

Smart Monitoring System for Baby

Maresh Kaluti¹, Nirbhay S Urs², Kavana D³, Sahana H⁴ and Harshitha K⁵

¹⁻⁵Computer Science and Engineering, PES College of Engineering, Mandya, Karnataka, India

Email: ¹maresh.rkcet@gmail.com, ²nirbhaysanjevurs@gmail.com, ³kavanad273@gmail.com

⁴sahanahsana14@gmail.com, ⁵harshithakundar03@gmail.com

Abstract—In this revolutionary world, we are noticing an exponential increase in women's workforce. This has become one of the main reasons that affect baby care in many families from the birth of the baby to a certain age. The most vital factors that are to be followed in infants are body temperature and sleep patterns. In this IOT and ML Project, which is based on baby monitoring system, which is a smart cradle structure, tracks the overall temperature of the room and its humidity with sound of the baby, and all these data received from the IOT sensor network will be processed using Raspberry Pi and transferred to a web platform and checked in real-time. If the baby is crying, the cradle will start swinging automatically. If we observe any increase in the room temperature, the fan will be turned on. This project is included with an emotion recognition unit. Furthermore, it stores data in private cloud servers and includes a GUI. The end result of our proposed experiment indicates that this assistant could ease some workload of parents and enable them to take utmost care of their infants.

Index Terms— IOT, Machine Learning, Autonomous System, Raspberry Pi, Emotion Recognition, Smart Cradle.

I. INTRODUCTION

Many parents cannot make enough time for their small children due to clerical work and lack of people. Many new parents are inexperienced in raising children. Babies, on the other hand, should always be careful and seek attention. We need to devise an easy way to quickly calm an excited baby. Therefore, it is necessary to help parents take care of their infant by providing a single product that constantly monitors the infant. To help such parents, we decided to create a smart cradle to help mothers and fathers monitor their children and do some household work simultaneously. As lives started getting busier and parents to have a little time to provide for their little ones. The cradle systems started getting more modified. It becomes difficult for parents to understand the language of their infants but baby monitors help to try and understand their infants by providing them with vitals so the Parents can understand the cause of baby discomfort. If the system understands the baby's discomfort and why the baby is crying, it means that both working and non-working parents can save time and pay the care and attention needed to the baby. The prototype model of the room contains a moisture sensor, voice recognizer and other electronic devices connected to Arduino. The room device works with the sensor and Arduino adjustments. Parents can start & stop the operation of electronic devices according to the specified conditions and can operate them with their mobile phones even when they are not in the baby's room. There are many project works done for baby monitoring but they work only to monitor baby's temperature, heartbeat and some other baby's physical conditions. But there is less work done on the whole baby caretaker.

A) Problem Statement

The current number of working mothers has greatly increased. Subsequently, baby care has become a daily challenge for many families. Therefore, most parents send their babies to grandparents and foster parents. However, parents cannot continuously monitor the baby's condition, whether under normal or abnormal conditions. Therefore, IoT-based baby monitoring system is proposed as an efficient and cost-effective IoT-based real-time monitoring system.

B) Motivation

In the early stages, the baby needs enough rest and sleep to grow and develop. Therefore, it is the parent / guardian's responsibility to provide the baby with the necessary care and attention. However, in the modern lifestyle, parents are busy, have little time to care for their children, and do a lot of work. When a baby is born in a family, there must be someone to take care of the baby. Some parents have to fulfill their dual obligation to monitor their baby and do household chores. Keeping a servant could be an option but not all can afford servant. To help such parents, we decided to create a smart cradle to help mothers and fathers monitor their children while doing household chores.

II. OBJECTIVE

- A. The main purpose of this project is to design an integrated plan for childcare assistants.
- B. Finding out if the baby is wet or not. Infant hygiene is important so the quality of the crib is monitored. If the humidity level exceeds the limit, warnings are sent.
- C. Monitor the temperature and humidity of the baby's room. The ideal temperature for a baby, especially a newborn, is said to be 20-23 degrees Celsius. The raspberry pi switches on the fan placed on the cradle when the room temperature exceeds a certain limit.
- D. In the case of crying, the cradle will swing automatically.
- E. The infant monitoring unit collects data from various sensors and controls the cradle to create a comfortable environment for the baby. The data analysis unit includes crying detection, crying analysis and emotional monitoring units that determine the baby's emotional state.

