MASTERS THESIS PROPOSAL

IoT based Smart Cradle for Baby Monitoring System using Rasberry Pi

Student:
Wenqian Li
UNI
wli6@uw.edu

Committee Chair:
Prof. advisor name
Committee Member:
Prof. Someone else
Committee Member:
Prof. Somebody else

School of Engineering and Technology
October 29, 2024

Abstract

This paper presents an IoT-based Smart Cradle for Enhanced Baby Monitoring System using Raspberry Pi and Azure Vision. The project aims to provide real-time monitoring of the baby's environment by leveraging sensors, cloud computing, and computer vision technologies. The system enables parents to promptly respond to abnormal conditions, enhancing the safety and security of the baby. With instant alerts and automated responses, parents can have peace of mind and remotely interact with their baby. The system stores sensor data over time, allowing for trend analysis and providing valuable insights into the baby's health and well-being. The intuitive interface enhances the user experience, making it easy for parents to monitor their baby's environment and access historical data analysis.

Contents

1 Introduction **4**

2 Related Work **4**

3 Background **5**

4 Methodology **6**

5 Experiments **8**

5.1 Datasets 8

5.1.1 Dataset One 8

5.2 Evaluation 8

5.2.1 Metrics 8

6 Deliverables **8**

7 Timeline **8**

8 Education Statement **8**

1 Introduction

I nfant monitoring is essential for ensuring their safety and well-being. This project introduces an IoT-based Smart Cradle for Enhanced Baby Monitoring System using Raspberry Pi and Azure Vision. The motivation behind this project is to provide parents with real-time monitoring capabilities and peace of mind knowing they will be notified of any issues in their baby's environment. The goals of the project include providing enhanced safety and security for the baby, enabling remote interaction between parents and the baby, and facilitating data analysis to gain insights into the baby's health and well-being [8]. The specific contributions of this project include:Integrating sensors, cloud computing, and computer vision technologies to create an IoT-based Smart Cradle for Enhanced Baby Monitoring System. Providing real-time monitoring of the baby's environment and enabling prompt responses to abnormal conditions. Enabling remote interaction between parents and the baby through automated responses. Facilitating data analysis to gain insights into the baby's health and well-being.

2 Related Work

A .Sensor Technology: Previous research has explored the use of various sensors for monitoring infant vital signs and environmental conditions. These sensors may include temperature sensors, humidity sensors, motion sensors, sound sensors, and air quality sensors. Different sensor types are employed to provide comprehensive monitoring of the baby's environment and detect abnormalities or changes in conditions that may affect the baby's well-being[3, 7].

B .Edge Computing: Identify applicable funding agency here. If none, delete this text box. Edge computing plays a crucial role in IoT-based infant monitoring systems by enabling real-time data processing and analysis at the edge of the network, closer to the data source. This reduces latency and allows for faster response times to detected abnormalities or events. Edge computing platforms, such as Raspberry Pi, are commonly used in these systems to process sensor data locally and trigger alerts or actions as necessary[6, 5].

C .Cloud Services: Cloud computing services are utilized to store, manage, and analyze large volumes of sensor data collected from IoT devices. Cloud platforms, such as Azure, AWS, and Google Cloud Platform, offer scalable and reliable infrastructure for hosting IoT applications and processing sensor data. Cloud services enable features such as data storage, analytics, visualization, and remote access to monitoring systems[2].

D .Computer Vision: Computer vision technologies are increasingly integrated into IoT-based infant monitoring systems to analyze visual data captured by cameras. Computer vision algorithms can be used to detect specific events or objects, such as a crying baby, facial expressions, or gestures, enabling more advanced monitoring capabilities and automated responses[9, 3].

E .Data Analysis and Visualization: Data analysis techniques are applied to sensor data collected over time to identify patterns, trends, and anomalies in the baby's behavior and environment. Time-series databases, such as InfluxDB, are commonly used for storing and querying sensor data. Data visualization tools, such as Grafana, are employed to create visual representations of sensor data, enabling caregivers to gain insights into the baby's health and well-being[3].

F .Dashboards: User-friendly interfaces, such as mobile applications or web dashboards, provide caregivers with easy access to monitoring systems and real-time data insights. These interfaces allow caregivers to remotely monitor the baby's environment, receive alerts, and access historical data analysis from their smartphones or other devices.

3 Background

I nfant monitoring is crucial for ensuring the safety and well-being of babies, as it helps parents detect potential issues in real-time and respond promptly. Traditional baby monitoring systems, while effective, often lack the advanced features that modern technology can provide. The integration of Internet of Things (IoT) technologies into baby monitoring systems enhances their capabilities, allowing for more comprehensive monitoring solutions. The Internet of Things (IoT) encompasses a network of interconnected devices that communicate and exchange data over the internet. In the context of healthcare, IoT applications have gained significant traction, enabling real-time monitoring of patients and improving health outcomes. IoT-based systems leverage various sensors to gather data, which can be analyzed to provide insights into an individual's health condition[1]. Cloud computing platforms like Azure and AWS provide scalable and reliable infrastructure for storing and analyzing large volumes of data generated by IoT devices. They enable features such as data storage, analytics, and remote access, making it easier for parents to monitor their infants from anywhere. The ability to analyze data collected over time also helps in identifying trends and anomalies in the baby's behavior and environment[2]. This project aims to leverage these technologies to create a comprehensive Smart Baby Monitor, ensuring enhanced safety and well-being for infants while providing parents with peace of mind.

