



Baby Health Monitoring System

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Abstract- The current era of digitalization makes vast amounts of data and processing power available, which can be used to bridge the gap between a child and a working mother. Thus, an IoT-BBMS, or Internet of Things-based Baby Health Monitoring System, is suggested as an effective and affordable IoT-based system for real-time monitoring. Additionally, we suggested a new algorithm for our system that is crucial to delivering superior baby care while parents are abroad. This project suggests using an electronic monitoring system called a "Health Monitoring System" that makes use of the Internet of Things. The suggested remedy entails remote live child observation using a Telegram chatbot. The Baby Health Monitoring System uses an IR sensor to track the child's movement and a noise sensor to track the activity of the child's crying. When the child's body temperature rises beyond the predetermined threshold, the temperature sensor sends an IoT notification to the parent. The proposed solution can use Google Firebase and an Android app to watch the child remotely; however, we are using a Telegram chatbot where the data are automatically updated. A moisture sensor determines whether a baby's diaper is wet or dry. The proposed system prototype is built and tested to demonstrate its affordability and usability, as well as to guarantee safe operation and enable baby-parenting anytime, anywhere, through the network. According to the prototype, the baby monitoring system has successfully monitored the infant's situation and its surroundings.

Index terms- IoT, Smart Baby Cradle, Baby Monitoring System, Sensors, Telegram Chatbot

I. INTRODUCTION

As the number of working women has increased, protecting new-borns' health and safety has grown to be a top priority. Due to their incapacity to constantly watch over their children, many parents' resorts to leaving their infants in the care of family members or baby care centres. The authors suggest a smart cradle system that makes use of Internet of Things (IoT) technology as a solution to this problem. The system enables remote monitoring of a baby's activity and delivers real-time updates to parents regardless of their location by integrating various sensors and IoT-enabled gadgets.

Our proposed baby health monitoring system consists of sensor detecting movement in the baby and emitting an alarm, alarm going off when the infant continues to cry after a certain amount of time and a telegram alert is sent. If the mattress is wet, an alarm is sound, and an alert is sent. When the baby's temperature changes, the Telegram app sends an alert and the baby's live photo is sent. The diaper wet alarm is helpful for maintaining a healthy atmosphere around the baby.

For this proposed system, there are many advantages which include safety of the baby, quick alerts, peace of mind, creating a healthy environment.

Since each cradle is connected to the proposed system and telegram message alerts are sent to nurses or doctors if they are not nearby, the proposed system can even be used in neonatal units in hospitals, making it compatible not only with residential customers but also with industrial customers like hospitals and nursing homes.

II. LITERATURE SURVEY

IOT-enabled smart cradle systems allow parents to keep an eye on their kids even while they are gone from the house. Additionally, they are able to track the baby's movements wherever they are in the world. According to Sumalatha, et al. [1], the Smart Cradle's architecture allows for video monitoring. When a baby's cry is detected, the cradle swings. This system takes into account every detail necessary for the care of the infant.

Hotur et al. [2] report that a survey was conducted in 2019 and found that there are 23.8 million (or two-thirds) working women with infants; juggling work and babysitting is a demanding undertaking. They made design improvements and integrated MP3 players for relaxing music, temperature detectors, and bed wet sensors into the ESP32 (microcontroller) platform. IoT platforms are easy to use with high-speed internet, and any uncertainty caused to a baby will be reported to the parents via SMS over GSM. In their model, child abuse prevention was also a priority.

Baby health monitoring system was created by A. Kumaravel et al. [3] taking into account all the little aspects needed for the care & safety of the infant in the cradle. They featured cloud computing, cry detection, internet of things, and user-friendly web applications. Various Sensors/Modules were fitted to the Cradle in order to track the baby's every move. The bed's wetness is detected by a humidity and temperature sensing module, and the cry detection circuit analyses cry patterns. The collected sensor data was stored in the cloud and periodically examined. These datasets were subjected to a health algorithm to obtain information about the bodily conditions, which was beneficial because any recurring signs of an illness could be quickly recognised.

A system that is affordable for telemedicine applications was presented by V.S. Kumar et al. [4]. The study focuses on programming current operating levels and monitoring temperature swings to eliminate the requirement for

periodic calibration of oxygen saturation sensors. The study suggests using photoplethysmogram and ECG signals acquired simultaneously to calibrate blood pressure monitoring without a cuff and precisely measure pulse transit time (PTT). The portable system is made to display medical signals and parameters while offering a high-quality graphical user experience. The article also emphasises how the system can remotely monitor patient conditions thanks to its camera interface. Overall, the study advances telemedicine technology by providing a unique and useful method for patient monitoring.