III. LITERATURE SURVEY

A) Automatic E-baby Cradle Swing based on Baby Cry By Misha Goyal and Dilip Kumar

Introduces the design and launch of the new low-cost traditional E-Baby Cradle which automatically changes when a baby cries. The speed of the cradle can be controlled as required by the parent. The system has an inbuilt alarm that indicates wetness of mattress and duration of cry. This system can be enhanced with more features like a baby rotating toy with music and camera. Baby can be monitored live via 3G by their parent.

B) Baby cry detection in domestic environment using deep learning By Yizhar Lavner, Rami Cohel, Dima Ruinskiy, Hans Ijzerman

The author proposes two machine learning algorithms that automatically detect baby crying with voice recording. Logistic regression is the first algorithm. To train this classifier, features such as Mel frequency cepstral coefficients, pitch, formants, etc. are extracted from the recording. The second algorithm uses a convolutional neural network (CNN) that works with the log mel filter bank representation of audio recordings. Performance evaluation of the algorithms is carried out using a dataset which consists of babies (0-6 months old) recording along with respective tags. The recordings contain sounds of baby crying, parents talking and door opening and closing sounds. When compared to the logistic regression classifier, CNN classifier shows better performance.

C) Image processing techniques to recognize Facial Emotions By A. Mercy Rani, R. Durgadevi

Image Processing Techniques to Recognize Facial Emotions. Includes face detection, non-skin region extraction and morphological processing to recognize emotion. First, frame based detection is implemented. Then image quality is analysed. Face location is detected using viola-jones algorithm. Extraction of non-skin regions and morphological operations are applied to the extracted image to extract the facial feature for recognition of facial emotions.

D) An emotion Recognition Model Based on Facial Recognition in Virtual Learning Environment By D Yang, A Alsdan, PWC Prasad, AK Singh

This paper provided a proposed model to solve the problem of emotion recognition based on facial recognition in virtual learning environments and the efficiency and accuracy are considered at the same time. Since this study does not deal with image lighting and poses, it is unclear to what extent these factors affect facial expressions and thus final emotion recognition. All of these questions should be investigated and experimentally validated in future studies.

E) Image de-noising using fuzzy and wiener filter in wavelet domain By Akash Kethwas and Bhavana Jharia

The de-noising of images is the initial step in image processing. Robustness and detail preservation are the two most important aspects of modern image enhancement filters. There are several methods for image de-noising in spatial and transform domains. The current trends of image de-noising research are the evolution of mixed domain methods. Based on the result, it is clear that ATMA V with HAAR gives vulnerable results for image de-noising, while HAAR with ATMED wavelet gives better results as compared to previous techniques, as shown in the result part. Thus HAAR with ATMED is the promising method for image de-noising. Future endeavors include a better expandable proportion of wavelet coefficients in order to get better de-noising effects using fuzzy filters.

IV. SYSTEM ANALYSIS

A) Existing System

The existing system presents the design and implementation of a new domestic low cost e-baby cradle that automatically swings when the baby cries. To do this, it has a crying analysis system that recognizes the baby's crying voice and swings the cradle accordingly until the baby stops crying. Cradle speed can be controlled according to user needs. The system has two built-in alarms. One is when the mattress is wet. This is an important parameter to keep your baby in a hygienic condition, second when baby does not stop crying within a specified time, which tells that baby needs attention. This system helps parents and nurses take care of their babies without physical attention.

B) Proposed System

The proposed solution is an infant care assistant consisting of infant monitoring, data transfer, data analysis, and user interface units. The baby monitor collects data from various sensors and controls the cradle to create a comfortable environment for the baby. The data transfer unit is a medium for the transfer of data between the user, the infant monitoring unit and the data analysis unit. The data analysis unit comprises the cry detection, using moisture sensor, temperature sensor, Humidity sensor, Noise sensor which determine the state of the infant. The user interface gives the user global remote access and operational control over the Infant monitoring system.

