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Baby Monitoring System using Image Processing and IoT

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Abstract*: Non-contact-based baby monitoring system using image processing is proposed in this paper which is used for proper safety and monitoring the activity of baby by their busy parents. The system detects the motion, crying and present position of the baby. If any abnormal action is detected, then the system sends a message in the form of text and images of baby to the particular user through email. Raspberry Pi B+ module is used to process the videos taken by pi camera, MIC is used for crying detection and image processing is used for detection of real-time motion of babies and boundary condition of the bed. The system required to first install OS Raspbian, and all the other packages like OpenCV, Numpy and Virtual environment. Face detection algorithm is trained using Haar classifier for positive face images and negative nonface images. This system will help in decreasing the chances of the baby's falling from the bed. Also, this system can be used in hospitals while baby is sleeping where the stress among the nurses will be reduced.

Keywords: **Raspberry Pi, Face detection, Non-contact, baby monitoring.**

I. INTRODUCTION

In India, now a days both the parents need to work in order to balance the financial demands for their and look after their babies, so more workload and stress is there in such families, especially on female counterparts. In order to solve this problem, a Non-contact-based baby monitoring system using image processing for face detection can be developed which would help the parents to monitor their babies with the help of received data via email. Image processing is used to analyze and manipulate the images with the help of a computer. Also, real-time computer vision library is used in this system. Raspberry pi 3B+ module is used which is a full-fledged credit card sized computer. This module has a faster 64-bit, 1.4 GHz quad core processor and 1GB RAM.

II. LITERATURE REVIEW

Various methods are available in the literature for baby monitoring. Symon et al [1] presented smart baby monitoring system based on Raspberry Pi. The system detects the baby's motion and sound. The video of baby's present position is also displayed on a monitor in this system.

Rameesa et al [2] proposed a safe child monitoring system based on Raspberry Pi microcomputer and a Pi camera. This system is accessed online through the website. Shreelatha et al [3] presented an advanced baby monitor system which monitor baby movements, temperature and humidity surrounding the baby. The system also give the log record of the baby's activity and sleep cycles so that parents could monitor their child remotely.

A prototype for baby monitoring based on the GSM network is developed by Patil and Mhetre. The system monitors baby's body temperature, pulse rate, moisture condition, movement and transfer these parameters to parents using GSM network.[4].

Ziganshin et al [5] presented a system using smart wearable device and android application. This wearable device monitors the baby's pulse, temperature and position and generates an alert in case of an irregularity on the android app.

Saranyaet [6] presented child monitoring system based on android phones to detect the safety zone of the baby by using GPS sensors, acceleration sensors, and mobile GIS (Geographic Information System).

Baby monitoring is really a tough job for the parents where both are working. We have come up with an idea to design an automatic system which can give solution to the parents to monitor them from their workplace.
The main objectives of this system to create a Non-contact-based baby monitoring system with Internet of Thing capabilities. To prevent a baby from falling from the bed which can cause sudden death of a baby. For monitoring the baby at the hospitals. To detect if the baby is approaching to the boundaries of a bed, if detected, the message will be generated in the form of E-mail which will be having the snap of the baby to notify the parents or guardian.

III. PROPOSED SYSTEM

The proposed system is about monitoring the activities of baby remotely. It mainly consists of sensor, hardware unit, cloud server and parent's application. The system is based on an internet enabled single board computer called Raspberry Pi 3 B+. All the peripherals interfaced with RPi module are either connected wired or wirelessly. The RPi module shall be used in headless configuration, i.e., without keyboard, mouse or monitor connected to it. A separate keypad consisting of three buttons and one LED shall be interfaced with GPIO pins of RPi module as shown in Fig. 1.

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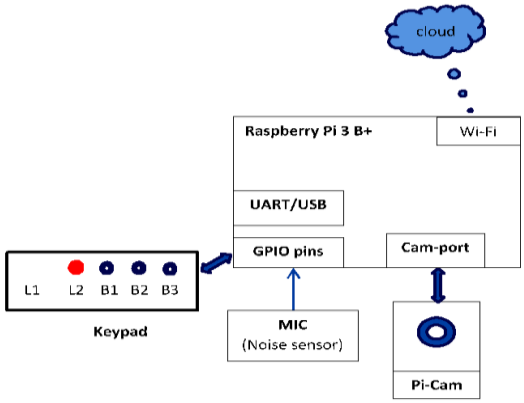

Fig. 1.System Block Diagram

In the Fig. 1, L1 is the Acknowledgment LED, L2 is indicator for internet availability, B1 is Shutdown, B2 is Restart and B3 is Acknowledgement button. Pi Cam is used to figure-out the baby's position on the bed (whether it's near the edge or not), by implementing image processing techniques through OpenCV library. A noise sensor shall be interfaced to trigger the Pi-cam and deduce if the baby is crying. The complete circuit diagram for the above system is shown in Fig. 2.

