Smart Monitoring System for Physically Handicapped Infants using IoT

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Abstract. The Internet of Things (IoT) has brought about a change in every person's life, making it easier with smart and intelligent devices. The problems of the physically disabled are also being addressed through smart controlling systems. Technology has made disadvantaged people equal to their peers by completely eliminating their disability and empowering them to do whatever they want to do. A physically handicapped infant needs constant monitoring which can often be challenging. Therefore, the goal of this project is to install a smart monitoring system on the infant's activities. The core of this project is the ESP32 microcontroller on which different sensors are set up. The sensors included are APDS9960 for gesture recognition (signalling any movement in the baby and whether the baby is asleep or awake), MPU6050 Multi Axes Accelerometer for fall detection (to protect the baby from falling). In conclusion, the project assists in taking care of physically challenged infants by their guardian. In the future, a camera for more efficient supervision might be added.

1 Introduction

The Internet of Things (IoT) has changed everyone's lives by making them easier with smart and intelligent gadgets. The problems of the physically disabled are also being addressed through smart controlling systems. Technology has made struggling people equal to their peers by completely eliminating their disability and empowering them to do whatever they want to do. Infants with physical disabilities need constant supervision, which can often be difficult. The smart monitoring system can be used in circumstances when people need to be closely watched, as is the case with physically disabled people. Keeping an eye on even the smallest movement of these infants is crucial since they require extra care. Given their busy schedules, parents today find it difficult to take care of a baby. Finding a balance between family and professional obligations is getting more and more challenging. It might be challenging to care for an infant in these circumstances by physically delivering them. Consequently, the gadget helps a parent working from home to maintain balance. It relieves the parent's burden of manually supervising the infant. This tool is used anytime physically checking something's safety is difficult. It can also be utilized when a person's family needs to verify that they are healthy. To assure the safety of the baby, it might, for instance, monitor

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the infant's condition, which would require less hospital staff. This research may one day be expanded to include the prediction of the baby's movement using machine learning. In identifying atypical circumstances and estimating the location of the baby, the suggested job is very successful and economical.

2 Existing methods

The following section depicts few of the existing methods.

The noise cancellation system was developed by authors [1] because the current climate (noise, temperature and humidity) has an effect on the environment of infants and children due to the radical environmental changes the world is experiencing in terms of noise pollution and global warming. To accomplish better day to day environments in a child room, checking and control frameworks turned out to be vital.In the baby's room, current systems only monitor and control temperature, humidity, and lighting. To reduce noise pollution and improve comfort in children's rooms, this paper proposes an innovative noise reduction system based on previous research in the field. The design and implementation of the proposed system is discussed, its components and interactions described in detail. A preliminary cost estimate is also provided [1].

In the context of gifts, wherever parents are busy with their careers, it becomes extremely inconvenient to ask them to have enough time to take care of their children [2]. Sometimes it doesn't make sense for them to hire a nanny. This resulted in their child being admitted to daycare for the duration of their employment. Most daytime babies stop crying or sleeping after being in the crib. In today's lifestyle, it is extremely embarrassing for babysitters and nannies to sit close to their children and tell them the truth whenever they cry or sleep. So Rachana palaskar, Shwetha Pandey and others devised a system that could help parents take care of the child without physical concern. An automatic bassinet can be an assistive device related to the automatic introduction of a baby bassinet. This system serves two main purposes in helping parents. The crib's automatic movement notifies parents if necessary. Taking care of a baby is a difficult task for working parents [2].

A successful case of applying UWB technology to vital signs monitoring systems created by the authors is presented in this paper [3]. Baby Monitor for non-contact remote respiratory and heart rate monitoring designed for both infant and consumer monitoring applications. Unlike conventional audio and video-based infant monitors that do not provide useful information on when the baby is asleep (no sound or still images), these devices allow parents to permanently control and effectively prevent sleep syndrome, sudden infant death syndrome (SIDS). SIDS is believed to be the leading cause of death in healthy infants after 4 months of age [3].

