IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SMART CRADLE: A TECHNOLOGICAL LEAP IN INFANT MONITORING AND COMFORT SOLUTIONS *Modernizing Infant Care through Technology and Innovation*

[1]**Pooja Amin**
Department of Information Technology
Chikitsak Samuha's S.S. & L.S. Patkar College of Arts & Science, and V. P. Varde College of Commerce & EconomicsMumbai, India

[2]**Aditya Satam**
Department of Information Technology
Chikitsak Samuha's S.S. & L.S. Patkar College of Arts & Science, and V. P. Varde College of Commerce & EconomicsMumbai, India

[3]**Daniel Sanctis**
Department of Information Technology
Chikitsak Samuha's S.S. & L.S. Patkar College of Arts & Science, and V. P. Varde College of Commerce & EconomicsMumbai, India

[4]**Kshitij Shetty**
Department of Information Technology
Chikitsak Samuha's S.S. & L.S. Patkar College of Arts & Science, and V. P. Varde College of Commerce & EconomicsMumbai, India

[5]**Kshitija Saitavdekar**
Department of Information Technology
Chikitsak Samuha's S.S. & L.S. Patkar College of Arts & Science, and V. P. Varde College of Commerce & EconomicsMumbai, India

ABSTRACT

Parents prioritize the well-being of their infants, and technological advancements have enhanced safety, comfort, and convenience for both babies and caregivers. This paper presents the development and assessment of a smart cradle designed to monitor and respond to a baby's needs through built-in sensors. These sensors collect real-time data accessible via a mobile app, allowing for continuous monitoring and timely interventions. The cradle automatically adjusts to ensure the baby's comfort and hygiene and features a hands-free mode that dynamically positions it relative to the parent. Preliminary results from testing the prototype indicate that this smart cradle significantly enhances caregiving by providing essential support and improving the overall parenting experience. By leveraging innovations in childcare technology, this study highlights the potential of smart cradles to transform traditional caregiving practices.

Keywords— Smart Cradle, Real-Time Monitoring, IoT, Autonomous Features, Modern Parenting Solutions, Hands Free Mode

• INTRODUCTION

Modern parenting demands innovative solutions to ensure the well-being and safety of infants while providing convenience for parents. Traditional cradles, though functional, lack the technological advancements necessary to address contemporary challenges in infant care. This project introduces a smart cradle designed to bridge this gap by incorporating various sensors and autonomous functionalities. The primary objective is to create a cradle that not only monitors and responds to the baby's needs but also provides real-time data to parents through a mobile application, ensuring a safer and more comfortable environment for the baby. By leveraging technologies such as odor and temperature sensors, a web camera for live monitoring, and automated rocking mechanisms, the smart cradle offers a comprehensive approach to infant care. Additionally, the inclusion of ultrasonic sensors for obstacle detection and hands-free mode enhances parental convenience, allowing the cradle to move autonomously while maintaining a safe distance from the parent. This integration of advanced technology aims to redefine traditional infant care, making it more responsive, efficient, and aligned with modern parenting needs.

• LITERATURE REVIEW

The integration of Internet of Things (IoT) technology in infant care has garnered significant attention in recent years, leading to the development of innovative solutions such as smart cradles. These systems leverage advanced sensors and actuators to provide a comprehensive approach to infant monitoring and care, enhancing both safety and convenience for parents. Various studies have explored the potential of these technologies. For instance, "A Smart Baby Cradle Based on IoT" highlights the utilization of sensors and actuators for automated cradle rocking and real-time environmental monitoring, facilitating remote interaction through mobile applications. Similarly, "Revolutionizing Infant Care with the Smart Cradle: A Comprehensive IoT Solution" emphasizes the integration of facial recognition and proximity sensors to enhance safety and provide automated responses based on environmental stimuli. Another study, "IRJET_Review_3_Paper_on_Smart_Baby_Cradle," reviews the effectiveness of moisture and sound sensors in detecting and responding to the baby's needs, thereby reducing parental stress . Furthermore, "IoT Based Smart Cradle Using PI" discusses the implementation of ultrasonic sensors and GSM modules for obstacle detection and real-time notifications, ensuring the cradle's adaptive functionality in dynamic environments. The convergence of these studies underscores the critical role of IoT in transforming traditional infant care methodologies, providing a foundation for further advancements in this domain. Collectively, these works illustrate the potential of smart cradles to set new benchmarks in childcare technology, offering robust solutions that cater to the nuanced needs of modern parenting.

• SENSORS

Odor Sensor:
Detects urination or defecation by sensing odor changes.
Helps ensure timely diaper changes to maintain the baby's hygiene.

Temperature Sensor:
Monitors the baby’s body temperature to ensure it is within a safe range.
Provides real-time temperature data to alert parents if the baby has a fever.

Rain Sensor:
Positioned under the baby to detect urine leakage from the diaper.
Sends alerts to the mobile application if moisture is detected.