V. SYSTEM ARCHITECTURE

This system consists of an Arduino UNO microcontroller with a built-in Wi-Fi module. The UNO is a microcontroller based on ESP8266. It has 17 GPIO PINS(0-16) out of which 6 pins (GPIO 6-11) are connected to the flash memory chip. It has both input/output digital pins, a single analog input, inbuilt Wi-Fi module and a USB connection. It contains everything you need to support a microcontroller. Simply connect it to your computer with a USB cable or turn it on with an AC-DC adapter or battery to get started. The microcontroller is connected to the temperature and humidity sensor (DHT11), sound sensor, APR module, BJT, and servomotor. Sound sensors are used to detect baby sounds. That is, it detects the sound and notifies the MCU mainly when the baby is crying. The MCU in turn notifies the Servo motor that makes the cradle swing. When the baby cries in the cradle, the microphone detects this and converts the audio signal into an electrical signal. Then an electrical signal is sent to the amplifier. The microcontroller then notifies the Blynk server, which informs the parents that the baby is crying. At the same time, the microcontroller also notifies the servomotor that rotates the cradle. If the baby relaxes and stops crying the parent is again notified that the baby is fine and stopped crying. After a certain time, the cradle stops swinging. The temperature / humidity sensor consists of a material called a thermistor and an IC on the back of the sensor. To measure humidity, use a humidity detection component with two electrodes sandwiched between a board that holds the humidity. So as long as the humidity change, the conductivity of the substrate changes or the resistance between these electrodes changes. These sensors, on the other hand, use a thermistor to measure temperature. The thermistor is a variable resistor, and its resistance changes as the temperature changes. These sensors are made by sintering semiconductor materials such as ceramics and polymers and changing the resistance significantly with a slight temperature change.

- Raspberry Pi B+ - The data from the sensors is collected and processed by the Raspberry Pi 3B+. Raspberry Pi is a small signal board computer stamped with chips and I/O connectors. The Raspberry Pi receives inputs from the data acquisition unit. The analog sensor signals are converted to digital signals using MCP3208 12-bit Analog to Digital Converter (ADC), which is based on successive approximation register (SAR) architecture. The data is analyzed in the Raspberry Pi and appropriate actions are executed based on the set thresholds and algorithms. The decision making algorithms basically monitor the sensor data and when the threshold is crossed or abnormalities are detected, it raises alerts. These alerts are mailed to the user and also uploaded on the webpage. The Raspberry Pi controls the infant soothing unit which calms down the infant when infant cry is detected. All sensor data and results of the Raspberry Pi control system are uploaded to the local database and private cloud interface for storage and also sent to the webpage for display. The Raspberry pi also receives inputs from the user through the web page to control the infant soothing unit and the camera module
 - Temperature Sensor - These sensors use a solid-state technique to determine the temperature. That is to say, they don't use mercury (like old thermometers), bimetallic strips (like in some home thermometers or stoves), nor do they use thermistors (temperature sensitive resistors).
 - RELAY - Relays are the switches which aim at closing and opening the circuits electronically as well as electromechanically.
 - BATTERY - A rechargeable battery, storage battery, secondary cell, or accumulator is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells.
 - Dc motor - A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy.
 - Moisture sensor- A moisture sensor is used to detect whether the infant has wet the cradle bed or not. Infant hygiene is important and hence the extent to which the cradle bed has been made wet is monitored. If the moisture level crosses a threshold, alerts are sent. The data of the moisture sensor is correlated with the infant's cry for cry analysis and finding the cause of the cry.
 - Fan- When the temperature of the room is above 23 degrees Celsius the fan is switched on by the raspberry pi. The fan is directed towards infant to increase comfort. The fans can be switched on and off remotely
 - GUI- Graphics User Interface (GUI) has been developed to facilitate the user's interaction with the infant. It enables the user to check the temperature and humidity of the infant's surrounding and if the bed is wet
- Camera - Raspberry Pi Camera Module v2 is a high quality 8 mega pixel image sensor. The camera module is mounted to focus directly on the face of infant. Facial features are extracted from the image and analysed to determine emotions. For the emotion sad, the results are correlated with the cry detection and cry analysis results. Furthermore, the camera module is used to check whether the infant is awake or has left the cradle. If the infant leaves the cradle then alerts are sent and a loud alarm is sounded from the cradle speakers

