT in the domain of infant care by introducing a real-time data tracking baby cradle system. The novelty lies in its integration of multiple sensors with cloud connectivity to allow continuous monitoring and automated control. The system employs a sound sensor to detect crying, a moisture sensor to monitor diaper wetness, and a DHT11 sensor to track temperature and humidity. The modeling process involves the careful orchestration of hardware components and communication protocols to create an automated, responsive cradle. The NodeMCU is programmed to collect data from the sensors at regular intervals. The sound sensor detects the baby's cry by registering changes in sound levels; when the set threshold is breached, the motor is triggered to rock the cradle. The paper reports consistent and reliable performance across various tests. During the prototype testing phase, the sound sensor reliably triggered the motor when the sound level crossed 70 dB, which is the average threshold for infant crying. The moisture sensor was tested by applying controlled amounts of liquid to simulate a wet diaper, and it successfully detected moisture in all cases where resistance dropped below the calibrated value [8].

3.Methodology

The proposed system aims to revolutionize infant care by leveraging the integration of modern computing technologies with smart applications. This smart cradle system enables predictive parenting through real-time monitoring and analysis of an infant's sleep patterns, offering parents valuable insights into their child's sleep behaviour for optimal care and early identification of sleep-related issues. The AI-driven aspect of the system utilizes advanced machine learning algorithms, with a focus on the novel proposed model algorithm called "DreamFlowRNN." By combining Recurrent Neural Networks (RNN) and Flowbased models, DreamFlowRNN can effectively capture temporal dependencies in sleep data and generate more realistic sleep patterns.

This integration enables the cradle system to perform sophisticated sleep pattern analysis, including sleep stage classification, sleep disturbance detection, and prediction of future sleep patterns. The AI-Driven Sleep Pattern Analysis empowers parents with valuable insights and actionable recommendations for personalized sleep routines and early identification of potential sleep-related issues. The processed data is transmitted through wireless communication modules such as Wi-Fi or Bluetooth to a cloud platform or mobile application. This enables parents or healthcare providers to remotely monitor the baby's status and receive instant alerts in case of abnormal conditions. The collected data is stored for further analysis, helping in understanding sleep patterns and health trends. Overall, the methodology ensures continuous monitoring, timely response, data storage, and remote accessibility, making the smart cradle an efficient and reliable infant care solution.

3.1 Proposed system

The proposed IoT-based Baby Cradle System represents an innovative solution designed to address the challenges and issues associated withtraditional infant care. This system leverages Internet of Things (IoT) technology to provide a modern and connected approach to baby cradles, offering numerous benefits to both infants and their caregivers. Cradle system has ability to send alert when baby is crying, it can also swing automatically when baby is crying.

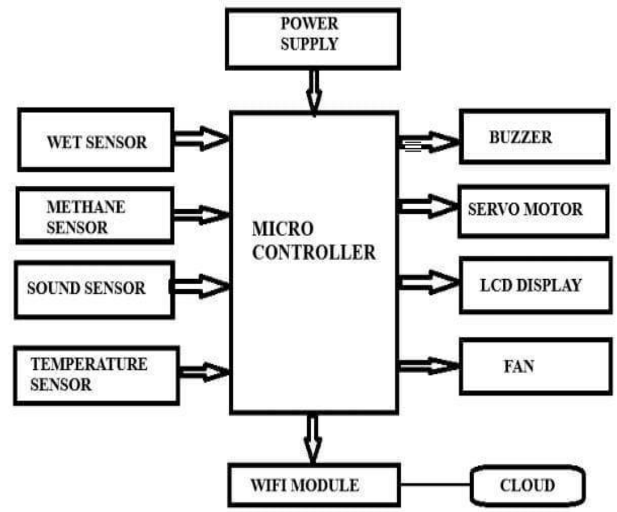

Fig-1 Block Diagram

IOT based baby monitoring and automatic swing system that can monitor the baby's condition in real time is proposed to solve these problems. All data taken from the sensors will be stored in cloud and analyzed at regular intervals and notification about the events and the view images captured are uploaded to cloud server. Cradle will trigger automatically via motor driver by microcontroller when the baby cries continuously upon the set point values. The wetness, motion and cry status of the baby displayed on 16x2 LCD display.