Ultrasonic Proximity Sensor (Front):
Detects obstacles in front of the cradle, triggering a red bulb to alert the parent.
Prevents the cradle from colliding with objects in its path.

Ultrasonic Proximity Sensor (Rear):
Maintains a specific distance from the parent during hands-free mode.
Ensures the cradle moves at a safe distance, avoiding collisions with the parent.

• SYSTEM AND ARCHITECTURE

Overview of the System Architecture

The smart cradle's system architecture is designed to integrate multiple advanced technologies into a cohesive and efficient infant care solution. At the core of this system are an Arduino and a Raspberry Pi, which coordinate the various inputs and outputs from the sensors and actuators. The system architecture is visualized through a functional block diagram, which illustrates the connections between the cradle's main components: sensors, actuators, web camera, power supply, and the communication module. Each component plays a critical role in ensuring the cradle's functionality, from detecting environmental and physiological changes to enabling autonomous movement and real-time monitoring. An advanced feature of the system includes the Mel Frequency Cepstral Coefficients (MFCC) algorithm combined with a neural network model and a training algorithm to detect if the baby is crying. If crying is detected, an LED will glow to indicate this to the parents. This integrated approach ensures that the cradle operates seamlessly, providing a safe and responsive environment for the baby.

Hardware Components

The smart cradle is equipped with a variety of hardware components, each selected for its specific role in monitoring and ensuring the baby's comfort and safety. The Arduino and Raspberry Pi act as the central processors, managing data from the sensors and controlling the actuators. The (MQ-4) odor sensor is strategically placed to detect when the baby has defecated, prompting immediate alerts to parents for diaper changes. A DHT11 sensor monitors both the baby's body temperature and ambient humidity, ensuring the environment remains within a safe and comfortable range. The rain sensor, positioned under the baby, detects any urine leakage, adding an extra layer of hygiene maintenance. Ultrasonic proximity sensors (HC-SR04) are mounted at the front and rear of the cradle to detect obstacles and maintain a safe distance from the parent during hands-free mode. Additionally, a high-resolution web camera provides a live video feed, ensuring that parents can visually monitor their baby at all times. The servo motors (MG995) enable the cradle to rock gently, soothing the baby, while the DC motors facilitate autonomous movement. The entire system is powered by a reliable power supply, with considerations for battery backup to ensure continuous operation even during power outages. The MFCC algorithm, neural network model, training code, and loss function are used to detect crying, activating an LED indicator.

Software Components

The software architecture of the smart cradle is designed to manage and process data efficiently, ensuring real-time responsiveness and control. The system operates on a robust platform supported by both the Arduino and Raspberry Pi, executing complex code and real-time data processing. Sensor data is continuously collected and processed by the microcontrollers, which use predefined code to determine the appropriate responses, such as triggering the rocking mechanism or sending alerts to the mobile application. Control codes govern the movement of the servo and DC motors, ensuring smooth and precise operations. Data communication between the cradle and the mobile application is handled via the same network/Wi-Fi, ensuring reliable transmission of data. The software also integrates the MFCC algorithm and neural network model, which are trained to detect baby cries. When a cry is detected, the system activates an LED to notify parents. Additionally, the software manages the live video feed, enabling parents to view real-time footage of their baby through the application.

