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Internet of Things based Smart Baby Monitoring System

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Abstract: In today's world, taking care of a newborn baby may be quite a struggle for parents who are already juggling a lot of responsibilities at home, such as cleaning or working. In addition, parents who have physical limitations often need additional assistance when it comes to looking after their infant. There are previous projects where a baby monitoring system has also been done. Some of that systems used Raspberry Pi as a microcontroller with temperature, humidity, and microphone. While there is also a similarity in the output and input components between a few previous and current projects such as the Global System for Mobile communication (GSM) module and temperature sensor the only differing part is the model of the temperature sensor. Hence, this project of IoT-based Smart Baby Monitoring system was done to help in decreasing the burden of parents who do chores and works at home. It is possible to reduce some of the burdens that parents have while they are working by using this system, which has a variety of functions such as the ability to monitor temperature, sound, and video. A GSM module is utilized in this system, which makes it possible for the parents to get alerts regarding the status of their infant. The smartphone of the parent is where notifications will be sent. Therefore, a system that is specifically built for babies at home is required to relieve some of the burdens that are placed on parents when they are busy and allow them to be aware of the state of their kids at the same time.

Keywords: Raspberry Pi, GSM module, Baby Monitoring System, IoT

1. Introduction

In the world's current situation, parents are busy with their careers during the weekdays and the work around the house during the weekend. They need to do that while caring for their baby. Then, it becomes tough for a parent with a particular situation. For example, for a single-parent family to do all of that, health problems might slowly affect them. As additional information, there are around 235240 single mothers, equal to 1.7% of the total population in Malaysia [1]. Managing a career, housework,

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and baby simultaneously will lead to being tired more quickly. And lack of resting will quickly lead them to be less alert to their surroundings due to fatigue [2]. This project proposes an IoT-based smart baby monitoring system as a solution for the busy parent at home [3].

In another situation where both the parent has a deaf disability (either was born deaf, lost hearing from work, or in an accident) they need to try harder than an average parent to care for their baby. An estimation by Quigley and Paul in 1990 stated that 5% of Children of Deaf Adult (CODA) are born to two deaf parents and 10% to one deaf parent and one hearing parent [4]. So, they need extra help from an external source to make watching their baby easier. Extra help that they can use is either a caretaker or a monitoring system [5]. And if they decide to go with using a baby monitoring system, the current product on the market might not meet their expectation and need. The current product on the market act as surveillance for the parent in which the parents need to monitor their baby themselves. The current product didn't give out alerts and some might have a night mode function and recording which need parents to constantly check. Therefore, they can't find a suitable product that meets their need that can help them to monitor their baby's condition [6]. So, the proposed solution in this project is to improve the lack of features of the product in the current market by introducing an IoT-based smart baby monitoring system.

2. Materials and Methods

In this section, there are 3 stages that lead to the project's success by acknowledging each software and hardware function.

2.1 Internet of Things based Smart Baby Monitoring System Block Diagram

The input of this project are IR temperature and sound sensor (LM393), along with ESP32 camera. The control unit or microcontroller is Arduino UNO R3, and the output are GSM module, OLED display, and buzzer. Figure 1 shows the block diagram of this project.

