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# Smart Cradle for Baby Monitoring

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**Abstract:** The concept of an automated infant carer room is put forth in this project. The primary goal of this concept is to help parents who are extremely busy save time and energy. These days, working people are highly busy. Parents do not have enough time to provide their infants with the care they need. The entire space is therefore configured such that it can detect the baby's activity and function as needed. As they don't have to go and check on their baby frequently till they receive no information regarding the baby, parents may save time and energy. Using sensors and a microcontroller, this scenario's notion is realized. The microprocessor's sensors sense the environment in the room and keep tabs on the baby's behaviour. It functions according to the conditions we place on it. The user will be informed of the baby's status and have access to all data.

***Keywords*****:** *Cloud, Cradle, Remote Video Monitoring, Smartphone*

## 1. Introduction

Owing to office work or lack of resources, many parents are unable to spend enough time with their infants. In addition, a large number of first-time parents are lacking in parenting experience. On the other side, infants need continual care and attention. It is necessary to develop quick, easy techniques for calming angry newborns. Hence, it is necessary to support parents in raising their children by giving them a single product that would always monitor their children, give notifications when attention is needed, raise alarms in case of crises, and enable real-time communication between parents and children.

The first verbal communication of a newborn baby with the world is often their cry. Crying is a natural and essential part of a baby's development and serves as a biological alarm system. When a baby cries, it is a signal to the parents or caregivers that they need attention or assistance. As a result, infant crying serves as an important communication tool between the baby and the caregiver. The crying sound is designed to attract attention and motivate caregivers to take action to alleviate the infant's distress. Responding to a baby's cry is important for building a strong bond between the caregiver and the baby and promoting their healthy development. In some cases, parents or caregivers may find it challenging to identify the reason behind their baby's crying, which can cause stress and anxiety. To address this, there is a need for low-cost, indigenous electronic systems that can detect and communicate the baby's crying signals to the caregiver and for better response.

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Currently, most of the existing mechanical systems used for this purpose are imported and expensive. Therefore, there is a need to develop low-cost electronic systems that can be easily accessible to the general population. One such system is an emotion-based technique that has been implemented using a Convolutional Neural Network (CNN) algorithm. The CNN algorithm is a type of deep learning that can detect patterns and features in visual and auditory data, making it ideal for analysing sound signals, such as baby crying sounds.

Using this technique, the system can identify the emotions associated with the baby's cry, such as hunger, discomfort, or pain. Once the system detects the specific emotion, it sends a message to the parents or caregivers, alerting them to the baby's needs.

## 2. Related Work

A motor in the cradle rotates the movable toy, and noise sensors detect whether the infant is crying or otherwise making a loud noise [1]. When the baby cries out loud, the cradle swings automatically. The infant will be monitored by a camera while it is in the cradle. a GSM module to connect to a parental-controlled remote device. However, due to the presence of devices like fans, heaters, etc., they're a great possibility of the infant being physically hurt. This system also fails to provide the motion and sleep analysis of the infant which leads to not detecting the possibility of the occurrence of SIDS.

The system includes a swinging baby cradle and mini fan for temperature control, triggered by sound detection [2]. Data is sent to parents via MQTT servers, and alarms are triggered for abnormal conditions. Parents can monitor the baby through an external camera and control a lullaby toy remotely. However, the system requires wheels on the

cradle and does not provide positional, motion, or sleep analysis.

The technology makes it simple and affordable for working parents to manage their workload [3]. The most widely used Android cell phones allow for video surveillance. This system may be expanded in the future to include additional functions like IR (Infrared) cameras for night vision. Moreover, other client programs, such as iOS applications, etc., can be created for this system.

Heart conditions are continuously monitored by the system[4]. We are collecting ECG and PPG signals from that smartwatch and extracting the heart rate from them. Based on their heart rate and age, we can anticipate their cardiac status using these characteristics. A person's relative or the neighbourhood doctor has been notified as a precaution if the patient has an abnormal heart rate or any other signs that could indicate a heart condition. This makes the system more adaptable. This system's drawback is that it can only be used for remote monitoring. In this system, a variable device is used.