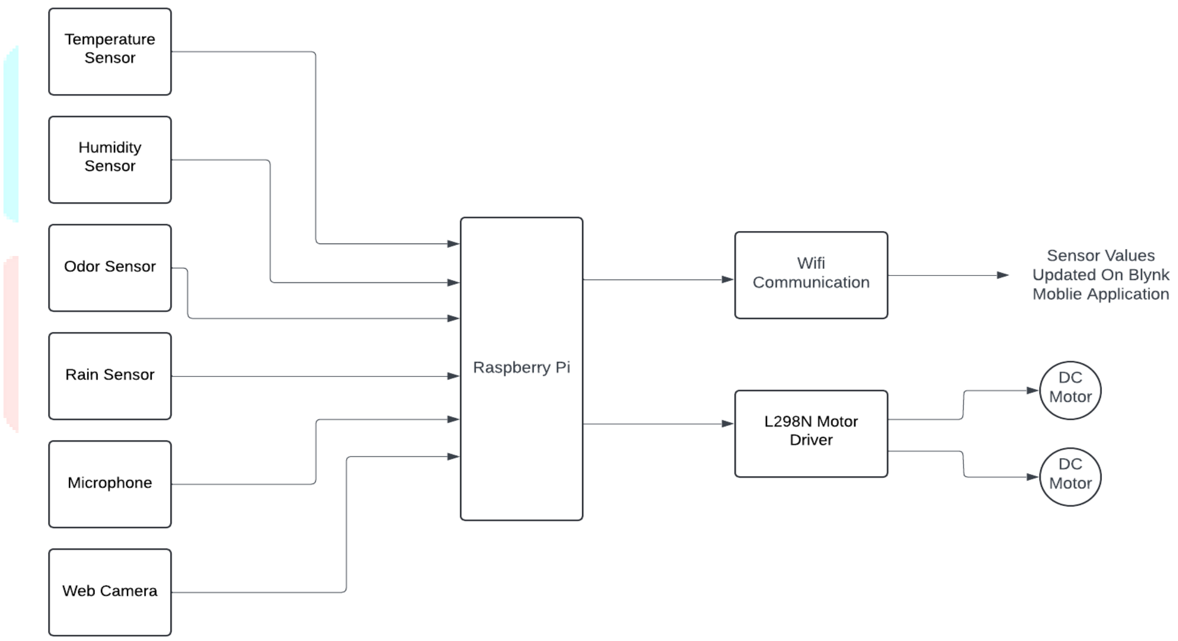

Fig 4.1 Proposed Architecture of Smart Cradle

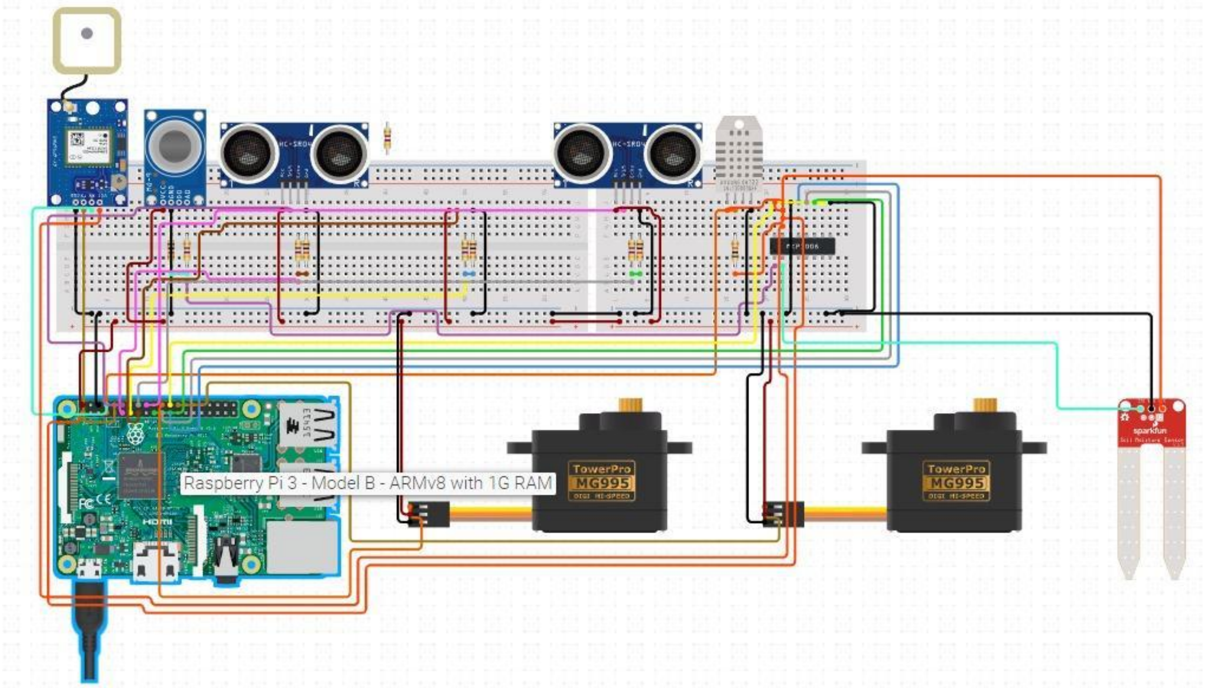

Fig 4.2 Circuit Diagram of Smart Cradle

Mobile Application Integration

The Smart Cradle mobile application serves as the user interface, providing parents with comprehensive control and monitoring capabilities. Designed with a focus on usability, the application displays real-time data from the cradle's sensors, including the baby's body temperature, ambient humidity, odor detection, and urine detection. This information is presented in a clear and accessible manner, ensuring that parents can easily monitor their baby's condition. The application also includes control features, such as a power button to activate or deactivate the cradle's wheels, allowing for autonomous movement. Furthermore, the application supports live video streaming from the web camera, giving parents the ability to visually monitor their baby from anywhere. The integration of the MFCC algorithm, neural network model, and training codes into the mobile app ensures that parents are alerted if the baby is crying, with an LED indicator providing a visual alert. This seamless integration of data and control features ensures that parents can maintain constant oversight and make informed decisions regarding their baby's care.

Safety and Security Measures

Safety is paramount in the design of the smart cradle. The system includes multiple safety features to protect both the baby and the data being transmitted. Ultrasonic proximity sensors (HC-SR04) ensure that the cradle can detect and avoid obstacles, with a red bulb alert system to notify parents of any detected hazards. This feature is particularly important when the cradle is in autonomous movement mode. Additionally, the MFCC algorithm and neural network model work together to detect when the baby is crying, triggering an LED to alert parents immediately. These measures collectively ensure a secure and safe environment for the baby, while also maintaining the privacy and integrity of the data being handled.