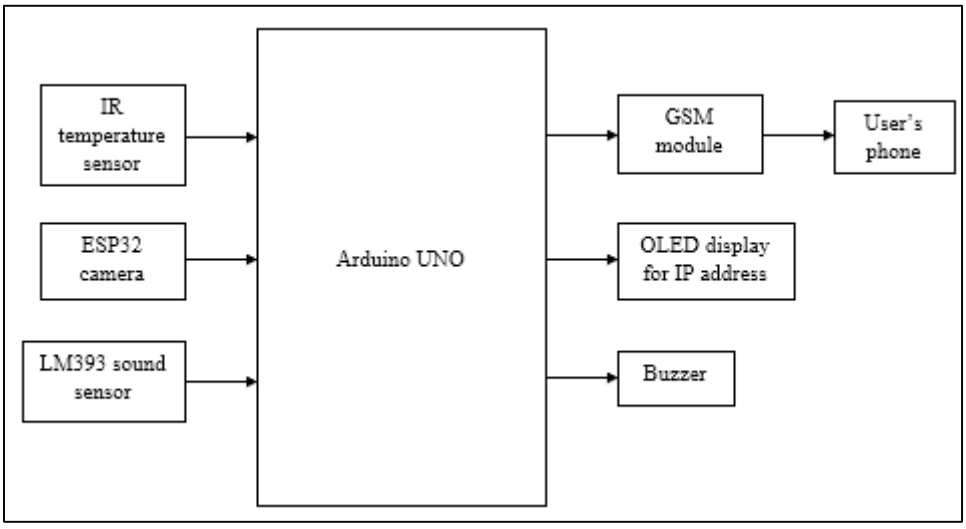

Figure 1: Block diagram of Internet of Things based Smart Baby Monitoring System

2.2 Methods

Figures 2 and 3 show the overall flowchart of this project and the flowchart of the system. All the process shows the order for the project accordingly. The purpose of this flow chart is to give an overview of the steps that was done throughout this project.