3.2Hardware Modules

1.Piezo Buzzer

The piezo buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. These buzzers can be used alert a user of an event corresponding to a switching action, counter signal or sensor input.

2.Arduino Uno

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

3.LCD display

LCD (Liquid Crystal Display) is made of nematic liquid crystals sandwiched between layers of filter glass, electrodes and polarizing film kept in front of mirror. Normally this crystal are in twisted state and allow light to pass through them so when there is no current, light entering through the front of the LCD will simply hit the mirror and bounce right back out.

4.Smoke Sensor

Smoke sensor/Air pollution sensors are devices that detect and monitor the presence of air pollution in the surrounding area. They can be used for both indoor and outdoor environments. These sensors can be built at home, or bought from certain manufactures. Although there are various types of air pollution sensors, and some are specialized in certain aspects, the majority focuses on five components: ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrous oxide.

5.Temperature sensor

In our project we are using LM35 for measuring skin temperature, to prove the concept of Body sensor networking, as here our aim to the make a

sensor network of different health parameter measurement and send data. So LM35 will do the best job. As its IC based easy to interface, easy to mount, widely available, mercury free, low cost and gives direct centigrade as output.

6.PIR Sensor

PIRs are basically made of a pyroelectric sensor (which you can see below as the round metal can with a rectangular crystal in the center), which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

7.Wet Sensor

The wet sensor module/board is shown below. Basically, this board includes nickel coated lines and it works on the resistance principle. This sensor module permits to gauge moisture through analog output pins & it gives a digital output while moisture threshold surpasses.

8. Servo motor:

Servo motors are DC motors that allow for precise control of the angular position. A standard DC motor, a gear reduction unit, a positionsensing component, and a control circuit make up a servo motor. When the baby is crying it is detected using mic sensor and with the help of servo motor the cradle swings.

8.Mini Fan

The mini fan is a small, low-power fan integrated into the smart baby cradle system. Its purpose is to provide gentle airflow within the baby cradle, contributing to a comfortable environment for the baby.

3.3Software Application

(i) Thingspeak

ThingSpeak is a cloud-based IoT analytics platform by MathWorks for collecting, visualizing, analyzing, and acting on real-time data from sensors and connected devices, using private/public channels, APIs (REST, MQTT), and MATLAB for advanced processing, making it great for prototyping IoT systems like environmental monitoring or smart farming. It turns devices into streams of data that you can monitor, process, and use to trigger actions, often working seamlessly with Arduino Internet of Things (IoT) is a concept that aims to take advantage of the benefits of connected internet connectivity continuously.

Fig-2 Thingspeak

It creates the network of physical devices embedded with computing system (identity, software, sensors) to connect and exchange data – like between home appliances, vehicles and other objects.

Each object is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure – wifi connection. According to Wikipedia, The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.

(ii)Arduino IDE

Fig-3 Arduino IDE

The Arduino IDE (Integrated Development Environment) is used to write the computer code and upload this code to the physical board. The Arduino IDE is very simple and this simplicity is probably one of the main reason Arduino became so popular. We can certainly state that being compatible with the Arduino IDE is now one of the main requirements for a new microcontroller board. Over the years, many useful features have been added to the Arduino IDE and you can now managed third-party libraries and boards from the IDE, and still keep the simplicity of programming the board. The main window of the Arduino IDE is shown below, with the simple simple Blink example.

(iii)mobile app or web dashboard

A mobile app or web dashboard acts as the user interface for your smart cradle system. It allows parents to monitor and control the cradle remotely in real time.

