EEE 416 –Microprocessor and Embedded Systems Laboratory
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Project Proposal Presentation

BUET

Smart Baby Cradle: An IoT-Based Infant Monitoring and Care System


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Outline

1. Summary
2. Introduction
3. Design
4. Implementation
5. Analysis and Evaluation
6. References

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1. Abstract

This project presents a **smart baby cradle system** that combines **cry detection** and **IoT-based control** to enhance infant care. Using an **ESP32 microcontroller** with Wi-Fi connectivity, the cradle operates in two modes: **automated**, where real-time audio analysis detects infant crying and triggers a motorized rocking mechanism to soothe the baby; and **manual**, where caregivers can remotely initiate rocking via a mobile application. This dual-mode design reduces caregiver response time, provides immediate comfort to the infant, and allows intervention without constant physical presence. The system offers a **low-cost, reliable, and scalable** solution for modern childcare in both domestic and clinical environments.

2. Problem Statement

- Babies cry frequently.
- Caregiver limitations.
- Delayed soothing leads to increased baby distress.

3.1 Design: Problem Formulation (PO(b))
3.1.1 Identification of Scope

- **Detect** infant crying in real-time.
- Auto-rock cradle to **soothe** baby.
- **Remote** manual control via mobile app.
- **Affordable**, IoT-based for home/clinical use.

3.1 Design: Problem Formulation (PO(b))
3.1.2 Literature Review

[1] Joshi, M.P. and Mehetre, D.C., 2017, August. IoT based smart cradle system with an Android app for baby monitoring. In 2017 International Conference on Computing, Communication, Control and Automation (ICCUBEA) (pp. 1-4). IEEE.

The authors designed a Smart Cradle that enables video monitoring **via mobile phones** for working parents. It automatically swings when the **baby cries**, alerts the parent if crying continues too long or the **mattress is wet**, and includes a rotating toy to entertain the baby.

CRY DETECTTION	✓
TEMPERATURE MONITORING	✗
DIAPER WETNESS	✓
FALL DETECTION	✗

3.1 Design: Problem Formulation (PO(b))
3.1.2 Literature Review

[2] W. A. Jabbar, H. K. Shang, S. N. I. S. Hamid, A. A. Almohammedi, R. M. Ramli and M. A. H. Ali, "IoT-BBMS: Internet of Things-Based Baby Monitoring System for Smart Cradle," in IEEE Access, vol. 7, pp. 93791-93805, 2019, doi: 10.1109/ACCESS.2019.2928481.

The authors developed an **IoT-based** baby monitoring system using NodeMCU and sensors to detect **crying**, **temperature**, and **moisture**, with features like automatic cradle swing, remote monitoring, and lullaby control via MQTT.

CRY DETECTTION	✔
TEMPERATURE MONITORING	✔
DIAPER WETNESS	✔
FALL DETECTION	✘

3.1 Design: Problem Formulation (PO(b))
3.1.2 Literature Review

[3] Suud, J., Suliman, F.H. and Shahari, K.H., 2025. Enhancing Safety: A Smart Baby Monitoring System for Deaf Parents. Borneo Engineering & Advanced Multidisciplinary International Journal, 4(1), pp.31-38.

The study developed a compact, Arduino-based baby monitoring system for deaf parents that uses acoustic analysis, visual OLED alerts, and vibration feedback to detect baby cries and real-time Bluetooth notifications.

CRY DETECTTION	✔
TEMPERATURE MONITORING	✘
DIAPER WETNESS	✔
FALL DETECTION	✘

3.2 Design Methods (PO(a))

MICROCONTROLERS

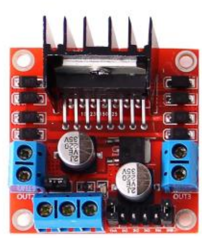
ESP32

The ESP32 is a **low-cost**, **low-power** microcontroller with built-in **Wi-Fi and Bluetooth**, ideal for **IoT** and embedded applications.

3.2.1 COMPONENTS

ACTUATORS

DC Motor



Motor Driver

The **Motor Driver (LM298N)** acts as an interface between the Arduino Uno and the motor, allowing safe and controlled power delivery. When the Arduino sends a signal to the motor driver, it powers the motor to swing the cradle. The driver also allows control over motor direction and speed, enabling smooth and reliable movement.

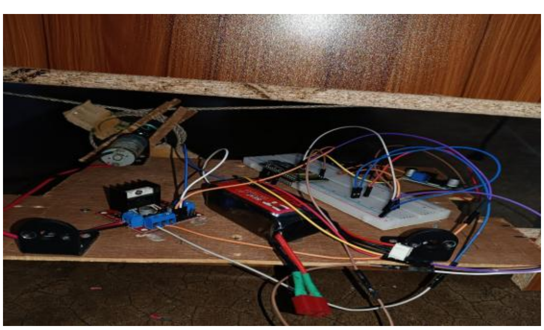
3.2.1 COMPONENTS

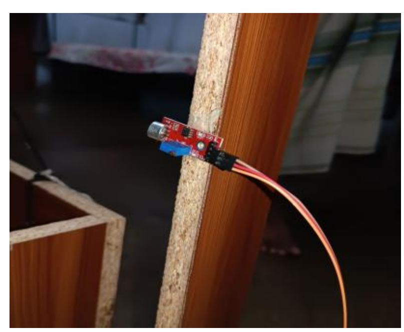
SENSORS

Sound Sensor

The **Microphone** captures real-time audio from the environment, including the baby's sounds. This audio signal is sent to the ESP32, where it is processed to distinguish between crying and non-crying. The microphone plays a crucial role in enabling accurate cry detection for automated cradle response.