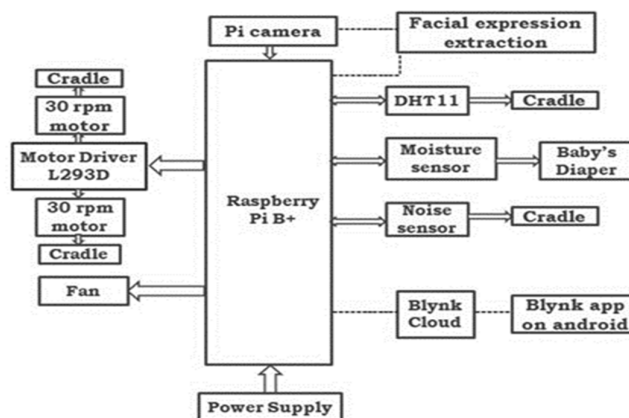


Figure. 1 System Architecture Diagram

A) Hardware Requirements

- Raspberry pi
- Pi camera
- DHT11 sensor
- Moisture sensor
- Noise sensor
- Relay
- DC Motor

B) Software Requirements

- Blynk app
- Python
- Py-charm
- Open Cv

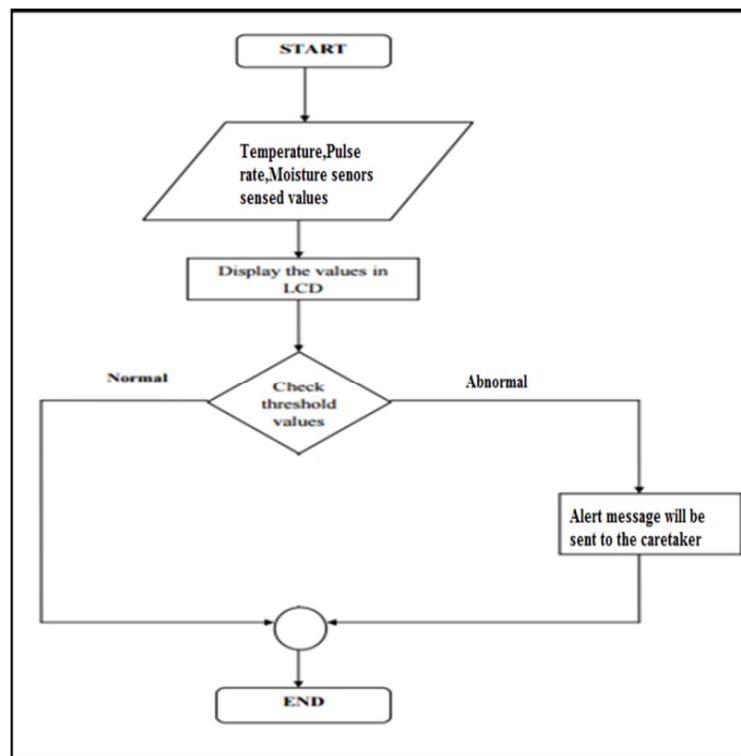


Figure. 2 Data Flow Diagram

VI. CONCLUSIONS

The baby care assistant can collect important information about the baby and its surroundings through sensors and process this information to determine the baby's condition by voice and image processing and automatically rock the cradle, play music, and adjust the room temperature to soothe a crying child. The Infant Care Assistant is able to successfully assist busy parents in taking care of their infants. In addition, the system can store important data and trigger alarms. Finally, incorporating a GUI makes it user-friendly and interactive.

VII. FUTURE SCOPE

Additional features such as an android application can be integrated to receive live feed of the infant, control the music, rock the cradle and also adjust temperature and other parameters as required. By studying the behavioral patterns of the infant, a deep learning model can be trained to identify and implement better conditions for the infant. This proposed prototype can be turned into a real device. Different types of cameras such as the

360degree rotating ones can be used for better views of the room or ones with better resolution for better picture quality. The system can be integrated with heart rate and respiratory rate measuring systems whose outputs can be directly sent to any considering doctor. The mobile app can be modified to operate with other OS as well.

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