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An Automated Baby Monitoring System

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Abstract: ***Now a days caring for an infant is a tough job for parents who are working away in different location. This task presents an infant observing framework for occupied guardians so they can guarantee the appropriate consideration and wellbeing of their children. This framework can recognize the child's movement and helps in detecting audio; particularly crying and infant's current position can be predicted using CNN so the parent can check the status of the infant along with the sensor data while away from the infant. The proposed work will read the data from various sensors and then the data is processed by the Raspberry PI continuously. The PI camera is also integrated to capture the pictures from the video stream of the baby. Hence there will be continuous monitoring of the baby. This infant checking framework is equipped for distinguishing temperature and crying state of the child naturally. The Raspberry Pi B module is utilized in managing all the connected components. Sound sensor is utilized to distinguish child's crying, temperature sensor to identify infant's temperature and Pi camera is utilized to catch the infant's condition and capture the video or photographs of the baby during the abnormal conditions and send them to the guardian or parent over the internet using the IOT modules. This proposed framework can give a simpler and helpful route for occupied guardians as far as dealing with their infants.***

Keywords: Raspberry pi, Pi camera, Sound sensor, Temperature sensor, Load cell, Convolutional Neural Network

I. INTRODUCTION

The expense of healthcare is a major concern across the world. Because of the high intensity of labour, baby care expenditures are significant. So, if there is something to monitor the baby care then the working mother can manage both the tasks. With this baby monitoring system parents also can do their work without any disturbance, and they can be confident of their baby's safety. Babies scream when they are hungry, exhausted, sick, or when their diaper needs to be changed.

The task is to develop a device which makes monitoring convenient and delivers good results. Hence, a baby monitoring system comes into place to take care of the baby in terms of its safety. Parents now a days are willing to work irrespective of the gender. This causes some difficulty for the working mothers to handle both taking care of baby and working from home. Here comes the personal baby caretaker and day care into picture. But leaving the infants with the care takers and going for work is not secure as they may not take care of the baby as a mother. And most importantly leaving them alone in home is not that secure for the things in our home too in some cases. So, if there is something to monitor the baby care then the working mother can manage both the tasks. With this baby monitoring system parents also can do their work without any disturbance, and they can be confident of their baby's safety. Hence, a baby monitoring system comes into place to take care of the baby in terms of its safety. The term "Internet of Things" refers to a collection of things and gadgets that are linked via the Internet. It enables various devices to transmit and receive data across the network. By using this monitoring system made of IOT parents can peacefully continue works without getting worried about our loved ones. Even though parents are far to baby they can still feel safe as the baby is monitored is continuously and can also receive alerts. Fever is measure in monitoring system, and variations in temperature plays a crucial role in infants' treatment, so temperature must be monitored continuously. Infant crying audio is also one of the measures of monitoring system, so detecting sound of the baby is very important. The advantage of this monitoring system is that it automatically intimates the parents by sending alerts of these type of measures from baby when baby facing abnormal conditions. By this, parents can get each and every moment of the baby and information about baby conditions

II. OBJECTIVES

This IOT based automated baby monitoring system helps users to monitor their infants virtually. The suggested system is designed around Raspberry Pi, camera and IOT sensors like sound sensor, load sensor and temperature sensors.

These sensors will be connected to the Raspberry PI. Open CV (Open computer vision) is used to capture the vision of baby. The baby will be continually observed using the camera, and the health conditions of the baby will be monitored using sensors.

If there are any changes in the baby's health condition, a mail will be received by the user through Gmail, allowing the parent to take the appropriate measures. The data readings received from the sensors will be processed and updated on a regular basis on the cloud server.

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The main objectives of the proposed baby monitoring system are:

- Make the task of working parents easier.
- To keep track of the baby's activities and health conditions using appropriate sensors.
- If any abnormal conditions occur, then give an alert

III. RELATED WORK

Jabbar [1] proposed a smart cradle by integrating all the temperature sensors, sound sensors and required sensors and also 5V USB power supply to the cradle. These sensors detect any abrupt conditions and give an alert.

