IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁞ Peer-reviewed & Refereed journal ⁞ Vol. 13, Issue 12, December 2024

DOI: 10.17148/IJARCCE.2024.131250

Smart cradle system using IOT

Prof. Prakruthi G R[1], Vivek S[2], Yogesh R[3]

Assistant Professor, Information Science Department, East West Institute of Technology, Bangalore, India[1]

Student, Information Science Department, East West Institute of Technology, Bangalore, India[2]

Student, Information Science Department, East West Institute of Technology, Bangalore, India[3]

Abstract: The IoT-based smart cradle introduces a paradigm shift in infant care, integrating cutting-edge technology to provide a comprehensive solution for modern parents. This cradle is equipped with an array of sensors that constantly monitor the baby's well-being. From tracking ambient temperature to sensing heartbeat and sound levels, the cradle gathers real-time data, offering parents valuable insights into their child's health and comfort. Caregivers gain remote access to the cradle's functionalities, which enables them to observe various aspects of the infant's surroundings and environment. This work aims to provide better monitoring of the infant by utilizing Machine Learning models for the classification of the infant's emotions as well as for intruder detection. This seamless integration of the cradle with IoT technology ensures that parents receive instant alerts and notifications in case of any anomalies, fostering a heightened sense of security.

INTRODUCTION

Childcare is a huge challenge and hurdle for a working parent. Parents cannot always care for their babies and spend time monitoring them due to other responsibilities. Keeping an eye on the infant and raising children in this present career-oriented world is a difficult challenge. In today's fast-paced world, parents often face challenges in ensuring the optimal well-being of their infants, especially during sleep and rest periods. There are a lot of security concerns that parents have with various daycare facilities and caregivers. The continuous dedicated monitoring of the baby expected by the parents cannot be fulfilled due to the lack of time.

Traditional baby cribs lack advanced monitoring and interaction capabilities, leaving parents concerned about their baby's safety, health, and overall comfort. Additionally, the demands of modern lifestyles require parents to balance childcare with other responsibilities, making it challenging to provide continuous, real-time attention to their infants. Thus, we proposed an IoT-based smart cradle to connect the babies and parents in a safe environment. In today's world, we can observe a rise in systems that apply the concept of the Internet of Things(IoT). The main attraction of this technology lies in the connection of “Things” to the Internet. These include various sensors, actuators, and other smart objects. This allows us to convert all physical environment parameters into digital values for monitoring and analysis. IoT also allows the introduction and encouragement of various smart industries. IoT can easily be found in our environment in healthcare, houses, cities, agricultural and transportation industries to name a few.

PROPOSED SYSTEM

The Smart Cradle System using IoT addresses the challenges faced by parents and caregivers in ensuring an infant’s comfort and safety while reducing the stress of continuous monitoring. The system incorporates IoT technology with sensors to monitor the baby's presence, crying, movements, and environmental conditions such as temperature and humidity. Actuators, including a motorized rocking mechanism, adaptive lighting, and speakers, respond automatically to soothe the baby when necessary. A connected mobile app allows parents to monitor their child in real-time through live video streaming, receive alerts about anomalies, and control cradle functions remotely. The cradle's microcontroller processes sensor inputs to trigger appropriate responses, while cloud integration stores data for analysis and remote accessibility. This innovative solution automates baby care by providing timely responses to the baby's needs, ensuring comfort and safety, and offering convenience to parents. Reliable power backup, robust security for transmitted data, and user-friendly features make this system an effective and practical tool for modern childcare.

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

DOI: 10.17148/IJARCCE.2024.131250

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.