In their study, N.L. Pratap et al. [5] described a smart cradle that included an automatic baby monitoring system. The device measures and keeps track of the baby's temperature, heart rate, gas molecule concentration, mobility, and position. It provides constant monitoring and a setting that resembles an incubator for the infant. Thermostat control, fan activation, cradle movement, and the playing of calming music are only a few examples of actions that are triggered when the detected parameters are abnormal. When a baby's diaper is moist or when the baby is crying, the system alerts parents and carers via a Telegram chatbot and emits a beeping sound. The prototype offers ease for carers and assists parents with time management. IoT technology is integrated into the system to improve baby care and monitoring.

III. METHODOLOGY

A. Hardware Part

The components we are using for our proposed system are ESP32, ESP32 Camera, IR Sensor, Buzzer, Moisture Sensor, LCD, Sound Sensor, Power Supply and Temperature Sensor.

We have made a circuit diagram (Fig. 1) for this project and the explanation of working of the system is given below:

- 12V adapter is connected to the electrical socket and the circuit.
- The ESP32 module is connected with the laptop using microUSB cable.
- The program is loaded into the ESP32 module.
- Once the buzzer beeps, we have to switch on the electric connection.
- When switched ON, 256V AC from the socket will be taken by the adapter, which will transfer it to DC voltage of 12V and the power supply will convert 12V DC to 5V DC and also to 3.3V DC.
- The LCD will glow and will display welcome message. It will get 5V DC from the power supply circuit.
- The sensors connected in the circuit will start working.
- The sensors will information to ESP32 module, which will send all information through Wi-Fi to the Telegram chatbot.
- Even the same information will be displayed on the LCD.
- The temperature sensor will get 3.3V DC from the power supply. If the temperature sensor detects high temperature of the baby, then one alert signal will be sent to the telegram chatbot from the ESP32 module.
- The moisture sensor will get 5V DC from the power supply. If the moisture sensor detects the diaper of the baby is wet, then it will send a signal to the ESP32 module, which will send an alert message to the telegram chatbot and also the buzzer will produce beep sound to alert the parents if they are nearby the baby.
- The sound sensor will get 5V DC from the power supply. It will detect whether the baby is crying or not

and accordingly it will send signal to the ESP32 module which itself will send an alert message to the parents through telegram chatbot.

- The IR sensor will be getting 5V DC from the power supply and the IR sensor will detect movement along with sending signal to the ESP32 module which will send an alert message to the telegram chatbot.
- The ESP32 camera will be connected with the power supply and will receive 5V DC. If the parent wants to get a picture of the baby, then the parents can type a particular command in telegram chatbot, which will signal ESP32 camera module to take a picture and send the same over Wi-Fi to the telegram chatbot.

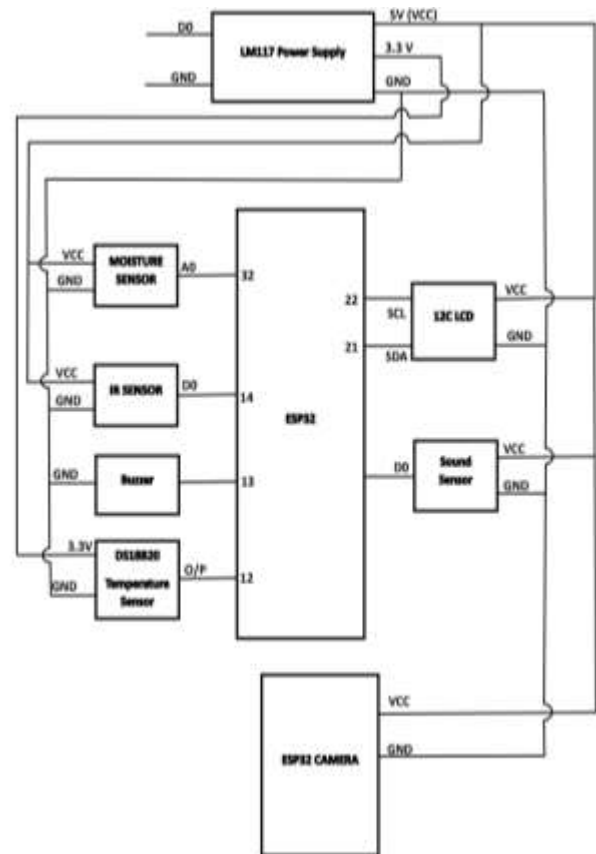


Fig. 1: Circuit diagram of the Baby Health Monitoring System

B. Software Part

After hardware, comes the software part of the project (Fig. 2). The program is done in Arduino IDE using Embedded C language.