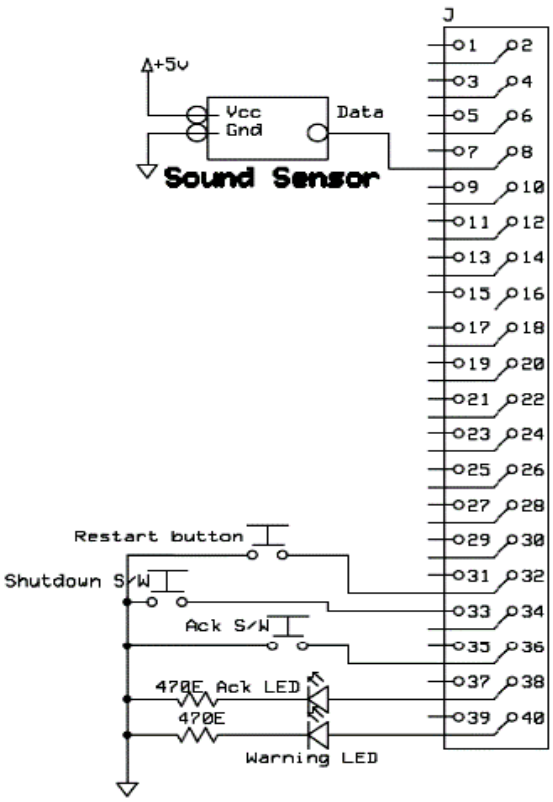

Fig. 2.Raspberry Pi GPIO Connections

The RPi module will send data about the baby's well-being periodically, through emails to the registered users. Also, occasionally, snaps of the baby shall be sent to the user on request. The system program shall be written in python language, which will begin executing on its own as soon as the system shall be powered up. Condenser MIC detect the crying signal of baby and send the signal to RPi. The Pi Camera module is used for taking video of the baby's present position. It works in a network of cloud in which message of alert with snap of baby's current position is send to particular registered user.

IV. HARDWARE DETAILS

The following section gives the details of hardware used in our system.

A. *Raspberry Pi 3 Model B+*

The Raspberry Pi 3 Model B+ as shown in Fig.3 is the heart of our circuit and currently the best Raspberry Pi computer. The B+'s main improvement over the 2016 Raspberry Pi 3 Model B is a boost to processor speed while the B+ shares the same quad-core, 64-bit CPU it has been clocked at 1.4GHz, a 16.7% increase over the Pi 3 Model B. This improved performance was born out in TechRepublic tests, where general performance of the B+ trounced earlier Pi boards. Perhaps the biggest plus point for the B+, like the other boards in the Pi family, is the versatility that comes from its software, as well as the hardware add-ons that can be hooked up to the board's 40-pin header.

Fig. 3.Raspberry Pi 3 B+ Module

B. *GPIO Pins Connections*

The Fig. 4 shows the connection details, in which the acknowledgement button is connected to pin no. 36 which is the 16th GPIO pin, by pressing this button we will able to know whether system is working or not and for this acknowledgement led is connected to pin no. 38 of Rpi which glows when the system starts working.

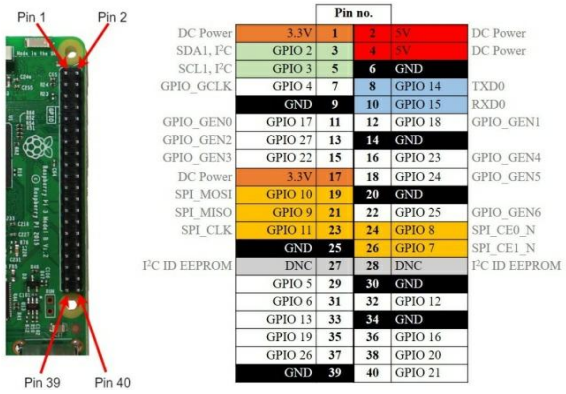

Fig. 4. Pin Connection of GPIO

Warning led is connected to pin no. 40 i.e. 21th GPIO pin which glows when system detects the abnormal condition. Restart button is connected to pin no. 32 i.e. 12th GPIO pin which is used to restart the Rpi headlessly. Now the shutdown button is connected to pin no. 33 i.e. 13th GPIO pin to shutdown RPi headlessly. Condenser MIC output is connected to pin no. 8 i.e. 14th GPIO pin which is used to detect the noise.

C. *Sound Detection Sensor Module (Condenser MIC EC0177)*

LM393 op amp is used for sound detection, which detects the sound when it is exceeded above threshold level. When the sound level exceeds the set point, an LED on the module is illuminated and the output is sent low. The sound detector module is Fig.5.

Fig. 5.Condender MIC

The complete flowchart of the proposed system is shown in Fig. 6. The software development for the desired results have been done using Haar cascade of Face Detection where the Python language is used for the programming of an entire code, which will begin executing on its own as soon as the system is powered up. Pi Camera is being used to figure-out the baby's position on the bed (whether it's in the center or not), by implementing DIP techniques through OpenCV library.