Purpose

1. Remote Monitoring: See the baby's status (crying, temperature, humidity, wetness) from anywhere.
2. Alerts & Notifications: Receive instant alerts if the baby is crying, or if environmental conditions are unsafe.
3. Control Cradle: Start/stop cradle swinging manually if needed.

3.4 Flow Chart

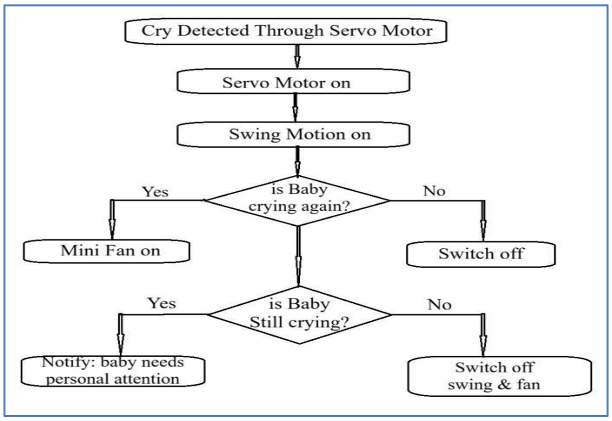

Fig-4 Flowchart

The flowchart represents a step-by-step control process for an automated baby care system designed to soothe a crying baby before alerting a caregiver. When a baby's cry is detected by the sensor, the system immediately turns on a servo motor that initiates a gentle swinging motion, similar to rocking a cradle, to comfort the baby. After this action, the system checks whether the baby continues crying; if the crying is detected again, a mini fan is activated to provide additional soothing through airflow, but if the baby stops crying at this stage, the system switches itself off to save power. The system then makes a final check to see if the baby is still crying even after both swinging and fan assistance—if so, it sends a notification indicating that the baby needs personal or human attention because automatic methods were not effective. If the baby has calmed down, the system safely turns off both the swing and the fan, completing the cycle.

4.Advantages and Applications of Cradle

4.1Advantages

An IoT-based smart cradle offers several advantages in infant healthcare by integrating sensors, connectivity, and automation. It enables real-time monitoring of a baby's vital parameters such as movement, breathing patterns, temperature, and crying, allowing parents or healthcare providers to detect abnormalities early. The cradle can send instant alerts and notifications to mobile devices if unusual conditions are detected, ensuring quick response and improved safety. Automated features like gentle rocking, vibration, and soothing sounds help calm the baby and promote better sleep without constant manual intervention. Remote access through IoT technology allows parents to monitor their baby from anywhere, providing peace of mind, especially for working parents. Continuous data collection helps doctors analyze sleep and health patterns for better medical decisions. Additionally, reduced manual handling lowers caregiver fatigue and the risk of infection in hospital environments, making IoT-based smart cradles a reliable, efficient, and modern solution for infant care. Automated features like self-rocking, vibration, and soothing sounds help calm the baby and promote better sleep without constant caregiver involvement. Remote monitoring allows parents to check the baby's condition from anywhere, which is especially helpful for working parents. The cradle also stores health and sleep data over time, supporting doctors in analyzing growth patterns and providing personalized care. In hospital environments, it reduces the need for frequent manual handling, lowering the risk of infection and caregiver fatigue. Overall, an IoT-based smart cradle increases efficiency, safety, comfort, and convenience in modern infant healthcare systems.

4.2 Applications

IoT-based smart cradles are widely used in healthcare and daily infant care due to their advanced monitoring and automation features. In hospitals and neonatal intensive care units (NICUs), they are used to continuously monitor newborns, especially premature or high-risk infants, while reducing the need for constant physical handling. In home healthcare, smart cradles help parents monitor their baby's health, sleep patterns, and comfort remotely through mobile applications. They are also useful for working parents, as real-time alerts and live monitoring provide peace of mind when they are away. In pediatric clinics, data collected from smart cradles supports doctors in analyzing infant sleep behavior and early health issues. Additionally, smart cradles are applied in research and child development studies to understand infant sleep cycles and growth patterns. Overall, IoT-based smart cradles are applied wherever safe, efficient, and continuous infant monitoring is required.

