Project Report For CS667: INTRODUCTION TO INTERNET OF THINGS & ITS INDUSTRIAL APPLICATIONS
2024-2025 Semester I

Project Title:
Smart Cradle

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1. Introduction:

Parenting today requires smart tools to make baby care easier. Traditional cradles do not have features to help with monitoring or automation, so parents need to watch over their baby constantly. This smart cradle uses IoT and machine learning to detect when a baby cries, monitor health, and keep the baby comfortable. It reduces the parent's effort and makes baby care simpler and more efficient.

2. Tasks:

1. Automate cradle swinging upon baby cry detection.
2. Turn On LED and Buzzer upon Poop and Pee detection.
3. Health Monitoring.
4. GUI to get data from different sensors and Swing Cradle.

3. Proposed Solution:

3.1. Cry Detection For detecting wether the baby is crying or not through audio, we have trained a decision tree classifier on a dataset we generated ourselves. We curated the dataset from audioset platform which contains over 2.1 million videos with labeled audio data.The data is labeled by humans. Using this labeled data, we could download approximately 500 10 second audio clips which contains a baby's cry and 500 10-seconds audio clips in which a baby does not cry. All the audio data was stripped down to length of 10 seconds as our raspberry pi will be capturing 10 seconds audio segments in the real world. We reduce the sampling rate of the audio to 38000KHz as we only need to capture the audio in the frequency spectrum in which the baby cries. Then the raspberry pi locally uses the trained decision tree

classifier to make predict whether the audio captured contains a baby's cry or not. The audio is taken through a usb mike connected to the USB port of the raspberry pi.

3.2. Automatic Swing Mechanism The cradle's swinging is automated using a stepper motor, which provides precise control over the movement. The motor is connected to the cradle frame and is controlled by a Raspberry Pi. When the system detects a baby cry using the machine learning model, the motor is activated to gently swing the cradle.

The stepper motor allows:

- Smooth and consistent swinging motion.
- Immediate response to baby cries, reducing manual intervention.

The swing can also be started or stopped manually through the Flask-based web interface, giving caregivers full control over the cradle's operation.

3.3. Pee and Poop Detection The system uses a soil moisture sensor to detect whether the baby's diaper is wet, indicating pee or poop. This sensor is placed under the baby's crib mattress, where it can measure changes in moisture levels. When moisture is detected, the system triggers:

- LED Light: A visual alert that turns on to notify the caregiver.
- Buzzer: An audible alert that sounds to draw attention to the wet diaper.
- Notification : Gets alert of moisture detected on Interface.

This automated feature ensures that caregivers are immediately alerted when the baby needs a diaper change, making it easier to attend to the baby promptly and maintaining hygiene. The moisture sensor is calibrated to detect even small amounts of moisture, ensuring the system reacts in time to prevent discomfort.

3.4. HTTP Communication and Flask Interface The system uses HTTP (Hypertext Transfer Protocol) to enable communication between the Raspberry Pi (RPi) and the user interface. The Flask web server, running on the Raspberry Pi, handles all the requests from the interface, allowing real-time interaction with the smart cradle.

The Flask-based graphical user interface (GUI) provides a simple, user-friendly platform for caregivers to monitor and control the system. Through this interface, users can:

- Swing the Cradle: The caregiver can remotely start or stop the cradle's swing with the press of a button.
- Check for Moisture: The moisture sensor data is displayed, showing whether the baby's diaper is wet, and alerts can be triggered.
- Monitor Temperature: The real-time temperature of the baby, detected by the MLX90614 IR sensor, is displayed to ensure the baby's comfort.
- Track Pulse and Heart Rate: The heart rate and pulse readings from the MAX30100 sensor are available to monitor the baby's health.

This system ensures that caregivers can interact with the cradle from any device connected to the network, making it easy to manage and control the baby's comfort and safety remotely.

3.5. Health monitoring The smart cradle is equipped with sensors to monitor the baby's vital signs and ensure their health and comfort. The system tracks the following parameters:

- Temperature Monitoring:The MLX90614 IR sensor is used to measure the baby's body temperature without any physical contact. This non-invasive infrared sensor detects temperature in real-time, ensuring the baby is not too hot or cold. The temperature data is continuously updated on the web interface, providing caregivers with up-to-date information.
- Heart Rate and Pulse Monitoring: The MAX30100 sensor is responsible for monitoring the baby's heart rate and pulse. This optical sensor uses infrared light to detect blood flow and calculate the heart rate and pulse rate. The data is displayed on the interface for caregivers to monitor the baby's health status.