Implementation and Testing

The development of the smart cradle involved an iterative process of prototype development and rigorous testing to ensure functionality and reliability. Initial prototypes were constructed and tested to validate the integration of the various sensors and actuators. Each component underwent thorough testing to ensure accuracy and responsiveness, with particular attention given to the sensitivity of the MQ-4 odor sensor, DHT11 temperature and humidity sensor, and rain sensor. The control codes for the MG995 servo motors and DC motors were refined to ensure smooth and precise movements. Data communication protocols were tested for reliability and security, ensuring that real-time data transmission was both robust and secure. The MFCC algorithm, neural network model, and training codes were tested to ensure accurate detection of baby cries, with the LED indicator providing immediate visual alerts. User testing was also conducted to gather feedback on the mobile application's interface and usability, leading to further refinements. This comprehensive testing process ensured that the final product was both reliable and user-friendly, capable of providing the intended benefits in a real-world setting.

MOBILE APPLICATION WITH DATA COMMUNICATION

The mobile application, named Smart Cradle, serves as a central interface for real-time monitoring and control of the cradle's functionalities. Implemented using the Blynk platform, this application is designed to provide parents with comprehensive oversight and control over the smart cradle's various systems. The application displays four critical values: the baby's body temperature, ambient humidity, odor detection indicating defecation, and urine detection. These metrics provide a holistic view of the baby's environmental and physiological conditions, ensuring timely interventions and maintaining the baby's comfort and well-being.

The temperature reading offers crucial information to prevent overheating or hypothermia, while the humidity level ensures the surrounding environment remains conducive to the baby's health. The odor sensor alerts parents when the baby has defecated, and the urine detection sensor notifies them when the baby has urinated, allowing for prompt diaper changes to maintain hygiene and prevent skin irritation.

In addition to monitoring, the Smart Cradle app features a power control button for the cradle's wheels, enabling parents to activate or deactivate the cradle's locomotion. This functionality allows the cradle to move autonomously when needed, enhancing parental convenience, particularly in hands-free mode. Furthermore, the application includes a live video stream of the baby, providing parents with visual assurance and the ability to monitor their child remotely at all times.

The integration of sensor data and live video feed into a single, user-friendly interface exemplifies the effective use of data communication technologies to enhance the safety, comfort, and convenience of infant care. The Smart Cradle application ensures that parents can stay informed and in control, even from a distance, thereby providing peace of mind and improving the overall experience of modern parenting.

I.CODE

6.1 Blynk Code

```
# Reads data from an Arduino via a serial connection and forwards the data to a Blynk server for remote monitoring.
def read_arduino_data():
    while True:
        try:
            if ser.in_waiting > 0:
                line = ser.readline().decode('utf-8').strip()
                print(line)
                if 'Temperature' in line:
                    temperature = float(line.split(' ')[1])
                    blynk.virtual_write(1, temperature)
                elif 'Humidity' in line:
                    humidity = float(line.split(' ')[1])
                    blynk.virtual_write(2, humidity)
                elif 'Methane Concentration' in line:
                    methane = float(line.split(' ')[2])
                    blynk.virtual_write(3, methane)
                elif 'Water Sensor Value' in line:
                    water = int(line.split(' ')[3])
                    blynk.virtual_write(4, water)
                elif 'Bad smell detected' in line:
                    blynk.virtual_write(5, 1)
                elif 'No bad smell detected' in line:
                    blynk.virtual_write(5, 0)
                elif 'water detected' in line:
                    blynk.virtual_write(6, 1)
                elif 'No Water detected' in line:
                    blynk.virtual_write(6, 0)
        except Exception as e:
            print(f"Error reading from serial port: {e}")
        time.sleep(0.01)  # Small sleep to prevent CPU hogging


def blynk_run():
    while True:
        blynk.run()
        time.sleep(0.01)  # Small sleep to ensure Blynk run doesn't hog CPU
```