As proposed by Yogita [2], Baby Monitoring System based on the Image Processing where the images of the baby are taken after a time interval and matched with the predefined images using cloud servers. Also, using sensors, it detects the abnormal conditions like high temperature and crying of the baby.

Ezhilarasi [3] built the monitoring system with IOT sensors like temperature sensor, pulse sensor and GPS tracker is also used to detect the location. The outputs from all these are stored in cloud as well as in mobile and web applications. Pruthvi Raj [4] designed his baby monitoring system mainly for detecting whether the baby is crying or not. For, this some signal processing methods like zero-frequency filtering is used. A robot is used between a baby and a parent equipped with audio-visualsensors.

The system proposed by Mohammed Ali A [5] monitors the baby using raspberry pi device and sensors like temperature, humidity and noise. Determines whether the baby is awake, sleeping or crying.

Ambar [6] designed this proposed system on an Arduino board which is connected to an incubator with some sensors that senses the humidity of baby and heartbeat of thebaby. The collected data from the humidity sensor and heartbeat sensor are sent.

The proposed monitoring system is designed using Leonardo Arduino board by Yunus Kavus [7]. This system is mainly designed for the parents who have hearing disabilities which becomes a problem to take care of their baby. Using sound sensor it collects data from infant and creates alert in form of alarm via Bluetooth and sends it to parents.

The monitoring system proposed by Khan [8] sends the automatic generated signals when the baby conditions change. This system is designed with assimilated electrocardiography, some IOT sensors like temperature and carbon dioxide and some other sensors are fixed to baby garment. All these are connected through Wi-Fi network.

This work proposed by Fatin Nadia [9] is a monitoring system used to take care of baby health by using temperature sensor. It is used to identify the temperature of the infant body and take care of the infant.

Ismael Ali [10] proposed a monitoring system which is integrated with sensors connected to a single device and provide data to parents.

In this system proposed by P. [11] various sensors are used to detect baby condition and monitor it via LCD screen, GSM module and a buzzer to get alerts of the baby when infant is in emergency.

IV. SYSTEM ARCHITECTURE

This proposed monitoring system for the safety of the infant, initially, the system is on by giving a power supply and after that the sensors are set to continuously read the values and the values are updated to the cloud server periodically. While reading the values of the sensors if the value of the temperature sensor or the sound sensor exceeds the threshold value then it activates the PI camera, and it captures the image of the baby and sent to the mail of the parent as an alert. The process of updating the data to the cloud server is a looping process.

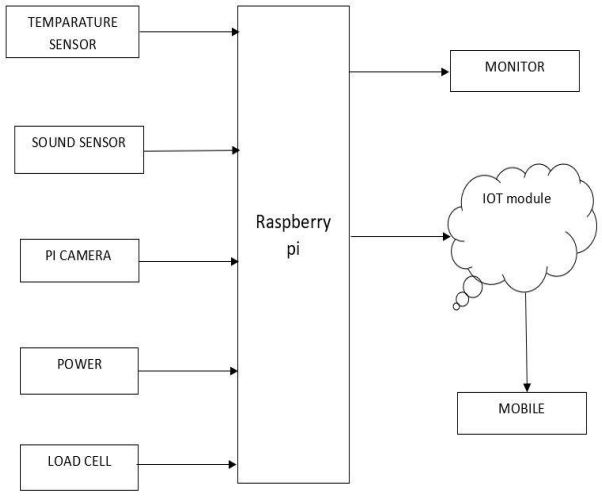

Fig.1 Block Diagram of the Baby Monitoring System

V. PROPOSED SYSTEM

Baby monitoring system assures the safety by monitoring its position continuously and it also reads the data from the respected sensors i.e., load cell, temperature sensor and the sound sensor. The data readings obtained from the sensors are processed to the Raspberry PI and if there are any abnormal values found then the PI camera captures an image and gives an alert to the parents through mail and the captured picture will be processed and analyzed using CNN to predict the position of the baby using predefined model. The data will also be updated in the cloud.