The environment within the infant incubator is monitored and controlled by the intelligent infant incubator[5]. Rural communities can benefit from this project. Small healthcare systems can also employ this equipment. The project is easy to complete and effective at managing the chamber's and room's temperature. It will serve as a manual for those who want to build baby incubators. This system's drawback is that in order to get reliable data, it must be calibrated every three months.

This system's design is based on cutting-edge factors including pulse rate and oxygen saturation [6]. These guidelines ensure that the infant is healthy, and parents will be updated on any unexpected changes to the newborn's physical appearance. Real-time video monitoring is a further aspect of this technology that allows for the supervision of infants. When a parent requests a live video feed, this function is initiated. This is useful in cases where the baby sleeps in an unexpected posture. Parents can easily view the infant and take the necessary activities for it by using this feature. The baby monitoring system is an effective medical instrument for tracking infants' health and a trustworthy real-time monitor of infants since it is capable of registering many physiological indicators and identifying unexpected events.

The project aims to provide parents with a cost-effective and intelligent baby monitoring system accessible through a web application on a local or remote network[7]. A MobileNet model architecture was utilized to develop a convolutional neural network to make the system intelligent. The dataset used was representative and included diverse images of various situations. Future improvements include automation of the cradle, control of the baby's room light, infrared camera use, protection against computer intrusions and virus attacks, and making the solution efficient and modular.

A patient monitoring system is used to measure the patient's vital signs, including the ECG, heart rate, Sp02, pulse rate, and temperature[8]. There is potential for entering the database automatically in the future. These values are manually put into a database and published to a web-based server. Further improvements will also be made to the visualization component. Also, the complete medical history of a patient with any number of chronic illnesses, including cancer, Alzheimer's disease, etc., can be submitted to a doctor located overseas for analysis and advice on the best course of action and medications.

The system [9], a wet detector for diapers has been designed and tested, which emits a clear sound from a buzzer when the diaper is wet. The system is cost-effective, except for the GSM alarm system which can be repurposed for other uses. The wet detector unit can be decoupled from the pressing studs for reuse, and it can be fabricated on a small, reusable board with minimal cost. While the system may seem expensive, it is important for the wearer's health, and it can also be used in other applications such as hospitals and care facilities. The alarm system can also be developed to support an Android application.

One of the hardest current issues for a newborn with SIDS problem is how to monitor them, the quick detection of any change in their sleep or temperature as well as the identification of breathing problems, and having an immediate report on this. This is made possible by the smart gadget [10]. These difficulties will give the infant trouble and many other issues. This study proposes and designs a multi-agent-based intelligent infant monitoring system. The presentation of a new dynamic method for infant sleeping/wake-up mode. The implementation and testing of an agent sensory input prototype.

## 3. Design and Development of the System

The system being designed is a microcontroller-based system aimed at helping parents and nurses in infant care. The system has several features that make it useful in monitoring and providing care to infants. One of the primary features of the system is that it starts playing the mother's voice automatically when the baby cries and stops when the baby stops crying. This feature can help soothe the baby and provide a calming effect. The system uses a sound detector that is interfaced with the controller to sense sound when the baby cries and activates the controller with its digital output. This feature helps to detect when the baby is crying, which can alert parents or caregivers to attend to the baby's needs promptly.

The mechanism also sounds an alarm when the mattress becomes wet as another feature. Under the bottom cover

where the infant sleeps, a temperature sensor continuously measures the temperature and transmits analog signals to the RL78 controller's built-in ADC. Continuous monitoring of the digital data is possible, and a drop in temperature denotes moisture in the cover. To ensure that the baby's cover is quickly changed, the controller can be programmed to sound an alarm. If the infant cries for longer than the predetermined amount of time, the device also sounds an alert, signaling that the baby requires attention. When the baby needs help, this function can let parents or other carers know.