- The sensors will start collecting data from the baby.
- If temperature is higher than the threshold value, then an alert message will be sent to the parent.
- If the baby is crying, then an alert message will be sent to the telegram chatbot.
- If the baby is moving, then an alert message will be sent to the telegram chatbot.
- If the baby's diaper is wet, then an alert message will be sent to the telegram chatbot. Also, buzzer will make beep sound to ensure if any person or parent is present nearby, so that the baby's diaper can be changed fast.
- If parents want then they can send command to get values from the sensors as message in telegram chatbot.

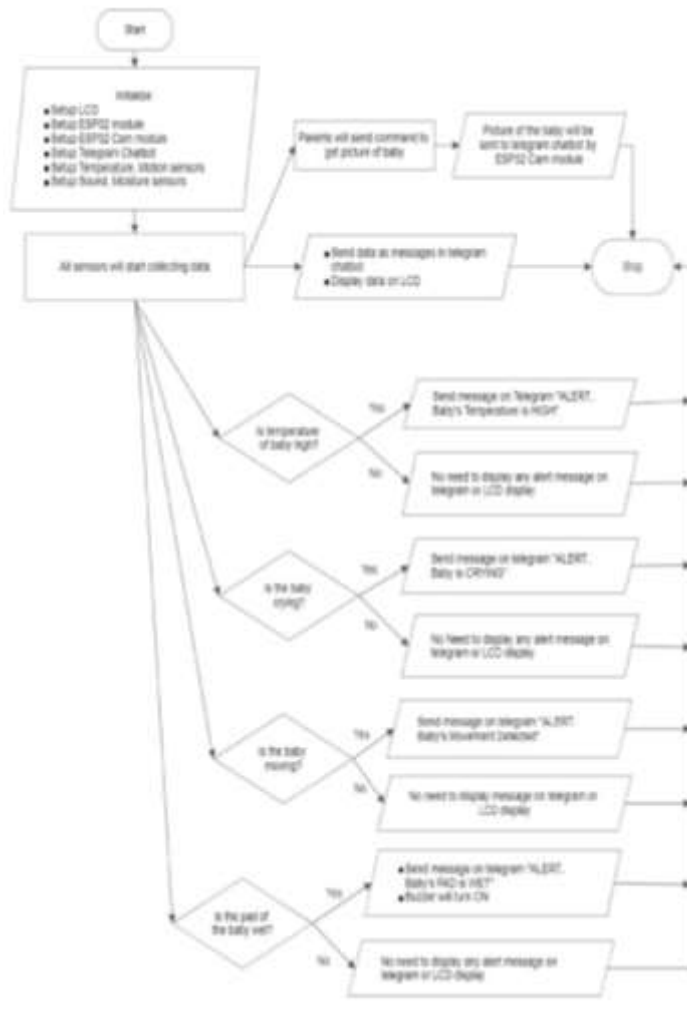


Fig. 2: Flowchart of Arduino coding of the Baby Health Monitoring System

IV. RESULTS

• Starting of the System:

- The ESP32 model is connected with the laptop using USB cable where type A is put in the laptop and the micro type is inserted in the port of the module.
- The codes are loaded into the ESP32 module and the laptop is connected to the Wi-Fi.
- The serial monitor is switched on and is kept at 115200 baud.
- The serial monitor will start displaying (Fig. 3).

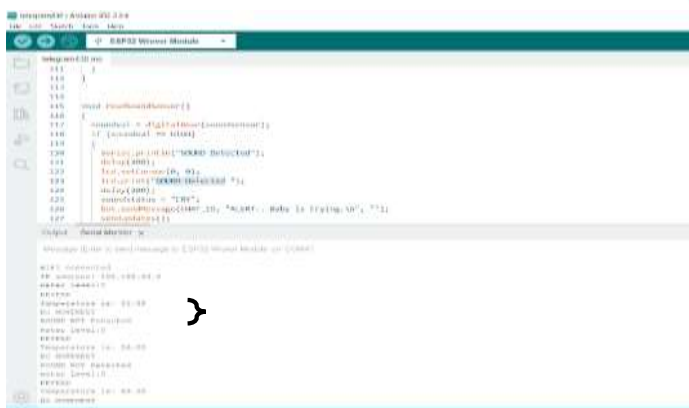


Fig. 3: Starting message displayed on serial monitor

- Within the first 4 seconds of hearing beep sound from the buzzer, the system needs to be connected to the power supply using 12V adapter.