Aslam and his team [4] presented a baby monitoring system for busy parents to ensure the safety and proper care of their children. . This system can hear and see the baby move; A display can show the baby's cries and video of the baby in its current location, especially for the mother or responsible person to watch the baby at a distance. This baby monitor can detect automatic movements and crying conditions. The Raspberry Pi B+ module is used to arrange the entire control of the device, the MIC capacitor is used to distinguish the baby's cries, the built-in PIR motion sensor to recognize the child's development and the Pi camera is used to capture the child's movements. Video of a sleeping baby is shown on a display. The proposed system could make it increasingly easier for parents with busy schedules to talk care of their children [4].

Rajesh and colleagues presented a paper [5] on Sudden Infant Death Syndrome (SIDS) marked by sudden infant death during sleep whose history was unpredictable and still unresolved. liked even after a thorough forensic autopsy and detailed investigation of the death. In it, we have developed a system that provides solutions to the above problems by

making racks smart using Wireless Sensor Networks (WSNs) and smartphones. The system provides live video visual surveillance, kennel fence and wake-up alarm services, temperature and light intensity reading monitoring services, vaccination reminders and monitoring weight [5].

Nowadays, taking care of a baby is a difficult task for working parents in various places. Therefore, Subhash and his team [6] have devised an article that aims to establish an infant observation framework for busy guardians so that they can ensure proper attention and welfare for their children. This frame can recognize the baby's movements and help detect sounds; especially the infant's cry and current position can be predicted by CNN so that parents can check the infant's status by sensor data while away from the infant. The proposed work will read data from different sensors and then the data is processed continuously by Raspberry PI. A PI camera is also built in to capture images from the baby's video feed. Hence there will be constant monitoring of the baby. This baby monitor is equipped to distinguish the baby's temperature and crying condition naturally. The Raspberry Pi B module is used to manage all connected components. The sound sensor is used to distinguish the baby's cry, the temperature sensor to determine the infant's temperature, and the Pi camera is used to capture the infant's condition and take a video or photo of the baby in abnormal condition and send them to the guardian or parent over the Internet using the IOT module. This proposed framework may provide a simpler and more useful route for busy caregivers regarding their newborn care [6].

3 Proposed method

3.1 Problem statement

The Internet of Things (IoT) has changed everyone's lives by making them easier with smart and intelligent gadgets. The problems of the physically disabled are also being addressed through smart controlling systems. Technology has made struggling people equal to their peers by completely eliminating their disability and empowering them to do whatever they want to do. Infants with physical disabilities need constant supervision, which can often be difficult.

3.2 Objectives

The purpose of this project is to construct a smart monitoring system for the infant's actions. The core of this project is the ESP32 microcontroller on which different sensors are set up. The sensors included are APDS9960 for gesture recognition (signaling any movement in the baby and whether the baby is asleep or awake), MPU6050 Multiaxes accelerometer for fall detection (to protect the baby from falling down). In conclusion, the project assists in taking care of physically challenged infants by their guardian. In the future, a camera for more efficient supervision might be added.

3.3 Architecture diagram

The architecture diagram is split into three phases. Phase 1 is the movement in the infant which is then sent to phase 2 where the sensors recognize the movement and the sensor values are updated. The updated sensor value in APDS9960 detects whether the infant is asleep or awake, and the updated sensor values in MPU6050 detect fall. The result is sent to the mobile of the parent/guardian as a SMS through Twilio API.

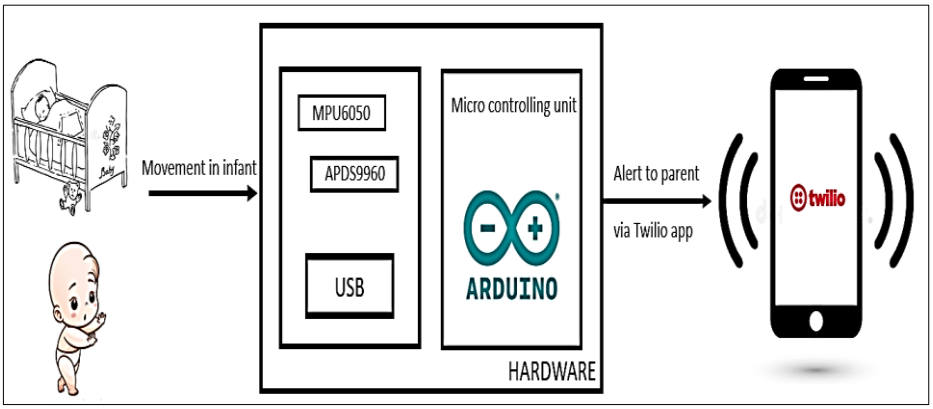

Fig. 1. Architecture diagram.