To catch the attention of parents or nurses, the system incorporates a WiFi interface that delivers notifications to mobile devices with Android operating systems. This feature can help parents or caregivers monitor the baby's status remotely and attend to the baby's needs promptly. The controller is connected to an LCD, which continuously shows messages with the status. This feature provides a visual display of the system's status, making it easy for parents or caregivers to monitor the baby's status. Finally, whenever the baby cries, the cradle will swing. This feature can help soothe the baby and provide a calming effect, which can help the baby fall asleep.

The microcontroller-based system designed to help parents and nurses in infant care has several useful features that can help monitor and provide care to infants. These features include playing the mother's voice when the baby cries, sensing wetness in the mattress and alerting the caregiver, sounding an alarm when the baby cries for more than a stipulated time, and providing a visual display of the system status, among others.

## 4. Methodology

The system uses Bluetooth for Android application control The flowchart shows the same working as the application for quick action by parents The wet sensor detects diaper condition for timely changes The sound sensor notifies parents when the baby cries or makes noise beyond a certain threshold Swinging of the cradle can be controlled with the Android application Components are connected to Arduino Mega for system control Raspberry Pi Camera Module is used for 24/7 live streaming of the baby's movement The camera is attached to the top of the cradle Parents can also monitor the baby's mood on the application.

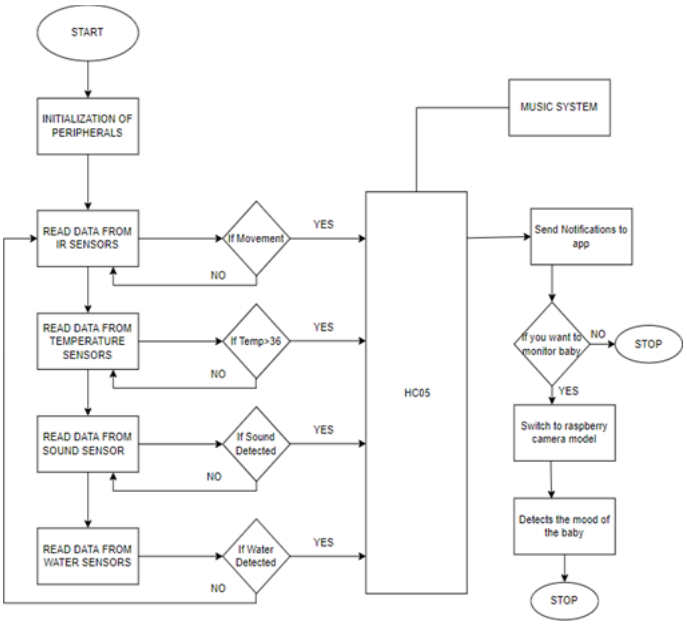


**Fig. 1.** Design Flowchart of the system contains all the modules that are to be integrated with the Raspberry Pi.

### 4.1. Raspberry Pi 3B+

A single-board computer called the Raspberry Pi 3B+ was introduced in 2018 as an improved model of the Raspberry Pi 3 Model B. A full-sized HDMI port, four USB 2.0 connections, a 1.4GHz quad-core ARM Cortex-A53 CPU, 1GB of RAM, built-in Wi-Fi and Bluetooth, Gigabit Ethernet, a 3.5mm audio line, and a MicroSD card slot are among its features. It also has improved thermal management, making it less prone to overheating. The Raspberry Pi 3B+ is widely used in a variety of projects such as home automation, robotics, media centers, and DIY electronics.

### 4.2. DHT11

The DHT11 is a straightforward, incredibly cost-effective digital temperature and humidity sensor. There are no analog input pins required because it uses a thermistor and capacitive humidity sensor to measure the air's humidity and delivers a digital signal on the data pin. Although relatively simple to use, data collection calls for exact timing.

### 4.3. USB Camera

A USB camera is a type of digital camera that connects to a computer or other device through a USB port. It is a popular type of camera for video conferencing, live streaming, and video recording. USB cameras are often used for surveillance, as they are relatively inexpensive and easy to install's cameras are compatible with most operating systems, including Windows, MacOS, and Linux.