A. Recurrent Neural Networks (RNN): RNN play a pivotal role in capturing temporal dependencies within infant sleep data. Specifically, RNNs excel at processing sequential information, making them adept at discerning intricate patterns and variations in sleep stages over time. By leveraging the recurrent nature of RNNs, the proposed system enhances the accuracy of sleep stage classification and enables the development of the innovative "DreamFlowRNN" algorithm, contributing significantly to the system's predictive capabilities for informed parenting decisions. These learning models are well-suited for dispensation of progressive data. These networks possess a feedback loop that allows information to persist across time steps, enabling them to capture temporal dependencies within sequences. The hidden state of an RNN at time step value tsv is denoted by h_tsv and is computed as follows:

$h\_tsv = f(IpWm * x\_tsv + U * h\_tsv-1 + b)$ --- (1)

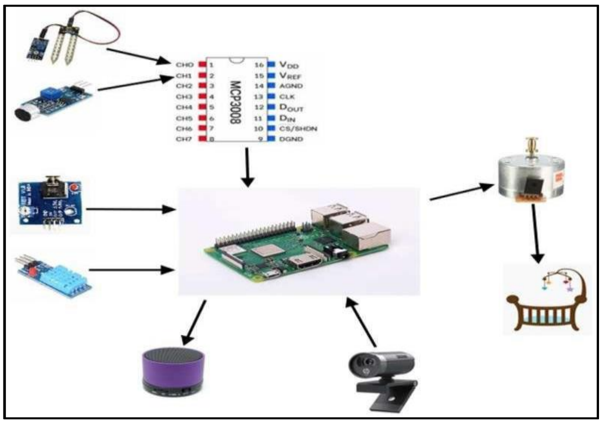
Where:
x_tsv is the input at time step value tsv,
IpWm is the input-to-hidden weight matrix representation, U is the hidden-to-hidden weight matrix representation,
b is the bias span, and f is the activation role.

B. Flow-based Model: Flow-based models are models are well-known for their ability to generate realistic samples and are employed in the proposed system to enhance sleep pattern generation.

C. DreamFlowRNN: Innovative AI-Driven Predictive Parenting Algorithm:
DreamFlowRNN is the novel AI-driven predictive parenting algorithm proposed for the IoT-Enabled Cradle System. It combines the strengths of Recurrent Neural Networks and Flow-based models to perform accurate sleep pattern analysis and prediction.

Training Phase:
1. Initialize the RNN parameters: IpWm, U, and b.
2. Iterate through the training dataset of sleep patterns (x) and their corresponding labels (y).
3. For each time step t in the sequence, compute the hidden state value representation h_tsv using the RNN equation described above.
4. Pass the final hidden state value representation h_T through a linear layer to obtain the flow parameters (θ) for the flow-based model.

SYSTEM ARCHITECTURE



IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 12, December 2024

DOI: 10.17148/IJARCCE.2024.131250

Conduction of a thorough analysis and study of the system requirements to identify potential challenges, assess the viability of the proposed system, and ensure completion of the project. Sensor requirements are analyzed along with its integration and data processing capabilities.

Compatibility of the Raspberry Pi to handle processing is studied. Along with these technical requirements, hardware availability is analyzed. Resources required include hardware components and the various software libraries and packages. Assess the functionality of the hardware components. Study the various algorithms for emotion classification. Compute the estimated cost of the project.

The use of the cloud has been to store the data. The system makes use of various components to monitor the environment and activities of the infant including sensors and a servo motor. Additionally, the motor was driven by a microcontroller upon the cry detection.

The hindrance that was observed in this system was the absence of the machine learning algorithm and that it only used a microcontroller.[6] In another system, where a sensor for noise detection is used to detect the baby's cries or loud noises, as the mobile toy rotates.

HARDWARE AND SOFTWARE REQUIREMENTS

- Requirements for Hardware:

Microcontroller/Development Board
ESP32/ESP8266 (preferred for IoT capabilities like Wi-Fi and Bluetooth). Alternatives: Arduino with Wi-Fi module (e.g., NodeMCU or HC-05 for Bluetooth).
Sensors
Sound Sensor: Detect baby crying.
Temperature and Humidity Sensor: Monitor environmental conditions (e.g., DHT11/DHT22).
Actuators
Servo Motor: For cradle rocking mechanism.
LED Indicators and Buzzer
For local alerts.
Connectivity Module
Built-in Wi-Fi in ESP32/ESP8266 or external modules like HC-05 (Bluetooth).
Cradle Structure
A physical cradle frame for the system setup.
Relay Module
For switching on/off devices (e.g., a fan or light).