The main characteristics of this baby monitoring system are:

• Raspberry pi is the control unit where all the components are connected to it and all the readings of the baby such as temperature, sound, weight are collected and processed.

• Temperature sensor helps in identifying and noting the readings of the temperature of the baby and if it is above the threshold value it activates the PI camera.

• Sound sensor helps in detecting the cry of the baby and if the sound is detected continuously, it activates the PI camera. • Load sensor is used for weighing a baby. Using this reading, we can detect whether the baby or present or not.

• Pi camera is a visual sensor which is used to capture images and send an alert through mail whenever the temperature sensor or the sound sensor detects the sound for some time.

• The user will receive the alert of the position of the baby through Mail whenever any abnormal conditions occur like any changes in the readings of the temperature sensor or the sound sensor or both.

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• The readings of the sensors will also be stored periodically in the cloud server so that the user will be able to see the data.

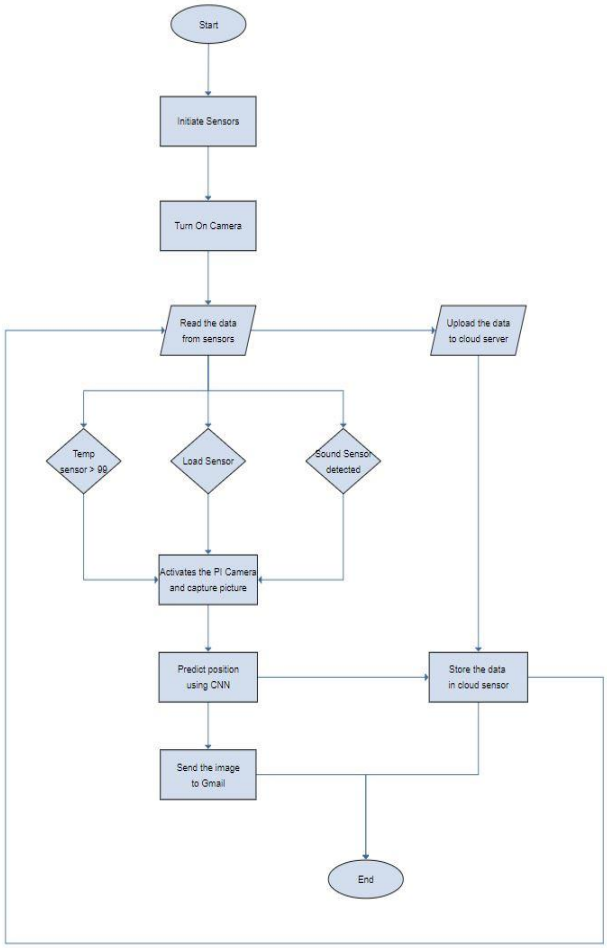

Fig 2. Flow Chart of Baby Monitoring System

VI. ASSUMPTIONS AND DEPENDENCIES

The baby monitoring system have certain assumptions such as the age of the baby must be below 1 year such that the baby is not able to crawl and speak because the safety is needed for them and if the age crosses the above mentioned value, then the baby tries to move here and there so that the device should also be moved wherever the baby goes. So, the age of the baby must be under one year. Make sure there are neighbors near the baby or else there should be a grandparent or a caretaker or a guardian present so that after receiving the alert we can intimate them whenever they are not in the vicinity of the baby taking care of some household works. Therefore, if we notify them then they will stop the work and take care of the baby and if any emergency the user will also reach home to take care. Also, make sure that the baby is completely in the range of the camera while keeping the device near the baby. Check the range of the camera and place the device so that the entire body of the baby is within the range of the camera and visible clearly.