IoT-based smart cradles are also applied in rural and remote healthcare settings, where access to continuous medical supervision is limited. By enabling remote monitoring and data sharing with healthcare professionals, these cradles help bridge the gap between infants and medical support. Community health workers can use the collected data to track an infant's health status, identify warning signs early, and recommend timely medical intervention, reducing infant morbidity and mortality in underserved areas.

5.Results

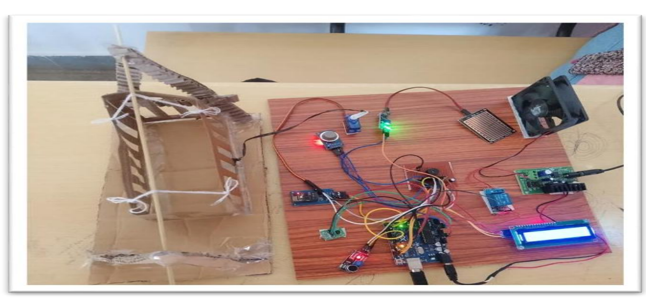

Fig-5 Result

Results System Performance: To evaluate the Smart Cradle System's dependability and performance, it underwent extensive testing. Throughout testing, sensor data from a variety of sources, including as accelerometers, temperature, humidity, and audio sensors, was gathered. The following significant findings were noted: Accuracy of Sensor: With an error rate of fewer than 2%, the cradle's sensors showed excellent accuracy in identifying the motions of the baby, the surrounding environment, and auditory stimuli. Data Transfer: Caregivers may monitor patients in real time thanks to the IoT devices' efficient, low-latency transmission of sensor data to the cloud infrastructure. Life of Battery: The stated goal was met by power management systems, which effectively optimized power usage

and produced an average battery life of seven days. User Satisfaction: To evaluate caregivers' experiences and satisfaction levels with the Smart Cradle System, field experiments were carried out. The following outcomes were noted: Interface User: The mobile application's user interface was rated 4.6 out of 5 by caregivers on an average user satisfaction measure, indicating that it was easy to use and intuitive. Control via Remote: High levels of satisfaction were expressed by caregivers about the convenience and ability to calm newborns that came with being able to remotely change cradle settings. Warnings and Announcements: The rapid alerts and messages were wellreceived by the users, as they enabled parents to promptly attend to their infant's requirements. In this aspect, the system's satisfaction rate was 96%. Discussion The Smart Cradle System's efficacy and potential to transform baby care are demonstrated by the outcomes of its testing and implementation.

Output of Wet Detection

Fig-6: Output of Wet Detection

The image shows an LCD display module that is used to show messages in a baby monitoring system. This type of display is commonly connected to a microcontroller like Arduino and can show important information to the user in real time. The message on the screen reads ―Baby Monitoring‖ and ―Wet Detected!!‖ which means the system is actively monitoring the baby and has detected wetness. This wetness detection usually refers to detecting if the baby's diaper or bedding is wet. Wetness detection is an important feature in a smart cradle because it helps parents or caregivers know immediately when the baby needs a diaper

change or if the bed needs to be cleaned. This improves the baby's comfort and hygiene. This real-time alert system on the cradle improves baby care by making sure caregivers are immediately informed of any wetness, helping to keep the baby dry and comfortable without needing constant physical checks.

Output of Sound Sensor

The image shows an LCD display connected to a microcontroller, displaying the message ―Baby Monitoring Sound Detected!!‖ This indicates that the smart cradle system has detected a sound, such as the baby crying or making noise. The sound sensor continuously monitors the baby's environment, and when it detects a sound above a certain level, it sends a signal to the microcontroller. The microcontroller then updates the LCD to show this message, providing immediate local feedback. In an IoT-based smart cradle, this detection can also trigger automatic responses like swinging the cradle to soothe the baby.