- Again, beep sound will come and the LCD will start glowing, showing "WELCOME" message (Fig. 4).
- Even in telegram chatbot "Baby Monitoring System", messages will pop up saying "WELCOME. Bot started up"



Fig. 4: LCD displaying WELCOME message

- The first sensor data given in the message will be wrong. But from the next messages, proper data will be displayed.
- Connection to Network:**
 - The modules need to be connected with the same Wi-Fi which is being used for the laptop / desktop system.
 - In Arduino coding, we have given a common Wi-Fi id and password, which will be used for the system along with the ESP modules.
- Data Generation:**
 - In Arduino uno serial monitor, the data will get generated and will be displayed as follows.
 - In telegram chatbot, the messages will pop up displaying the status of temperature, moisture content, movement, and sound of the baby.
 - The LCD connected to the Baby Health Monitoring System will start displaying messages if sound is getting detected or not, if there is any movement detected or not, if the pad is wet or not.

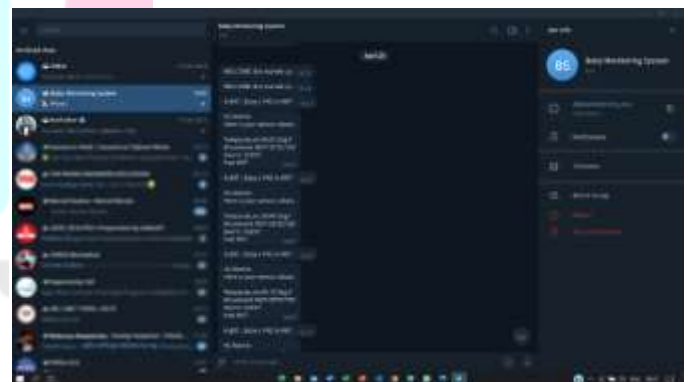


Fig. 5: Data generated in telegram chatbot

• Sound Detection:

- If sound (crying sound) is detected, the red light of the sound sensor will glow continuously, and the LCD will display that the sound is detected, along with the serial monitor of the Arduino IDE and also an alert message will be displayed in the telegram chatbot.

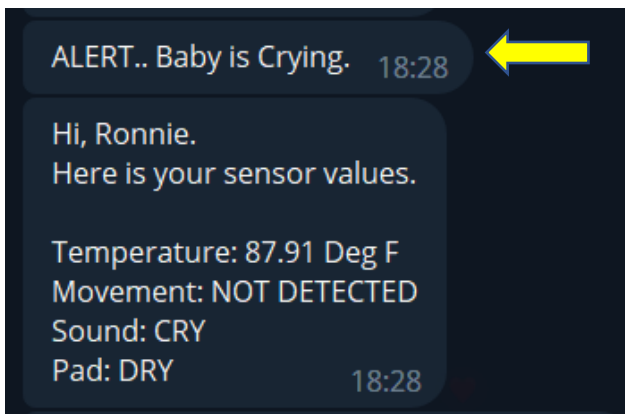


Fig. 6: Alert message sent in chatbot

- If sound (crying sound) is not detected, LCD will display that the sound is not detected, along with the serial monitor of the Arduino IDE and no alert message will be displayed in the telegram chatbot.



Fig. 7: LCD displaying that sound is not detected

- **Movement Detection:**

- If movement of the baby occurs, the IR sensor will detect the movement, the red light of the IR sensor will glow, and the LCD will display that the movement is detected, along with the serial monitor of the Arduino IDE. An alert message will be displayed in the telegram chatbot (Fig. 8).

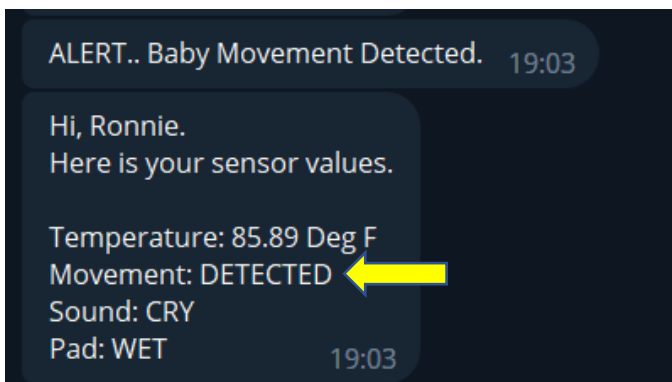


Fig. 8: Alert message sent in chatbot

- If movement of the baby does not occur, the LCD will display that the movement is not detected, along with the serial monitor of the Arduino IDE. No alert message will be displayed in the telegram chatbot (Fig. 9).