- Software Requirements:

Embedded Programming Tools
Arduino IDE: For programming the microcontroller.
ESP-IDF (for ESP32 advanced features, optional).
IoT Platform
Blynk, **Adafruit IO**, or **Firebase**: For IoT dashboard and notifications. Alternatives: Custom dashboard using **Node-RED** or **ThingsBoard**.
Mobile Application (Optional)
Custom app developed using **Flutter**, **React Native**, or **MIT App Inventor**.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 12, December 2024
DOI: 10.17148/IJARCCE.2024.131250

RESULTS

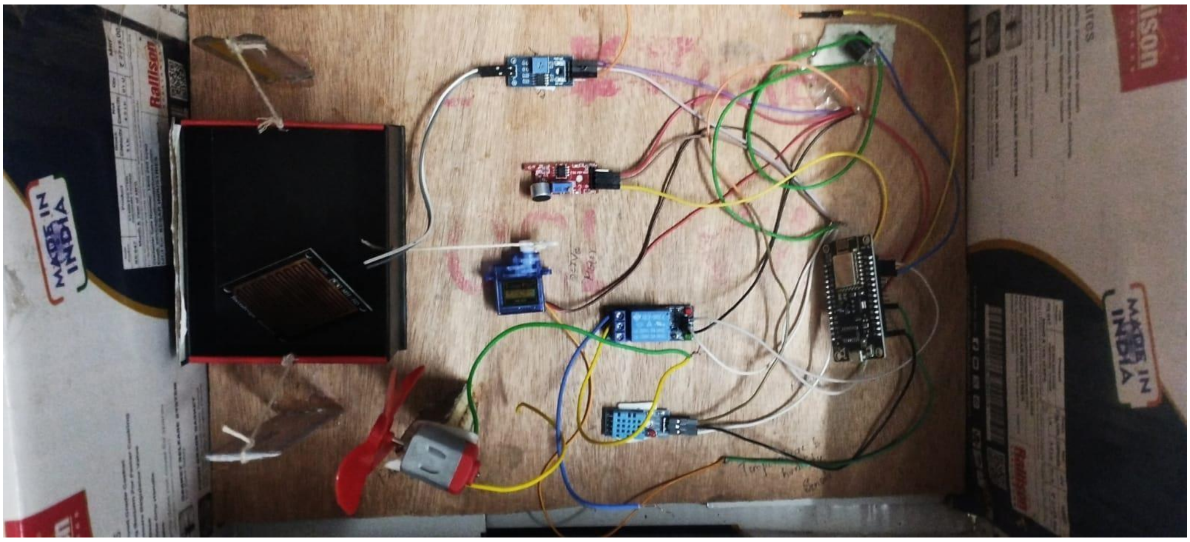


Figure 1: Smart cradle

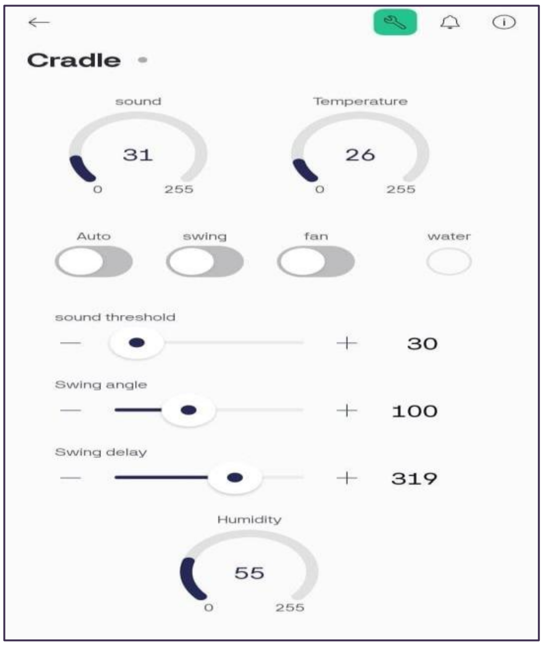


Figure 2: Home Page

CONCLUSION

This research work has presented a novel approach, aimed at revolutionizing infant care through innovative AI and IoT integration. The proposed system leverages the advanced DreamFlowRNN algorithm, combining Recurrent Neural Networks (RNN) with flow-based models to accurately predict sleep patterns, classify sleep stages, and detect disturbances in real-time. The integration of smart sensors within the IoT-Enabled Cradle System enables continuous monitoring of physiological and environmental parameters, offering parents invaluable insights into their baby's sleep behaviour. The simulation analysis showcased the superior performance of DreamFlowRNN over existing algorithms, LSTM, CNN, and SVM, in various metrics, including classification accuracy, precision for sleep stages and disturbances, inception score, and Frechet Inception Distance (FID). DreamFlowRNN consistently demonstrated higher accuracy and precision in sleep pattern classification and detection, and its ability to generate diverse and realistic sleep

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⋇ Peer-reviewed & Refereed journal ⋇ Vol. 13, Issue 12, December 2024

DOI: 10.17148/IJARCCE.2024.131250

patterns further validates its efficacy for Predictive Parenting. Through the IoT-Enabled Cradle System and the proposed DreamFlowRNN algorithm, parents can access realtime sleep insights and personalized recommendations for sleep routines, fostering a nurturing environment conducive to their baby's optimal sleep development. The integration of AIDriven Sleep Pattern Analysis with IoT technologies marks a significant step towards addressing the evolving needs of modern