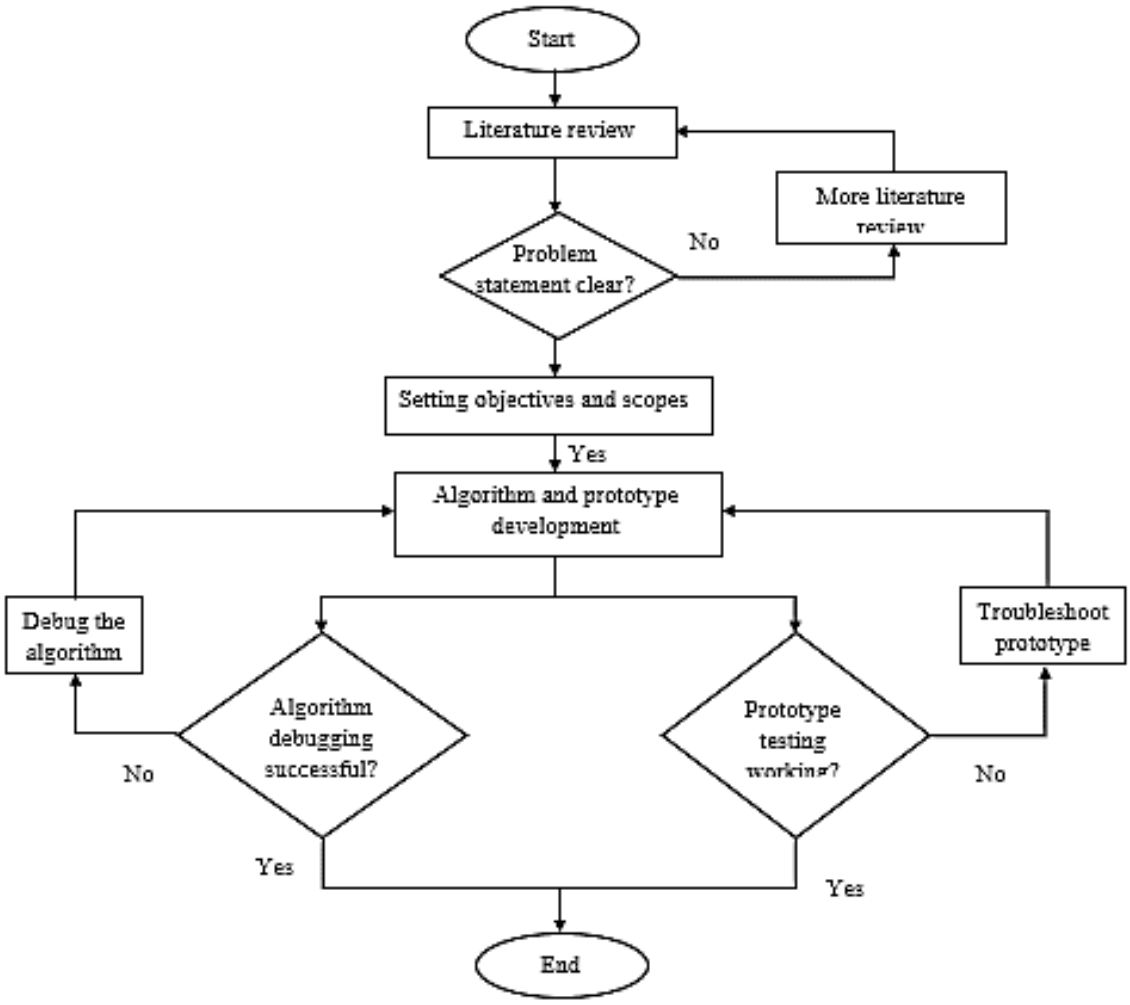

Figure 2: Overall flowchart of the project

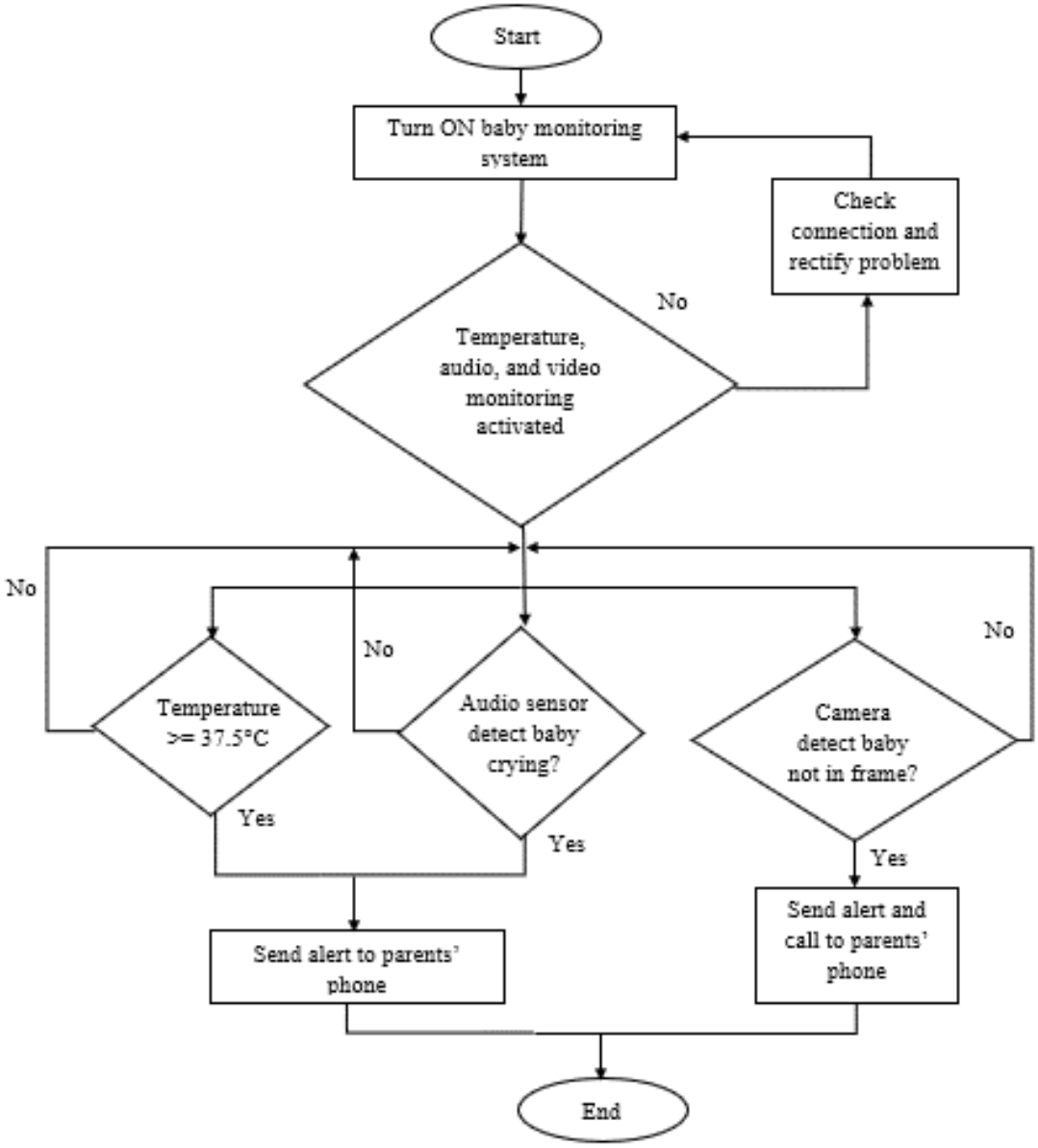

Figure 3: Flowchart of system

2.3 Electronic Setup

All the sensors' connections are combined in this circuit diagram. Figure 4 shows the circuit connection diagram for this project.

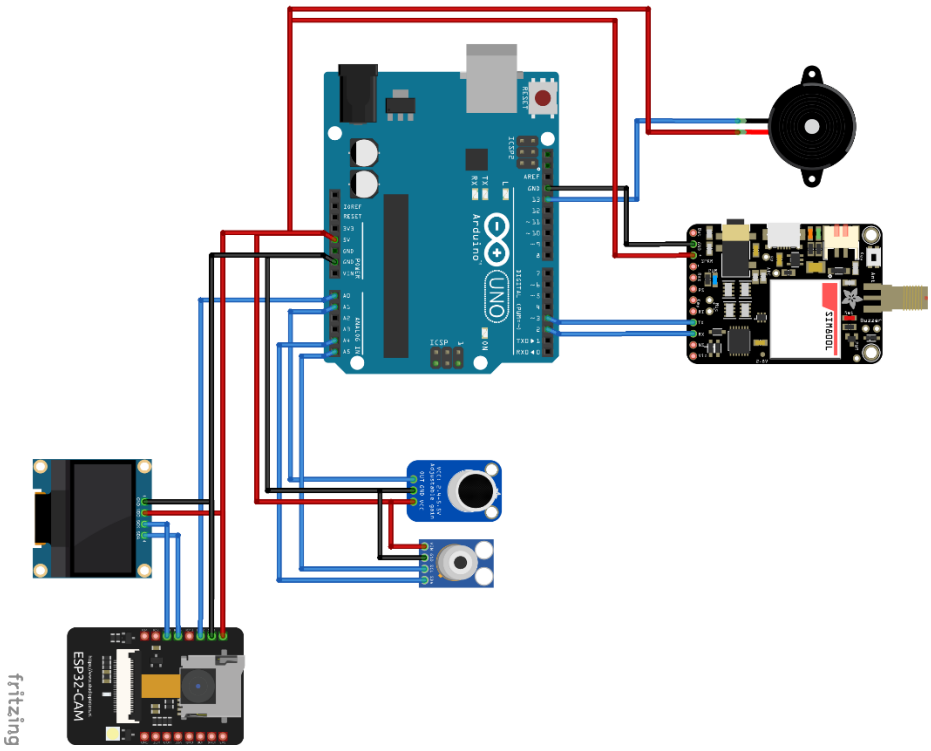

Figure 4: Circuit connection diagram

3. Results and Discussion

3.1 Prototype Setup

The outputs of this project are to send out an alert to the parents when the system detect that their baby's temperature was high using IR temperature sensor, the baby was crying using LM393 sound sensor, and baby not detected by camera in its frame through ESP32 camera. The alert that parents would receive after the system detect abnormality was send out using GSM module. The alert, which was send by GSM module can be read by parents on their mobile phone. They can also monitor their baby through ESP32 camera web server during the system was running. To ensure accuracy and quality, a prototype containing all the sensors and camera was built for testing and recording of data. Figure 5 shows the finished prototype for this project.