VII. METHODOLOGY

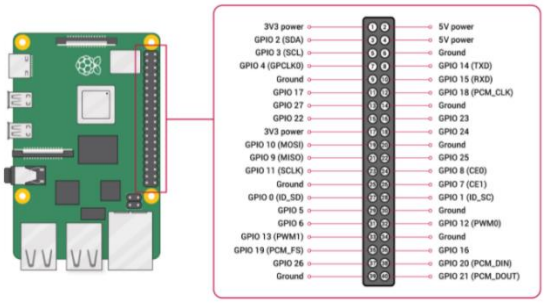

Fig 3. Pin Diagram of Raspberry PI

Mobile charger can be used to provide the power supply for the project. The pi camera is integrated with the raspberry pi through the camera slot. The sound sensor has a set of two pins for power supply which is connected to the ground (pin 6), 5v power (pin 4) and digital out pin is connected to the GPIO 2 (pin 3) of the Raspberry PI respectively.

This model contains a temperature sensor (DS18B20), which has a set of two pins connected to 3v3 power (pin 1), ground (pin 9) for the power supply like the sound sensor and third pin is plugged to the GPIO 4 (pin 7) for giving the output to the Raspberry PI.

Load cell is to be attached to the raspberry pi through HX711 which is an ADC converter. The ADC converter has a set of four pins of which two are used for the power supply that is they are connected to 5v power (pin 2), ground (pin 39) and the other two pins are connected to GPIO 19 (pin 35) and GPIO 26 (pin 37).

A. Algorithm:

1. START
2. Import the required libraries for IOT module and machine learning module.
3. Set the configuration and initialize the weight, temperature, and sound sensors.
4. Initialize the camera with frame size and allow some time for calibration.
5. Read the values from the sensors in the raw format and then convert them into the required measurement.
6. Send all the three sensors' data continuously to user's mobile application using cloud services.
7. If temperature is greater than 100F then, capture the picture from the video frame and send it to the given mail id as an alert using SMTP protocol after saving it.
8. Preprocess the saved image into a binary image for predicting the position of the baby using the model created after training with dataset using CNN. Update the baby status to the mobile application also.
9. If continuous sound is detected then, capture the picture from the video frame and send it to the given mail id as an alert using SMTP protocol after saving it.
10. Repeat step 8.
11. Again, start the code for reading the sensor data and processing further steps.
12. END.

B. Dataset:

To train the model for predicting the positions of the baby, we have used a dataset from Kaggle where the data set has numerous images for each classification. The images depict different positions of human beings; thus, the same dataset is used in training phase and validation phase of the model.

C. Preprocessing: Tensor flow and keras modules are imported to develop the model and to use various inbuilt functions. We will take capture an image and then we will re size it to 255*255. Images will be converted to grayscale images to extract different features of the image.

D. Model: The model is initialized with various parameters. In the proposed model, there are three convolutional layers of which the first one is input layer. Each convolutional layer has 8 filters and has a kernel size of 3 by 3. After every convolutional layer, there is an average pooling layer of size 3 by 3. The convolutional layers are followed by another three dense layers containing 500, 204 and 4 neurons respectively in each layer. Every dense layer has dropout layer attached to it as a tail except the layer of the output. The final dense layer is the layer that produces output and it contains four neurons in it. Adam optimizer is used in optimization. The speed of learning of the Adam optimizer is 0.01 and the rate of droupout is 0.3. The activation function used after the convolutional layers is “ReLU”, sigmoid is the activation function used after the dense layers and SoftMax is used for the output layer as an activation function. Loss functions are very crucial in learning because they determine the probability of how accurate the prediction is carried out. L2 regularization is used in this model. Regularization helps in preventing the model from becoming into a complex model. This helps in making sure that the data does not get overfitted which is nothing but making the model to give high accurate results in both training and validation phases.