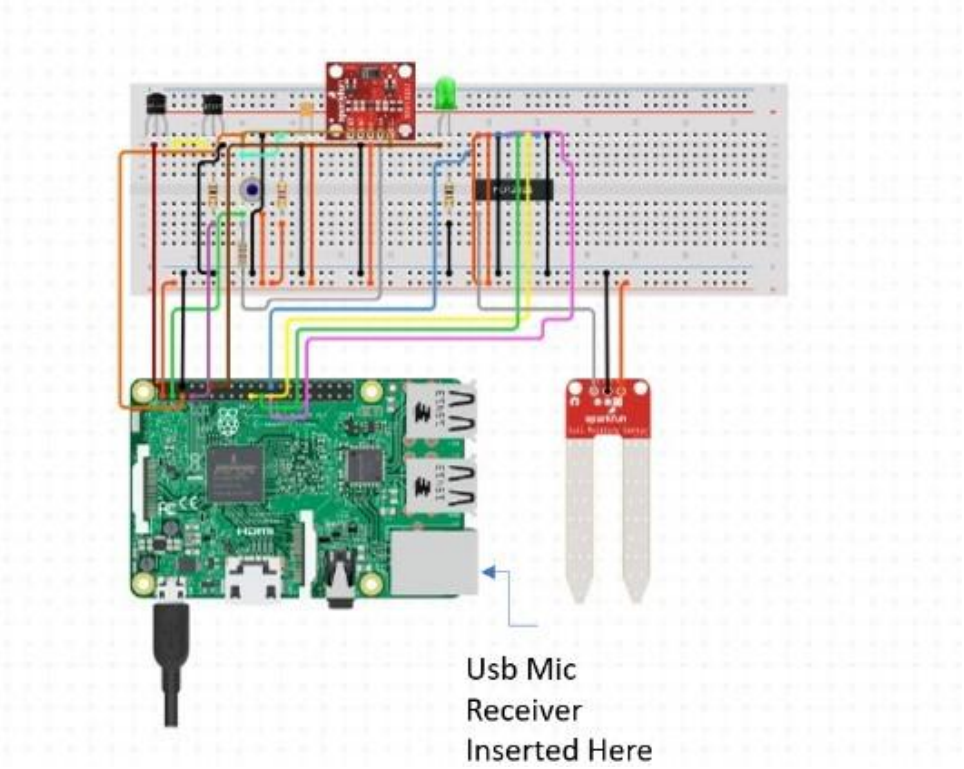
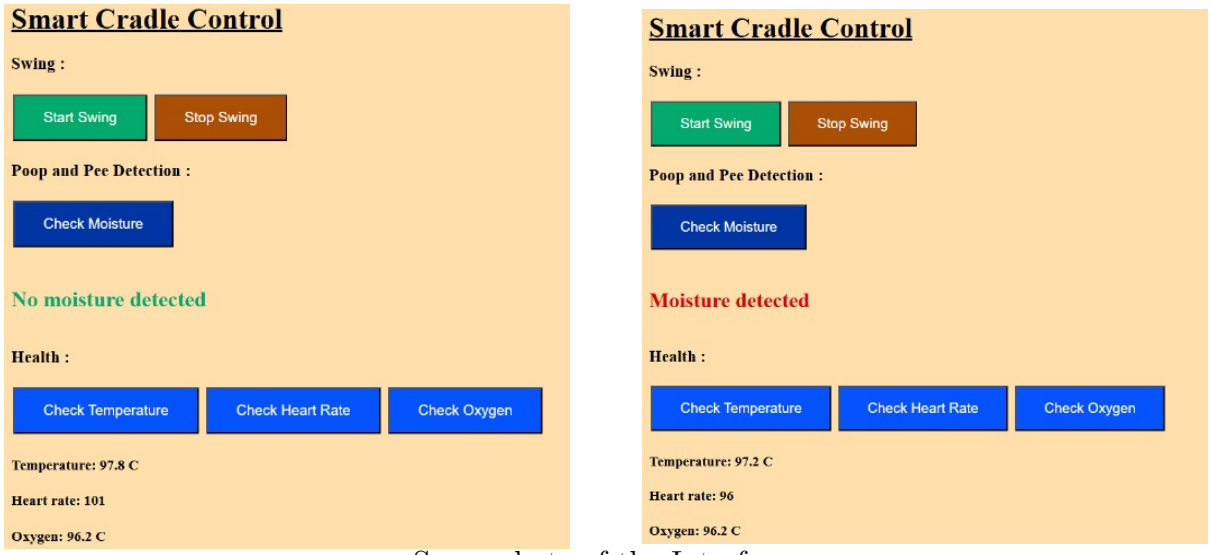


Figure 1: Pin Connections of Sensors with Raspberry Pi.

4. Results:

The system reliably detects baby cries and automates cradle swinging. The sensors provide accurate health and environmental data, while the Flask-based interface enables seamless remote interaction.



Screenshots of the Interface.

5. Conclusion:

The IoT-based smart cradle system effectively combines machine learning and advanced sensing technologies to improve baby care. It reduces caregiver stress and ensures the baby's comfort and safety, showcasing the potential of IoT in healthcare applications.

6. Link to source code:

Click here for source code link

7. Contribution of each Team member:

- Swaraj Sonavane: 40% (Cry Detection, Dataset Generation, ML model Implementation)
- Kumari Ritika: 40% (Automatic swing (software and hardware) implementation, GUI development and moisture detection)
- Ayushi Mishra: 20%(Temperature, Heart Rate and Pulse Monitoring)

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