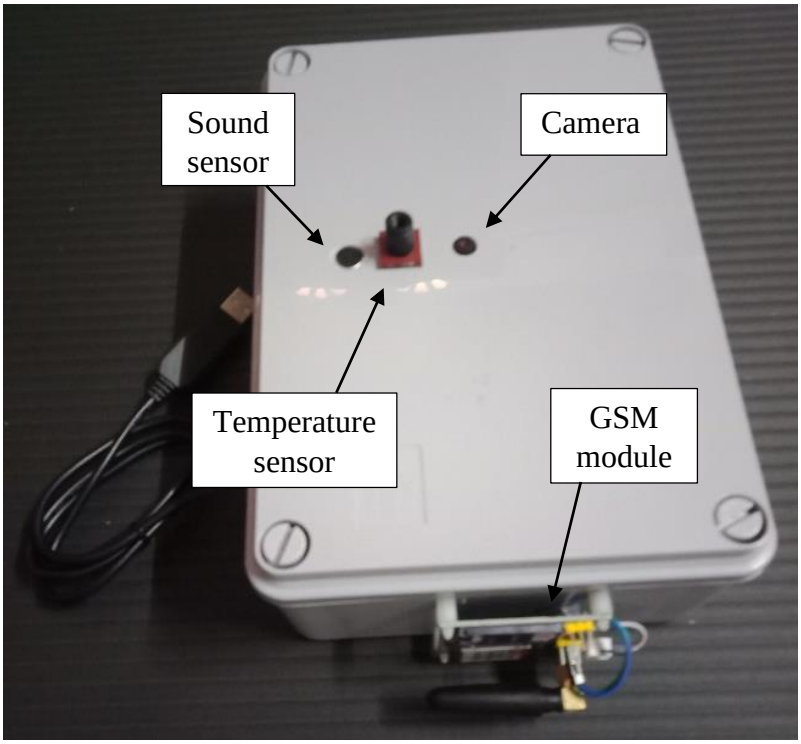

Figure 5: Prototype of the monitoring system

There are a few tests that was carried out throughout this project.

(i) Alert send out when IR temperature sensor detect temperature reaches 37.5°C.

(ii) Alert send out when there was no face detected in camera frame.

(iii) Alert send out when baby crying sample was played.

3.2 Temperature sensor

During this testing for IR temperature sensor in the prototype (Table 1), a lighter was used to raise the temperature. IR temperature sensor will function after a delay when the monitoring system was turned ON. The IR temperature sensor will detect instantly if the temperature within its area exceeds the set limit. An alert would be sent out automatically if the temperature is 37.5℃ and above which allows the parents to check on their baby when the notification was received. For testing purpose, two types of testing were done, testing temperature sensor with a lighter and with a person physically. Table 1 shows the result of the testing. Figure 6 shows the alert received by parents when the temperature reaches 37.5℃ and above.

Table 1: Testing done for temperature sensor

Type of testing	No. of tries		
	1	2	3
Lighter	Detected	Detected	Detected
Human	Detected	Detected	Detected