In[10], T. Wu and P. Chen proposed an independent baby care system with an Arduino-based system to check on the heartbeat, temperature, and humidity of a premature baby. The Arduino microcontroller is interfaced with input from the temperature sensor and heartbeat sensor. It sends that data through a Wi-Fi module to a web-based server to show constant real-time data from different sensors regarding the baby. If heartbeat or temperature is above or below a preset value, it will be displayed instantly on the website, and the website will command the buzzer and bulb accordingly.

M. P. Joshi and D. C. Mehetre proposed a mobile application-based system that shows a constant update of a baby placed in their smart cradle system [4]. The system can detect if the mattress for the baby is wet or not by using a moisture sensor. It can identify the baby's crying with a noise sensor and contains a camera for live-streaming to the app. The cradle also swings automatically when crying is detected with the help of a driver circuit. Finally, the authors have also proposed using IR cameras for night vision as a future scope for advancement.

The following section describes the hardware and software implementation of the proposed system in detail.

4 Methodology

S oftware:

Node-RED: A visual programming tool that allows for wiring together hardware devices, APIs, and online services. Node-RED facilitates the integration of various system components, enabling the automation of tasks such as data collection and alert notifications.

Grafana:A data visualization and monitoring platform used to create dashboards that display real-time data from the monitoring system. Grafana provides caregivers with an intuitive interface to visualize the baby's environment and health metrics.

InfluxDB: A time-series database that stores sensor data collected from the system. InfluxDB is optimized for high-write loads, making it suitable for continuously streaming data from various sensors.

Azure:A cloud computing service utilized for hosting and analyzing data. Azure provides scalable resources for processing sensor data and running computer vision algorithms to detect specific events, such as a baby crying. STL Files: These 3D model files are used for printing the prototype crib. The designs ensure that the hardware components are housed securely while allowing for functionality and safety.

Hardware:

Raspberry Pi: A single-board computer that serves as the core processing unit for the Smart Baby Monitor system. The Raspberry Pi runs the necessary software and processes data from connected sensors.

Grove Pi Sensors: A variety of sensors connected to the Grove Pi interface, which include: Sound Sensors: Monitor ambient noise levels to detect crying. Motion Sensors: Detect the baby's movements. Temperature Sensors: Monitor the environmental temperature. Humidity Sensors: Track humidity levels to ensure comfort. Air Quality Sensors: Assess air quality and detect harmful gases[7].

3D Printer: Used to create a prototype of the crib that houses the Raspberry Pi and sensors. The 3D-printed components are designed to integrate seamlessly with the electronic hardware.

5 Experiments

5.1 Datasets

5.1.1 Dataset One

5.2 Evaluation

5.2.1 Metrics

6 Deliverables

7 Timeline

8 Education Statement

References

[1] Alam, H., Burhan, M., Gillani, A., Haq, I., Arshed, M. A., Shafi, M., and Ahmed, S. Iot based smart baby monitoring system with emotion recognition using machine learning. *Wireless Communications and Mobile Computing 2023* (04 2023).

[2] Chen, J., Wang, C., Li, J., Jiang, C., and Duan, C. A non-isolated three-level bidirectional dc-dc converter. In *2018 IEEE Applied Power Electronics Conference and Exposition (APEC)* (2018), pp. 1566–1570.

[3] Iannini, L., Mancinelli, A., Lopez-Dekker, P., Hoogeboom, P., Li, Y., Uysal, F., and Yarovoy, A. Prf sampling strategies for swarmsar systems. In *IGARSS 2019 - 2019 IEEE International Geoscience and Remote Sensing Symposium* (2019), pp. 8621–8624.

[4] Joshi, M., and Mehetre, D. Iot based smart cradle system with an android app for baby monitoring. pp. 1–4.

[5] Matthews, E., Gao, Y., and Shannon, L. Exploring writeback designs for efficiently leveraging parallel-execution units in fpga-based soft-processors. In *2020 IEEE 28th Annual International Symposium*

on Field-Programmable Custom Computing Machines (FCCM) (2020), pp. 120–128.

[6] Nakamura, S., Murabayashi, F., Ieda, M., and Sawa, G. Degradation of polyethylene by combination of thermal aging and radiation. In *1984 IEEE International Conference on Eletrical Insulation* (1984), pp. 271–274.

[7] Park, Y., Lee, S. B., Yun, J., Sasic, M., and Stone, G. C. Air gap flux-based detection and classification of damper bar and field winding faults in salient pole synchronous motors. *IEEE Transactions on Industry Applications 56*, 4 (2020), 3506–3515.

[8] Pratap, N., Anuroop, K., Devi, P. N., Sandeep, A. A., and Nalajala, S. Iot based smart cradle for baby monitoring system. *2021 6th International Conference on Inventive Computation Technologies (ICICT)* (2021), 1298–1303.

[9] Tegos, S. A., Diamantoulakis, P. D., Lioumpas, A. S., Sarigiannidis, P. G., and Karagiannidis, G. K. Slotted aloha with noma for the next generation iot. *IEEE Transactions on Communications 68*, 10 (2020), 6289–6301.

[10] Wu, T.-H., and Chen, P.-Y. Baby care system design for multisensor applications. In *2019 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS)* (2019), pp. 1–2.