6.2 Cry Detection Algorithm

```
import numpy as np
import librosa
import tensorflow as tf
from tensorflow.keras import layers, models
import os

# Load and preprocess data (example)
def load_audio(file_path):
    signal, sr = librosa.load(file_path, sr=22050)
    return signal, sr

def extract_features(signal, sr):
    mfccs = librosa.feature.mfcc(y=signal, sr=sr, n_mfcc=13)
    return np.mean(mfccs.T, axis=0)

# Example dataset

# Path to the directory
directory_path = '/content/drive/MyDrive/crying'

# Check if the directory exists
if os.path.exists(directory_path):
# List all files in the directory with their full paths
   crying_files = [os.path.join(directory_path, f)  for  f   in  os.listdir
(directory_path)  if        os.path.isfile(os.path.join(directory_path, f))]
else:
    print("The directory does not exist.")

directory_path2 = '/content/drive/MyDrive/background sounds'

if os.path.exists(directory_path2):
    # List all files in the directory with their full paths
    non_crying_files = [os.path.join(directory_path2, f)  for  f   in  os.listdir (directory_path2)  if
os.path.isfile(os.path.join(directory_path2, f))]
else:
    print("The directory does not exist.")

X = []
y = []

for file in crying_files:
    signal, sr = load_audio(file)
    features = extract_features(signal, sr)
    X.append(features)
    y.append(1)  # Crying

for file in non_crying_files:
    signal, sr = load_audio(file)
    features = extract_features(signal, sr)
    X.append(features)
    y.append(0)  # Not crying

X = np.array(X)
y = np.array(y)

# Train-test split
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Model definition
model = models.Sequential()
```

```
model.add(layers.Dense(128, activation='relu', input_shape=(X_train.shape[1],)))
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dense(1, activation='sigmoid'))

model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])

# Train the model
model.fit(X_train, y_train, epochs=50, batch_size=16, validation_data=(X_test, y_test))

# Save the model
model.save('crying_detection_model.h5')

# Real-time detection
def predict_crying(audio_segment):
    features = extract_features(audio_segment, sr=22050)
    features = features.reshape(1, -1)
    prediction = model.predict(features)
    return prediction > 0.5

import numpy as np
import librosa
import tensorflow as tf

# Load the trained model
model = tf.keras.models.load_model('/content/drive/MyDrive/crying_detection_model.h5')

# Function to preprocess the audio and extract features
def load_and_preprocess_audio(file_path):
    signal, sr = librosa.load(file_path, sr=22050)
    mfccs = librosa.feature.mfcc(y=signal, sr=sr, n_mfcc=13)
    return np.mean(mfccs.T, axis=0)

# Function to predict if the baby is crying
def predict_crying(file_path):
    features = load_and_preprocess_audio(file_path)
    features = features.reshape(1, -1)
    prediction = model.predict(features)
    return prediction > 0.5

# Test audio file paths
test_files = ['/content/drive/MyDrive/background sounds/Recording (2).m4a']

# Predict and print the results
for file in test_files:
    is_crying = predict_crying(file)
    print(f"File: {file}, Crying: {'Yes' if is_crying else 'No'}")
```

RESULTS

The implementation and testing of the smart cradle yielded significant insights and confirmed the efficacy of integrating advanced technologies to enhance infant care. This section presents the results obtained from the comprehensive testing of the smart cradle's various components and functionalities.

Sensor Performance

The MQ-4 odor sensor demonstrated high sensitivity and reliability in detecting ammonia and other gasses associated with urination and defecation. During testing, the sensor consistently identified instances of diaper soiling, promptly triggering alerts to parents via the mobile application. The DHT11 sensor effectively monitored the baby's body temperature and surrounding humidity, providing accurate and consistent readings. This ensured that the cradle maintained a safe and comfortable environment for the baby.

The rain sensor, strategically placed under the baby, accurately detected urine leakage with swift response times. This prompt detection minimized potential discomfort and hygiene issues for the baby. The ultrasonic proximity sensors (SR04) effectively detected obstacles within a significant range, ensuring safe autonomous movement of the cradle. The obstacle detection system reliably alerted parents to any obstructions, indicated by the activation of the red bulb.

Actuation and Movement

The MG995 servo motors, responsible for the rocking mechanism, provided smooth and consistent movements, swinging the cradle up to 45 degrees from the neutral position. The motors respond accurately to the baby's crying, as detected by the MFCC algorithm and neural network model. The DC motors facilitated seamless autonomous movement of the cradle, maintaining a safe distance from the parent as detected by the rear ultrasonic sensor. The locomotion system operated reliably, with the cradle maintaining consistent speed and distance from the parent during hands-free mode.

Cry Detection and Notification System

The integration of the MFCC algorithm and neural network model for cry detection proved to be highly effective. The system was trained using a diverse dataset of baby cries and demonstrated reliability in identifying genuine cries. Upon detecting a cry, the system activated an LED indicator, providing a clear visual alert to parents. The LED alert system ensured immediate attention to the baby's needs, enhancing the overall responsiveness of the cradle.

Data Communication and Mobile Application

The data communication between the smart cradle and the mobile application, facilitated through the same network/Wi-Fi, was robust and reliable. Real-time data transmission ensured that parents received instant updates on their baby's condition, including temperature, humidity, odor detection, and urine leakage. The live video feed provided by the web camera was clear and consistent, allowing parents to monitor their baby visually at all times.

The mobile application's user interface was tested for usability and responsiveness. User feedback indicated a high level of satisfaction with the application's design and functionality. The control features, such as the power button for the wheels and the live video streaming, were intuitive and easy to use. Parents appreciated the real-time notifications and the comprehensive display of sensor data, which contributed to a heightened sense of security and convenience.