Fig-7: Output of Sound Sensor

Additionally, the system can send real-time alerts to parents through a mobile app or web dashboard, enabling remote monitoring and quick response. The LCD display acts as a simple interface for anyone nearby to see the baby's status, while the IoT functionality enhances safety and convenience by allowing parents to stay informed even when they are not physically present.

Output of Temperature Sensor

Fig-8 Output of Temperature Sensor

In a smart baby cradle system using Arduino, the LCD display shown in the image indicates the current monitoring status of the baby and the surrounding environment. The message ―Baby Monitoring‖ confirms that the system is actively working and continuously checking conditions inside the cradle. When the display shows ―Temp High! Fan ON,‖ it means that the temperature sensor has detected a temperature higher than the safe preset limit for the baby. In response, the Arduino automatically activates a cooling fan through a relay or transistor to reduce the temperature and maintain a comfortable environment. This automatic control helps protect the baby from overheating and reduces the need for constant manual supervision. The LCD provides clear, real-time feedback to parents or caregivers, making the smart cradle a safe and reliable monitoring system.

Output of Methane Sensor

Fig-9: Output of Methane Sensor

In a smart baby cradle system using Arduino, the LCD message shown in the image indicates that the cradle is actively monitoring the baby's environment. The text ―Baby Monitoring

confirms that the system is running normally. When the display shows ―Gas Alert! Fan ON,‖ it means that a gas sensor (such as an MQ-series sensor) has detected the presence of harmful or unsafe gas levels near the cradle. To protect the baby, the Arduino immediately switches ON a fan or exhaust system using a relay or transistor to improve air circulation and reduce the gas concentration. This automatic response helps maintain a safe and healthy environment for the baby and alerts parents or caregivers to potential danger through a clear visual warning on the LCD.

Graphical Results

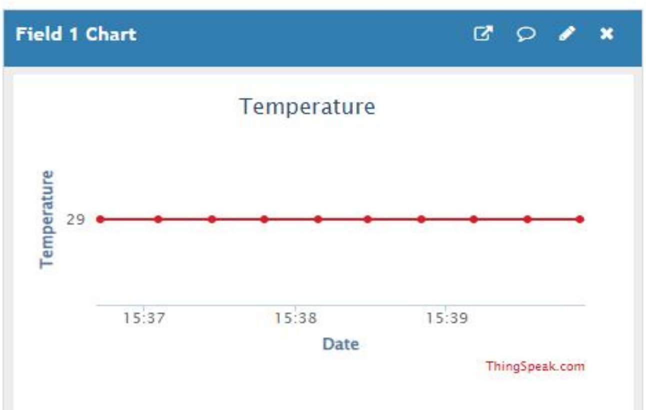

Fig-10: Temperature

This graph represents the temperature monitoring feature of a smart baby cradle using Arduino and IoT. The chart is taken from ThingSpeak, an online cloud platform used to visualize sensor data. In the smart cradle system, a temperature sensor placed near the baby continuously measures the surrounding temperature, and the Arduino sends this data to ThingSpeak through a Wi-Fi module. The graph shows temperature values plotted against time, indicating that the temperature remains stable at around 29 °C during the monitored period. This helps parents or caregivers remotely observe the baby's environment in real time. If the temperature crosses a predefined safe limit, the Arduino can automatically trigger actions such as turning ON a fan and displaying alerts on the LCD. Thus, this graph demonstrates how the smart cradle ensures a safe and comfortable environment for the baby through continuous temperature monitoring and cloud-based visualization.