### 4.4. Sound Sensor

The Sound Sensor Module is a device that detects sound and converts it into an electrical signal. It has a single signal

output and operates with a working voltage range of DC 4-6V. When sound is detected, the module outputs a low-level signal and turns on a signal light. It can be used in various applications, such as sound and light alarms, voice control, and sound detection.

### 4.5. Heartrate Sensor

A heart rate sensor is a gadget that uses the electrical impulses the heart produces to detect the rate at which a person's heart beats. It usually consists of a chest strap or a wristwatch-like device that uses optical sensors to monitor blood flow and detect the heart rate. The sensor converts the electrical signals or optical data into a digital signal, which can be transmitted to a display unit or mobile device for further analysis.

### 4.6. DC Motor

A DC (direct current) motor is an electrical device that converts direct current electrical energy into mechanical energy. It consists of two main parts: the stator (stationary part) and the rotor (rotating part). The stator is made up of a set of permanent magnets or electromagnets that create a magnetic field, while the rotor contains a set of conductors that carry electric current and interact with the magnetic field to produce torque.

The motor rotates when a DC voltage is provided because an electric current runs through the conductors of the rotor and interacts with the magnetic field of the stator to produce a magnetic field. By switching the polarity of the applied voltage, the rotation's direction can be altered.

### 4.7. Buzzer

When an electrical current flows through electronic equipment, the buzzer emits an audible sound. In the context of IoT (Internet of Things), a buzzer can be used as an output device to provide audible feedback or alerts in response to various events or conditions detected by sensors or other input devices. For example, a buzzer can be used to sound an alarm when a sensor detects a fire or an intruder or to provide feedback on the status of a home automation system. Buzzer modules can be easily integrated with IoT development boards such as Arduino or Raspberry Pi to add audible feedback.

## 5. Results and Discussions

In this part, the outcomes that were achieved as discussed. In the majority of the literature, the suggested module uses web applications to communicate information. The end user terminal in the suggested prototype is fitted with a mobile application that the parent or guardian can use. The android app displays the environment's temperature and humidity as well as the child's heart rate and can determine whether the child is in which emotional state. When the child starts crying the alert is initiated along with the enabling of auto swinging. Which stops after the child stops crying automatically. When the bad posture is detected then an alert is initiated.


**Fig 2.** Cry, Heartrate, and dampness detection and alert indication.

When the baby crying sound is detected the alert is sent to the application. The HeartRate sensor is interrupted and when the rate is abnormal there is an alert.


**Fig 2.** Temperature and bad posture alert indicator.

The figure shows when the sensor is sensed with an abnormality of temperature, and posture, and the baby is detected crying.

## 6. Conclusion

The baby monitoring system is designed to assist working parents in monitoring their babies when they are busy. The system includes various sensors that monitor the baby's safety, including a fire detection sensor, LDR sensor, room temperature and humidity sensor, gas sensor, and sound sensor. The system also comes with a web camera that enables parents to keep an eye on their child from a distance.

The system sends notifications and alerts to the parents in case of any exceptions or mismatches in the baby's room condition. The baby monitoring system ensures that the baby is safe, comfortable, and relaxed, and provides working parents with peace of mind.

## 7. Future Scope

The baby monitoring system can be added on with any number of additional sensors like a PIR sensor which can detect the third person entering the baby's room. This system can be improved by adding Image processing to detect the objects that the baby hold and the object around the baby. By image processing, we can identify the person present inside the room and information can be transferred to the parents. LCD can be attached to display parents' live video to claim the baby. Along with the mail, GSM messages can send to parents. To double-check that information is passed to the parents. Android application can be created to get all the sensor data. As smartphones play a vital role, developing an android application will help us to stay connected with the baby and easier to use. The Baby Monitoring System based on Raspberry Pi is still under development, but there is a lot of room for improvement depending on the state of technology and user demands.

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