Video Link To The Working Model Of Smart Cradle: ***SMART CRADLE WORKING MODEL***

Overall System Reliability

The overall reliability of the smart cradle was confirmed through extensive testing. The integration of hardware and software components functioned seamlessly, providing a stable and responsive infant care solution. The system operated continuously for extended periods without significant issues, demonstrating its suitability for real-world use. The power supply, including battery backup, ensured uninterrupted operation, even during power outages.

In conclusion, the results from the testing of the smart cradle project confirm its potential to significantly enhance infant care. The system's advanced sensor integration, effective cry detection, reliable autonomous movement, and user-friendly mobile application collectively provide a comprehensive solution that addresses key aspects of modern parenting. The positive outcomes from this project pave the way for further innovations and improvements in smart cradle technology.

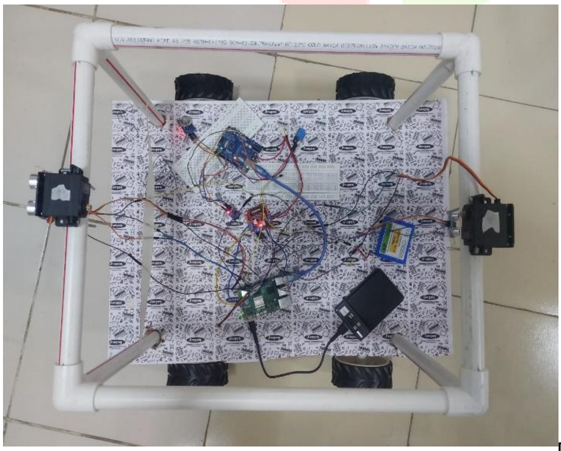

Fig 7.1 The circuit connection of Smart Cradle

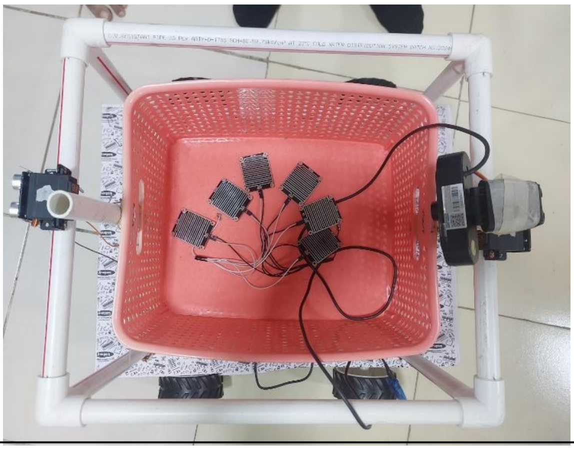

Fig 7.2 Placement of Rain Sensor inside cradle for urine leakage detection

Fig. 7.3 Smart Cradle Prototype

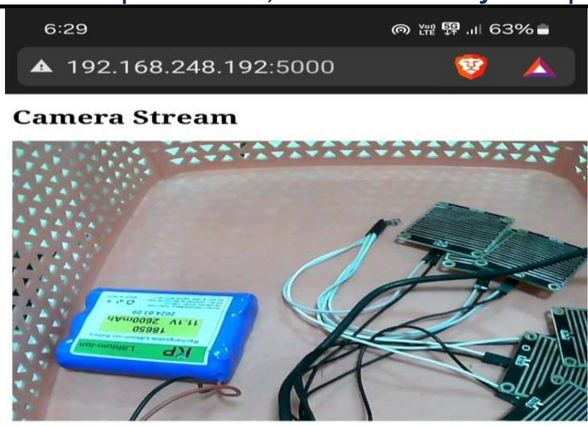

Fig. 7.4 Live Streaming of cradle through mobile application

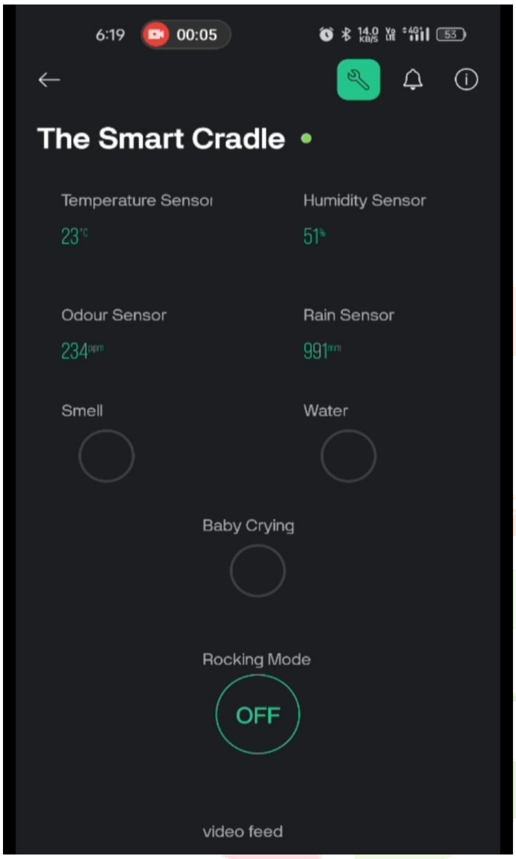

Fig 7.5 Initial Screen of Mobile application