3.4 Modules and description

3.4.1 Module 1: Detection of movement in the infant

Using the gesture recognition sensor(APDS9960), any slightest movement in the infant is detected suggesting that the infant is awake. The infrared signal of this device is generated by an LED. The infrared signal is generated by the LED or reflected by the obstacle surface when there is an obstacle or any gesture is made in front of the device. The APDS-9960's photodiodes detect this reflected light. The following are the APDS-9960 device's specifications:

- This gadget includes a gesture sensor, an RGB color sensor, a proximity sensor, and an ambient light sensor in one optical module.
- The combination of infrared LEDs and fully calibrated LED drivers allows for direct compatibility with existing footprints.
- RGB color detection and ambient light detection using UR and IR blocking filters.
- Programmable gain and integration times are also available for RGB color and ambient light detection.
- RGB color sensing provides data on the intensity of red, blue, green, and clear light.
- Due to its extremely high sensitivity, this gadget is also appropriate for operations behind opaque glass.
- Proximity motors have bias adjustment registers to correct for system bias caused by unwanted infrared reflections.
- Using the Fall Detection sensor (MPU6050), any irregular movement in the infant is detected, suggesting a fall or harm.

3.4.2 Module 2: Buzzer alert

A buzzer alert has two applications, namely;

- A 3 second buzzer goes when the infant is awake.
- A 10 second buzzer goes when an irregular movement suggesting fall is detected.

Qualities of a buzzer are as follows:

- Image outcome
- The buzzer's specs include the following.

- Black in colour.
- 3300 Hz is the frequency range.
- Operating temperature from -20 to +60 degrees Celsius.
- Operating voltage range from 3 V to 24 V DC is available.
- The decibel level of sound is around 85 dBA

3.4.3 Module 3: Notification via Twilio API

- A notification is sent via the Twilio API as a SMS to the mobile of the parent/guardian.
- Two types of notifications are sent -
  - If any movement is observed- "Alert! Baby woke up"
  - If any irregular movement is observed- "Caution! Fall Alert"

Working of Twilio API is represented in the following section.

Over a specific connection established between Twilio and the carrier, Twilio gets the message from the latter. The message is then received by Twilio's messaging processing stack, which is equipped with software that allows it to be read and understood. Carrier networks link the telephone network. All around the world, carriers are in charge of the flow of voice, text, and data. Connections into networks are for sale by carriers. Twilio app for delivering notifications:

- Push Notifications on the Web.
- Set your Service instance's push notifications to enable.
- Configure Firebase.
- Upload your API Key to Twilio.
- Incorporate your Access Token with the API Credential Sid.
- Startup Firebase in your web application.

4 Results and discussions

4.1 Description about dataset

The working principle of the gyroscope is based on gravity. It is interpreted as the product of angular momentum, which is generated by the torque on the disc to produce the gyro precession in the spinning wheel. This process is known as gyro motion or gyroscopic force and is defined as the tendency to maintain the direction of a rotating object. We know that the angular momentum of a rotating body must be conserved. This is done because when there is a change in the axis of rotation, there is a change in direction, which changes the angular momentum. Therefore, it can be said that the operating principle of the gyroscope is based on the conservation of angular momentum.

- Manufacturing plant aligned responsiveness scale factor
- Client individual test

Accelerometers can measure accelerations on one, two, or three axes. 3-axis units are becoming more popular as their development costs decrease. Usually, accelerometers contain capacitive plates inside. Some of them are fixed, while others are attached to small springs that move internally as the force of acceleration acts on the sensor. As these plates move relative to each other, the capacitance between them changes. From these capacitance changes, acceleration can be determined. Other accelerometers can be centred around piezoelectric materials. These tiny crystalline structures generate an electrical charge when subjected to mechanical stress (e.g., acceleration).