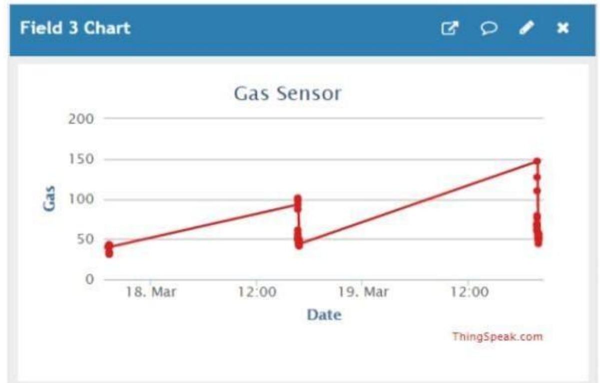

Fig-11: Gas Sensor

The given graph represents gas sensor readings in a smart cradle system, where the sensor continuously monitors the air quality around the baby.

The x- axis shows the date and time, while the y-axis indicates the gas concentration level detected near the cradle. Lower values represent safe air conditions, whereas higher values indicate the presence of harmful gases such as smoke or gas leakage. The rising trend and spikes in the graph show moments when gas levels increase, which can be dangerous for the baby. In a smart cradle, when these gas levels cross a predefined safe limit, the system triggers alerts to parents through an IoT platform like ThingSpeak and may also activate alarms. This ensures real-time monitoring of the baby's environment and enhances safety by allowing immediate action in case of poor air quality.

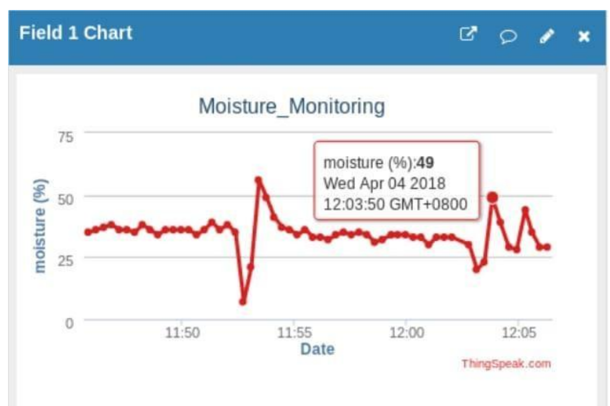

Fig-12: Moisturizer Sensor

The given graph shows moisture monitoring data in a smart cradle system, where a moisture sensor is used to detect wetness in the baby's mattress or diaper area. The x-axis represents time, and the y- axis shows the moisture level in percentage. Normally, the moisture values remain within a steady range, indicating a dry and comfortable condition for the baby. Sudden drops or sharp changes in the graph indicate the presence of moisture, which may be due to diaper wetness or spillage. When such abnormal moisture levels are detected, the smart cradle system can immediately notify parents or caregivers through an IoT platform like ThingSpeak and may also trigger an alert. This feature helps ensure the baby's comfort and hygiene by allowing timely attention and preventing skin irritation or discomfort.

6.FUTURE SCOPE

The IoT Smart Cradle System for Baby using ESP8266 has a vast future scope, with numerous possibilities for expansion and improvement. One potential area of development is the integration of artificial intelligence (AI) and machine learning (ML) algorithms to enhance the system's ability to detect and respond to the baby's needs.

7.Conclusion

In the model we have implemented various types of sensors which brings the automation to the cradle swing. The study of various types of sensors helps to achieve the smartness of cradle with additional features to the cradle. In the present study, smart baby cradle system is developed.Because the IoT-based Smart Cradle System combines the needs of caregivers with state-of-the-art technology, it represents a major improvement in newborn care. This study emphasizes sensor accuracy, power economy, and intuitive design while showcasing the effective usage of an intelligent cradle system. In order to meet the demands of modern newborn care, the system offers real-time monitoring, remote control, and enhanced security for caregivers. It also shows promise for further advancement in areas like global networking, AI integration, and sophisticated health monitoring. The Smart Cradle System paves the way for a time when data-driven insights will improve newborns' wellbeing and caregivers will have access to cutting-edge solutions for peace of mind as IoT technology advances. In conclusion, IoT- based Smart Cradle Systems have the power to completely transform baby care in the age of technology.

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