Sound Detection Sensor Module (Condenser MIC EC0177) has been successfully mounted on the circuit and introduced into the program, so that it will be enabled whenever the baby will cry (sound is detected). A separate keypad consisting of two buttons and two LED's have been interfaced with GPIO pins of RPi module. (L1- Acknowledgment LED (Indicator for internet availability), L2- shutdown LED, B1- Acknowledgment button , B2- Shutdown button). The RPi module will send the baby's snap periodically as soon as the baby reaches towards the boundary of the bed, through an email to the registered users so that they can take the necessary actions to prevent it from falling.

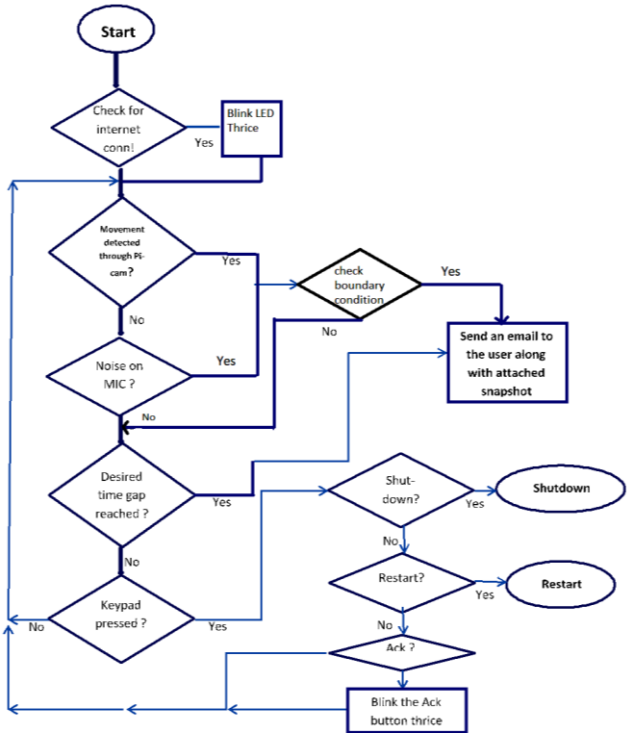

Fig. 6. Flowchart of the proposed system

V. RESULT AND DISCUSSION

The Raspberry Pi camera is set up in such a way that it can capture the doll's face and body correctly. Image processing is used to detect the baby's movement after detecting the movement or baby is near the edge of bed the Pi camera triggers, it will click the snap and send boundary alert as shown in Fig.7 to the parents through mail.

Condensor MIC is used to detect the baby's crying. When baby is awake from sleeping and starts crying, MIC receives an input signal from baby and send it to RPi module. Raspberry Pi receives a signal and activates the pi camera and send alert mail to parents. We are making Raspberry-pi headless so, we are providing a keypad to operate Rpi. Shut down button is used to shutdown Rpi headlessly, Restart button is used to restart Rpi, Acknowledgement button is used to know whether the system is working or not which we can be seen by ack (Acknowledgement) led.

We have made our own Haar cascade classifier for the doll shown, by collection of positive and negative images in the ratio of 1:10. Objectmarker.exe or Image clipper tool is used to create the dataset of positive images. The dataset is trained using Haar Classifier.

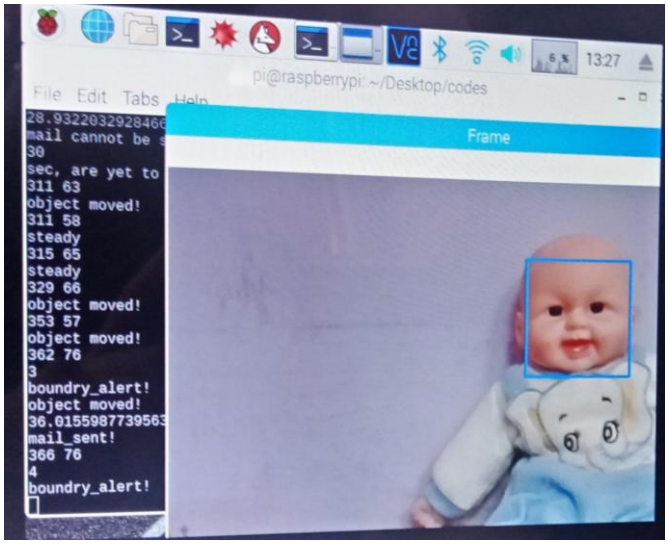

Fig. 7. Motion and Boundary Detection

We are sending the email at the desire time interval of 120 sec where the detection of the crying and the present position be judged and when the baby reaches to the boundary of the bed, the alert will send to parents with the snap of the baby. The alert in the form of mail is send to the parent's email which shows the current position of the baby and if they find something wrong like baby reaches to the edge of the bed then proper action might be taken by them.

VI. CONCLUSION

An automatic non-contact-based baby monitoring system using image processing is proposed in this paper. This system sends the message to parents through mail when abnormal condition occurs. The main advantage of this is that it is more user friendly, cost-effective and no harm to baby as it is non-contact-based baby monitoring system. It might be used in hospitals by the nurses to monitor the baby. We used RPi module as it provides more advantage comparatively Arduino and Microcontroller. It can detect whether the baby is sleeping or awake. This system will help in decreasing the chances of the baby's falling from the bed.

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