Alterations in spatial attention-based neural responses have been demonstrated in multiple regions of the visual cortex, suggesting that the neural correlates of attention are enhanced responses to stimuli at a particular site. frequent position and reduced response to stimuli elsewhere. Here, we demonstrate feature-based, non-spatial modulation of attention of visual motion processing and show that attention increases the gain of direction-selective neurons in the region. MT visual cortex without narrowing of the directional correction curves. These results place important limitations on the neural mechanisms of attention, and we propose to unify the effects of spatial location, direction of motion, and other characteristics of stimuli. supported in a "similarity gain model".

4.2 Implementation of modules

The Realtime data of the sensors is updated to Firebase. The project aims to install a smart monitoring system on the infant's activities. The core of this project is the ESP32 microcontroller on which different sensors are set up. The sensors included are APDS9960 for gesture recognition (signalling any movement in the baby and whether the baby is asleep or awake), MPU6050 Multi-axes accelerometer for fall detection (to protect the baby from falling down). The output is viewed on the mobile of the parent/guardian as an SMS sent through Twilio API. Two types of messages are sent based on the movement of the infant:

- On the detection of slight movements signalling the infant is awake, the message sent is - "Alert! Baby woke up".
- On detection of a fall, the message sent is- "Caution! Fall Alert"

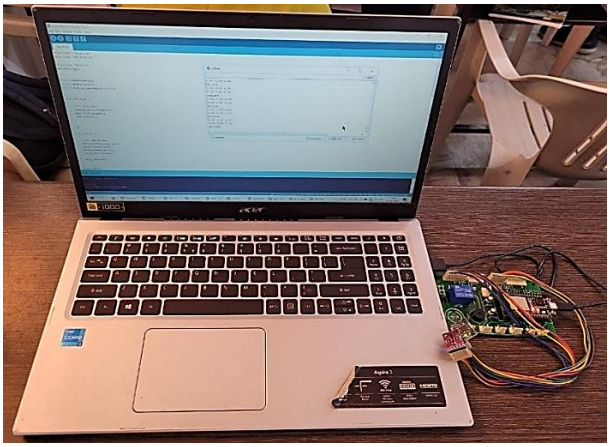

Fig. 2. Prototype of proposed model.

4.3 Significance of proposed method with advantages

The smart monitoring system can be used in circumstances when people need to be closely watched, as is the case with physically disabled people. Keeping an eye on even the smallest movement of these infants is crucial since they require extra care. Given their busy schedules, parents today find it difficult to take care of a baby. Finding a balance between family and professional obligations is getting more and more challenging. It might be challenging to care for an infant in these circumstances by physically delivering them. Consequently, the gadget helps a parent working from home to maintain balance. It relieves the parent's burden of manually supervising the infant.

This tool is used anytime physically checking something's safety is difficult. It can also be utilized when a person's family needs to verify that they are healthy. To assure the safety of the baby, it might, for instance, monitor the infant's condition, which would require less hospital staff. This research may one day be expanded to include the prediction of the baby's movement using machine learning. In identifying atypical circumstances and estimating the location of the baby, the suggested job is very successful and economical.

(a)

(b)

Fig. 3(a) and (b). Screenshot of the SMS notifications sent to the specified phone number.

Fig. 4. Screenshot of the SMS sent to the specified phone number.

5 Conclusion

An intelligent monitoring system can be used in situations where people need to be closely monitored, such as people with physical disabilities. These infants need additional attention and thus keeping track of their slightest movement is necessary. In today's scenario, taking care of a baby is a difficult task for parents due to their work life. It is becoming difficult to strike a balance between parental and occupational responsibilities. Amidst these situations, taking care of an infant by delivering their physical presence could be difficult. Therefore, to maintain a balance even for a parent working from home, the device comes to aid. It lessens the load of manually monitoring the infant on the parent. This device is used whenever manual safety control is problematic. It can also be used when family members need to check a person's health insurance. For example, it can monitor the condition of the baby, which reduces work for hospital staff so that we can ensure the safety of the baby. In the future, this work could be developed in the field of machine learning to also predict the baby's movements. This consulting work is very effective and cost effective in detecting anomalies and predicting the baby's position.

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