Fig. 9: LCD displaying that sound is not detected

- **Wet Diaper Detection:**

- If the diaper is wet, then the moisture sensor will detect and the buzzer will start chiming off. LCD will display a message saying WETPAD. Even the information will be displayed on serial monitor of Arduino IDE. An alert message will be displayed in telegram chatbot (Fig. 10).

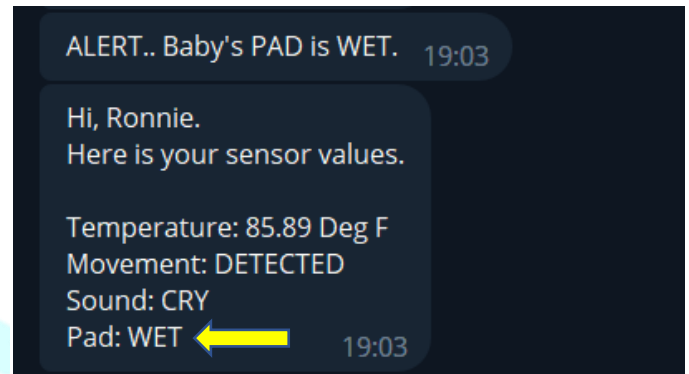


Fig. 10: Alert message sent in chatbot

- If the diaper is dry, then the moisture sensor will not detect any water level and the buzzer will not chime. LCD will display a message saying DRYPAD (Fig. 11).



Fig. 11: LCD displaying that sound is not detected

- **Temperature Detection:**

- The temperature sensor will continuously detect the temperature of the baby and will give the readings constantly. The LCD will not display any details regarding temperature of baby. If the temperature is more than 98.6 ° F, then the serial monitor will display that temperature is high, and also one alert message will be sent to the parents via telegram chatbot (Fig. 12).

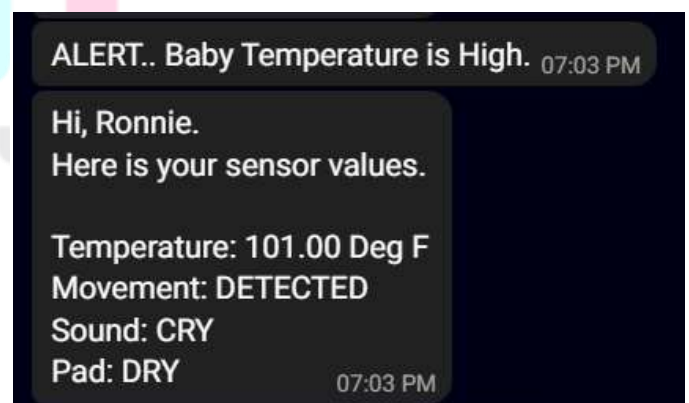


Fig. 12: Alert message sent in chatbot

- **Asking for Picture of the Baby:**

- Whenever the parents want to take pictures of the baby, they have to type one command in telegram chatbot, i.e., /photo, which will allow the users to get pictures of their babies. The camera is fixed

on a high place from where the whole baby can be seen and its picture can be taken properly.

- When the ESP32 camera module receives the command from telegram chatbot and in return signals the camera to take picture and again send it back to the telegram chatbot. This might take a little time, but if the internet connection is strong enough, then the picture will be sent faster.



Fig. 13: Response of /photo command



Fig. 14 (a,b): Movement of baby detected



Fig. 15: Complete view of Baby Health Monitoring System

TABLE 1
OVERALL RESULTS

Features	Conditions	Message on Telegram	Message on LCD
Sound / Crying	If baby is crying and sound detected	"ALERT.. Baby is Crying"	"Sound Detected"
	If baby is not crying	No alert message displayed	"No Sound Detected"
Temperature	If temperature is high	"ALERT.. Baby Temperature is High."	"High Temperature"
	If temperature is normal	No alert message displayed	No message displayed

Movement	If movement detected	"ALERT.. Baby Movement Detected."	"Movement Detected"
	If movement not detected	No alert message displayed	"No Movement"
Diaper	If diaper is wet	"ALERT.. Baby's PAD is WET."	"Pad is Wet"
	If diaper is dry	No alert message displayed	"Pad is Dry"
Photo	If parents give command for photo	Photo will be sent immediately	No message displayed

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