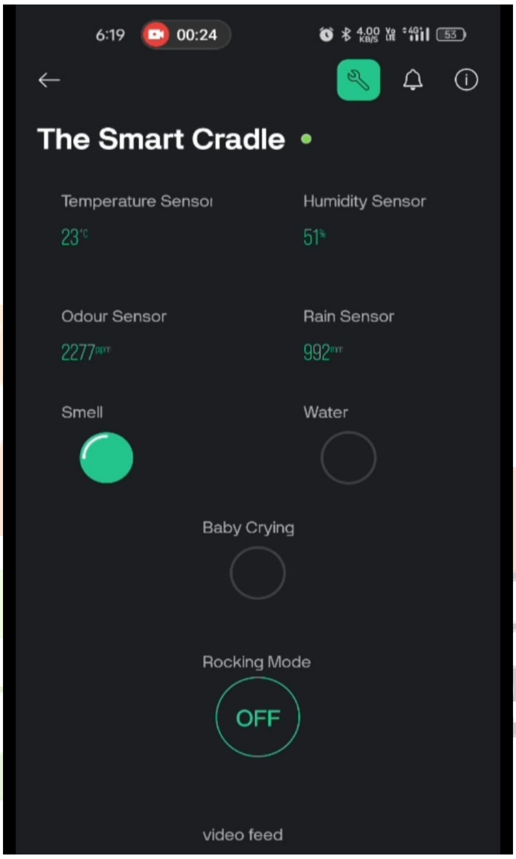

Fig 7.6 Snapshot while odor was detected in SmartCradle

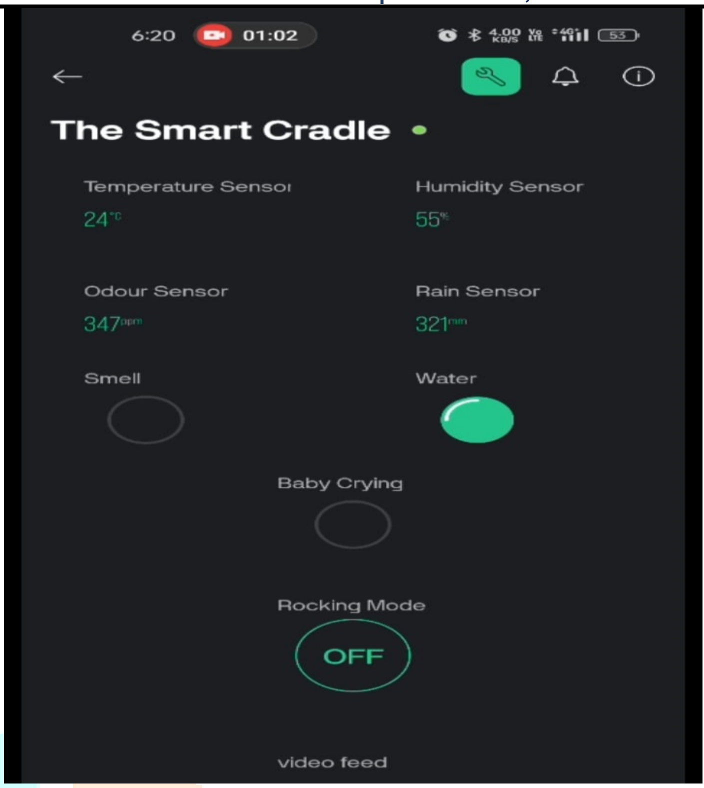

Fig 7.7 Application snapshot after urination was detected

- **ADVANTAGES**

The smart cradle presents numerous advantages that significantly enhance traditional infant care through advanced technology integration. One of the primary benefits is enhanced monitoring, with sensors providing continuous, real-time data on the baby's condition, ensuring timely interventions for issues like diaper changes or temperature fluctuations. The inclusion of a Raspberry Pi camera offers a live video feed, enabling parents to monitor their baby remotely, which is particularly useful for working or traveling parents. The autonomous movement feature allows the cradle to follow the parent at a safe distance using ultrasonic proximity sensors and DC motors, activated and controlled via a mobile application that also provides real-time notifications and settings adjustments. The automated rocking mechanism soothes the baby by gently swinging the cradle when crying is detected, promoting better sleep and comfort. Additionally, the cradle's obstacle detection and alert system enhance safety by ensuring a clear path when in motion. Overall, the smart cradle offers a convenient and user-friendly experience, integrating modern technology to create a responsive and interactive environment for infants, thereby reducing parental stress and enhancing the overall infant care experience.