E. Training and Testing: All the images are divided into batches of size 16 on the random basis and they are trained batchwise to build the model before updating the parameter values in the model. Since each batch is made on the random basis, all types of images are present in each batch. Epoch parameter value is given as 40 which describes how many times the model is iterated through the dataset during training phase. After the model is trained with the help of data set obtained from kaggle, the model is saved and further will be used in testing phase to predict the output. Some of the data is separated from the training dataset to do the validation and used for the testing purpose. The model can classify the image and predict the output with high accuracy.

VIII. RESULTS AND DISCUSSION

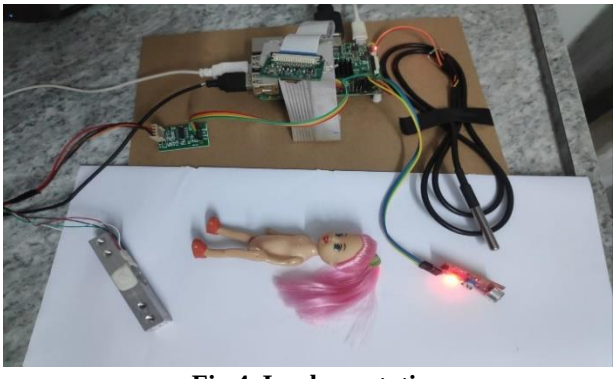

Fig 4. Implementation

In the above figure (Fig.4.) temperature sensor, sound sensor, load sensor connected to raspberry Pi are initialized and detect the baby conditions.

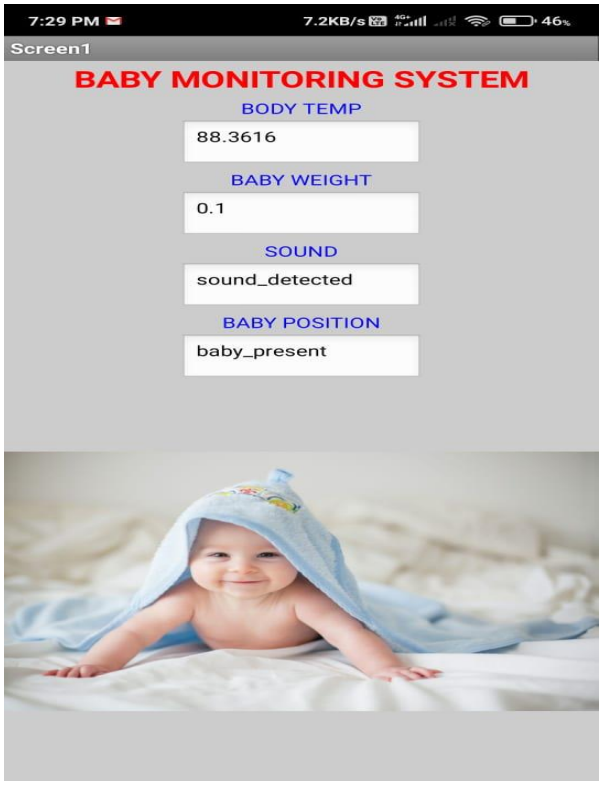

Fig 5. Mobile Application

In above figure (Fig 5.) data collected from sensors are displayed in the mobile application. We can see the detected values as sound detected from the sound sensor, temperature of the baby from temperature sensor (DS18B20) and whether the infant is present or not through load sensor.

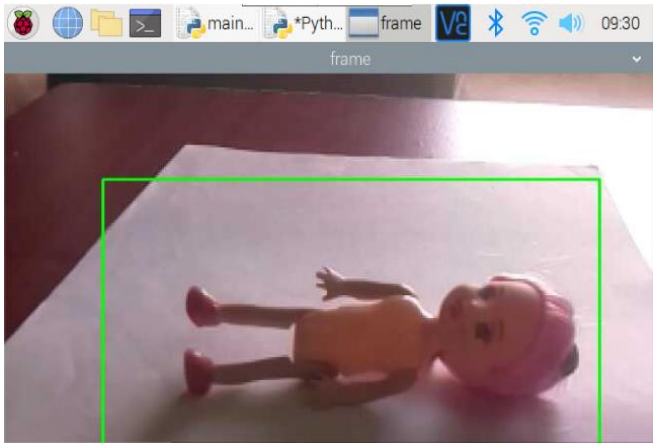

Fig 6. Placing the baby in the frame to get accurate prediction and good picture

In above figure (Fig 6.) mail is received to the receiver with an image of the baby captured by Pi camera when the baby is in abnormal state.