parenting and facilitating early identification and intervention of sleep-related issues. While this research presents a promising foundation for Predictive Parenting with the IoT-Enabled Cradle System and DreamFlowRNN, several avenues including conducting longitudinal studies with a larger and diverse cohort of infants can provide a more comprehensive understanding of sleep patterns and behaviour over time, and exploring the integration of multiple data sources, such as audio, video, and environmental data, can further enrich the analysis of sleep patterns and disturbances can be done for future exploration in the domain.

REFERENCES

[1]. Joseph, S., Gautham.J, A., Kumar, A., & Harish Babu, M. K. (2021). IOT Based Baby Monitoring System Smart Cradle. In 2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India (pp. 748-751). doi: 10.1109/ICACCS51430.2021.9442022.

[2]. Oliveira, K., Cardoso, F., Sousa, F., & Moreira, W. (2020). A Lightweight Slice-Based Quality of Service Manager for IoT. IoT, 1(1), 49-75. doi: Not specified in the reference.

[3]. Fattah, S., Sung, N.-M., Ahn, I.-Y., Ryu, M., & Yun, J. (2017). Building IoT Services for Aging in Place Using Standard- Based IoT Platforms and Heterogeneous IoT Products. Sensors, 17(10), 2311. doi: Not specified in the reference.

[4]. Oktian, Y. E., Witanto, E. N., & Lee, S.-G. (2021). A Conceptual Architecture in Decentralizing Computing Storage and Networking Aspect of IoT Infrastructure. IoT, 2(2), 205-221. doi: Not specified in the reference.

[5]. Patil, A. R., Patil, N. J., Mishra, A. D., & Mane, Y. D. (2018). Smart Baby Cradle. In 2018 International Conference on Smart City and Emerging Technology (ICSCET), Mumbai, India (pp. 1-5). doi: 10.1109/ICSCET.2018.8537356.

[6]. Nawaz, A. (2015). Development of an Intelligent Cradle for Home and Hospital Use. National Inst. of Technology. doi: Not specified in the reference.

[7]. Saude, N., & Vardhini, P. A. H. (2020). IoT-based Smart Baby Cradle System using Raspberry Pi B+. In 2020 International Conference on Smart Innovations in Design, Environment, Management, Planning and Computing (ICSIDEMPC), Aurangabad, India (pp. 273-278). doi: 10.1109/ICSIDEMPC49020.2020.9299602.

[8]. Goyal, M. (2013). Automatic E-baby Cradle Swing Based on Baby Cry. ACSD CDAC Mohali Punjab INDIA and Dilip Kumar ACSD, 71(21), June.