- **DISADVANTAGES**

Despite its numerous advantages, the smart cradle also presents certain disadvantages that must be considered. The complexity of integrating multiple sensors, actuators, and communication modules can lead to potential technical issues and require regular maintenance, posing a challenge for less technologically adept parents. The inclusion of sophisticated components such as high-resolution cameras, biometric sensors, and AI algorithms significantly increases the cost, making the smart cradle less accessible to a broader audience. The cradle's reliance on electrical power is another limitation, as continuous monitoring and autonomous functions require a stable power supply, and power interruptions could compromise functionality, potentially increasing household energy costs. Moreover, while face detection and biometric monitoring enhance security and health monitoring, they also raise privacy concerns, with sensitive biometric data stored on servers susceptible to cyber threats. These factors—complexity, cost, power dependency, and privacy concerns—must be carefully addressed to optimize the cradle's design and ensure its widespread adoption and effective use.

- **FUTURE PREDICTIONS**

The future of smart cradle technology is poised for remarkable advancements through the integration of cutting-edge features such as advanced AI, voice recognition, face detection and recognition, and biometric monitoring. Advanced AI will enable the cradle to analyze extensive data, predict the baby's needs, and respond proactively, enhancing both the baby's comfort and parental peace of mind. Voice recognition will allow parents to issue verbal commands, providing a hands-free and convenient way to control the cradle's functions. The implementation of face detection and recognition technology will ensure that the cradle only follows authorized individuals, adding a significant layer of security while enabling hands-free locomotion when the parent is validated and within a specific proximity. Additionally, biometric monitoring will provide real-time health data, such as heart rate and oxygen levels, ensuring immediate alerts for any anomalies and contributing to the baby's long-term health monitoring. These innovations collectively promise to transform smart cradles into highly responsive, secure, and health-conscious devices, significantly enhancing the overall infant care experience.

• CONCLUSION

In conclusion, the development of a smart cradle integrating advanced sensor technologies, autonomous functionalities, and real-time data communication represents a significant leap forward in infant care. This project demonstrates the potential of combining multiple cutting-edge components, such as odor, temperature, and rain sensors, along with a Raspberry Pi camera and ultrasonic proximity sensors, to create a responsive and interactive environment for infants. The smart cradle's ability to provide enhanced monitoring, autonomous movement, and immediate notifications to parents through a dedicated mobile application ensures a higher level of safety, comfort, and convenience.

However, the implementation of such sophisticated technology also presents challenges. The complexity of the system necessitates regular maintenance and may pose a barrier for less technologically adept users. The increased cost associated with advanced components could limit accessibility, and reliance on electrical power introduces vulnerabilities in areas with unstable supply. Additionally, while biometric monitoring and facial recognition offer enhanced security and health monitoring capabilities, they also raise significant privacy concerns that must be addressed to ensure data protection. Despite these challenges, the smart cradle's benefits in providing real-time health monitoring, facilitating parental convenience, and enhancing the overall safety and well-being of infants are substantial. Future iterations of the smart cradle should focus on simplifying the user interface, reducing costs, ensuring reliable power solutions, and strengthening data security measures. By addressing these aspects, the smart cradle can become an indispensable tool in modern parenting, offering unparalleled support and peace of mind to parents while ensuring the optimal care and comfort of their infants. This project sets the foundation for continued innovation in smart childcare products, promising significant advancements in the near future.

REFERENCES

[1] "Sarah, A., & Brown, B. (2020). A Smart Baby Cradle Based on IoT. International Journal of Computer Science and Mobile Computing."
[2] "Sharmadha, S., & Shivani, S. (2018). Survey on Digital Age- Smarter Cradle System for Enhanced Parenting. International Journal of Applied Engineering Research."
[3] "Samuel, N., & Nikhil, T. (2021). Smart Cradle System. International Research Journal of Engineering and Technology."
[4] "Bodla, S., & Yerru, P (2022). Smart Cradle. International Research Journal of Modernization in Engineering Technology and Science."
[5] " Harshad, S., & Bhushan, S. (2019). IOT Based Smart Cradle System for Baby Monitoring. International Research Journal of Engineering and Technology."
[6] " Kshitij, L., & Sanket, D. (2019). Smart Baby Cradle. International Journal of Research in Engineering, Science and Management."
[7] "Kannan, P., & Allwin, D. (2021). IoT Based Smart Cradle Using PI. IOS Press."
[8] " Amruta, M., & Komal, L. (2020). Review 3 Paper on –Smart Baby Cradle Monitoring System. International Research Journal of Engineering and Technology."
[9] " Devesh, S., & Durgaprasad, G. (2020). Iot-Based Smart Cradle Monitoring System for Newborns. Webology."
[10] "Garcia, M., & Fernandez, A. (2019). Automation in Childcare: The Role of IoT. Journal of Automation and Control."
[11] "Li, J., & Chen, K. (2019). Enhancing Infant Safety with Proximity Sensors. Sensors and Actuators Journal."