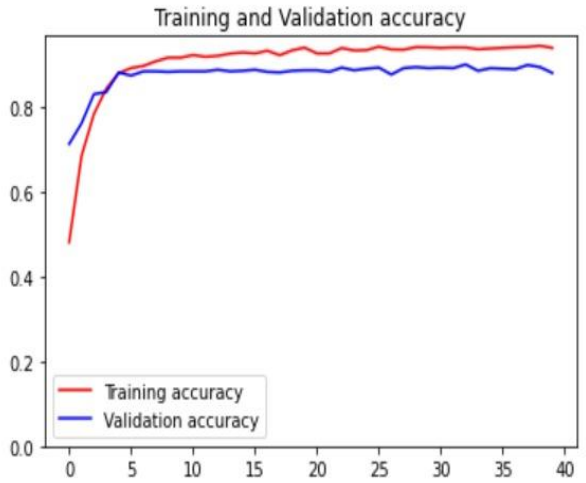

Fig7. Accuracy Plot Obtained in training phase and testing phase to predict the position.

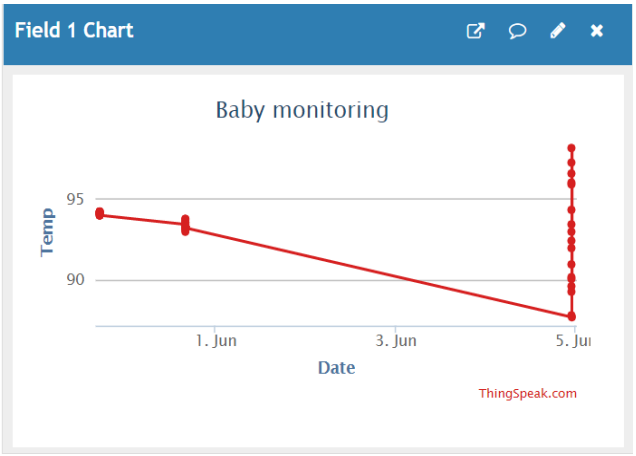

Fig 8. Plot of Temperature sensor reading vs Date.

Data collected from the load sensor into the cloud over a period is plotted. This graph helps in analyzing the condition of the baby regarding the load.

In this baby monitoring system, the parents are notified through Gmail whenever abnormal conditions occur. The difference between this proposed system and the existing work is that by observing health conditions using appropriate sensors and by giving an alert through Gmail to the parents. It also stores the recorded readings in the cloud. This proposed system also predicts the position of the baby using convolutional neural networks by checking the predefined and pretrained data and intimates the position of the baby to the parents. This device is utilised whenever manually monitoring the safety of anything is problematic. It may, for example, monitors the condition of the baby which reduces the manpower in the case of hospital staff so that we can ensure the baby's safety. This suggested work is very efficient and cost-effective in detecting the abnormal conditions and predicting the position of the baby.

IX. CONCLUSION

The baby monitoring system can be utilised in situations when individuals must be closely monitored. This device is utilised whenever manually monitoring the safety of anything is problematic. It can also be used when the safety of a person's health needs to be checked by their family. It may, for example, monitors the condition of the baby which reduces the manpower in the case of hospital staff so that we can ensure the baby's safety. This work in future can be developed in the field of machine learning to predict the movement of the baby also. This suggested work is very efficient and cost-effective in detecting the abnormal conditions and predicting the position of the baby.

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