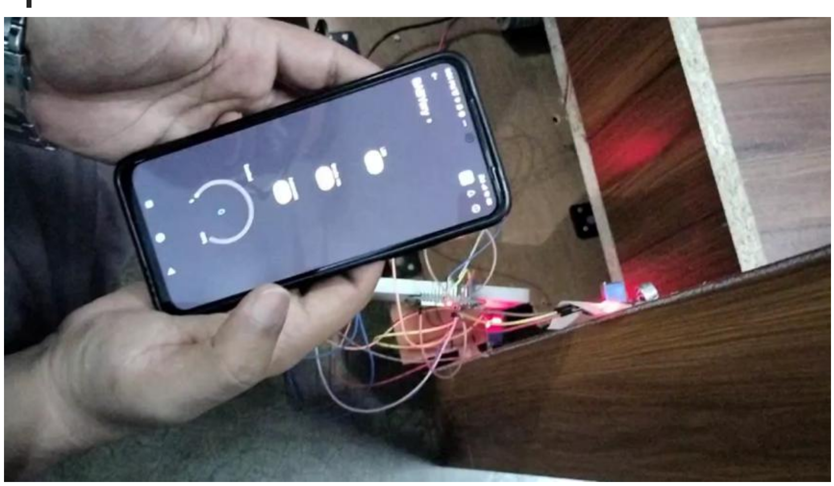
3.3 Design: Circuit Diagram





3.4 CAD/Hardware Design

4 Implementation: Demonstration



5.1 Novelty

- **Cost-Efficient Design**
- **Minimal yet Essential IoT Integration**
- **Low-Power Consumption**
- **Remote Access**
- **Less Prone to Errors**

5.2 Design Considerations (PO(c))

5.2.1 Public Health & Safety
•Ensures infant safety with secure cradle motion and non-hazardous materials.
•Reduces caregiver fatigue and stress.

5.2.2 Environment
•Low-power consumption minimizes energy impact.
•Durable components reduce electronic waste.

5.2.3 Cultural & Societal Needs
•Supports working parents and caregivers.
•Adaptable for diverse childcare practices.

5.3 Investigations (PO(d))

5.3.1 Result & Analysis

- Achieved high cry detection accuracy.
- Verified reliable auto-rocking and remote control performance.

5.3.2 Interpretation

- System effectively soothes infants and reduces caregiver response time.
- Demonstrates feasibility of cost-efficient, low-power IoT childcare solutions.

5.4 Limitations of Tools (PO(e))

Sensor Accuracy

- Low-cost sound sensors have limited precision in detecting infant cries; high-quality alternatives are expensive.

Bulky Structure

- Current cradle design is not easily portable.

Microcontroller Constraints

- ESP32 has limited processing power for advanced cry-detection models.

Wi-Fi Dependency

- Requires constant internet connection for remote control.

Complex Motion Mechanism

- Rocking mechanism increases design complexity and maintenance needs.

5.5 Impact Assessment (PO(f))

5.5.1 Societal & Cultural Issues

- Supports working parents and modern childcare needs.
- Adaptable to different cultural childcare practices.

5.5.2 Health & Safety Issues

- Safe cradle motion, non-toxic materials.
- Prevents prolonged infant distress, reducing stress for caregivers.

5.5.3 Legal Issues

- Compliance with IoT device regulations and electrical safety standards.
- Must ensure user data privacy in connected applications.

5.6 Sustainability Evaluation (PO(g))

- **Energy Efficiency** – Low-power ESP32, PWM motor control, rechargeable LiPo battery.
- **Material Selection** – Recyclable, durable materials to reduce environmental impact.
- **Modular Design** – Easy repair, upgrade, and responsible disposal.
- **Cost-Effectiveness** – Affordable components, open-source software (Blynk).
- **User Empowerment & Health** – Reduces caregiver effort and stress.
- **Waste Reduction** – Minimal packaging, standardized recyclable components.

6. Reflection on Individual and Team work

Task	ID(s)
Paper study and relevant knowledge of the terminology	2006108, 2006109, 2006107, 2006110
Software and circuit setup	2006109, 2006108
Hardware setup	2006107, 2006110
Software and hardware integration	2006108, 2006109, 2006107, 2006110

7. Project Management and Cost Analysis (PO(k))

Component	Cost (Taka)
LiPo Battery	2000
LiPo Battery Charger	800
ESP32 Devkit	550
KY-038 Sound Sensor	100
Jumper Wire	230
Cardboard	1500
LM2596 Buck Converter	150
Breadboard	200
Cradle	700
Motor Driver	200
Grand Total	**6530**

8. Future Work (PO(I))

1. **Enhanced Cry Detection**
2. **Improved Mobility & Design**
3. **Battery Life Optimization**
4. **Offline Functionality**
5. **Enhanced Safety Features**

9. References

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