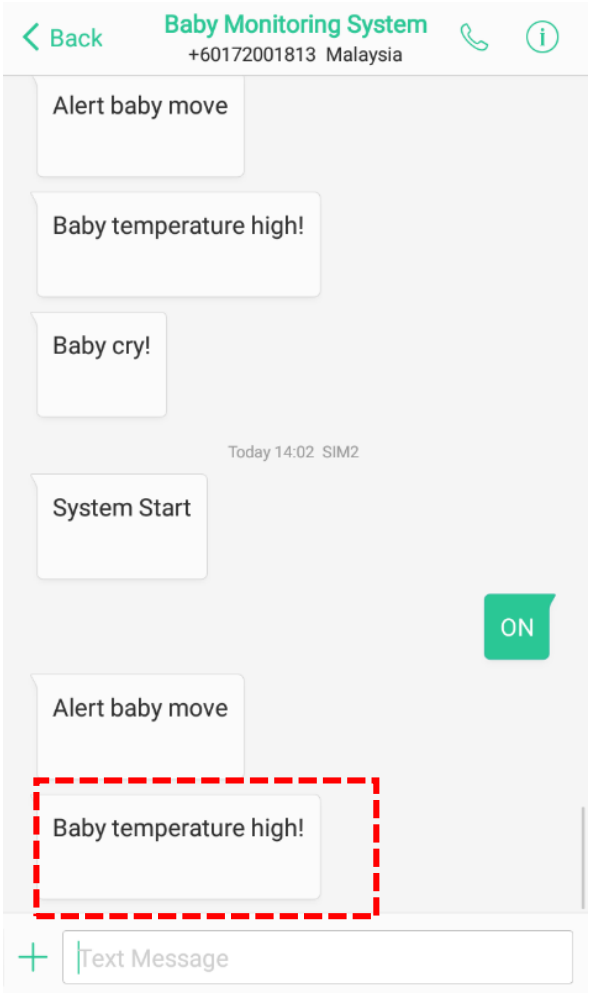

Figure 6: Alert received when temperature sensor detects high temperature value

3.3 ESP32 camera

In this testing, Arduino UNO, GSM module, and ESP32 camera components was connected and successfully work together. An additional function for user convenience was added for ESP32 camera which the notification and alert would be sent out only if the user turn ON the function like shown in Figure 7 (a). A short beep from the buzzer would indicate that the instruction that was sent out by the user was received. This would start the camera monitoring with face detection function which if the user when out of frame, a message followed by a call would be received by the user like Figure 7 (b) and Figure 7 (c).

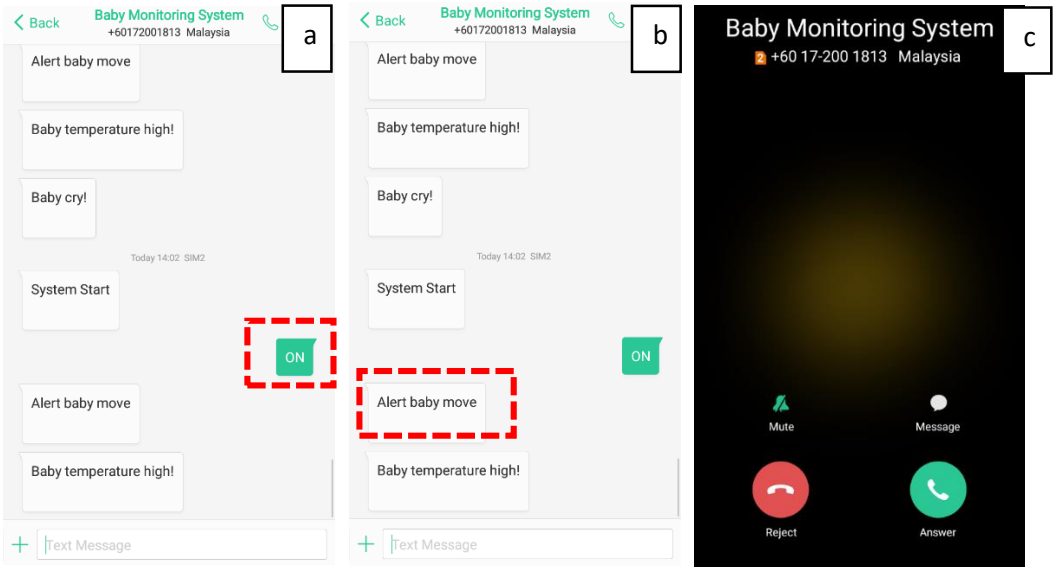

Figure 7: ESP32 camera testing

3.4 Sound sensor

In this project, sound sensor was used to detect baby cries using frequency pattern which through testing has successfully work. Figure 8 shows that user successfully received an alert when baby cries was detected.

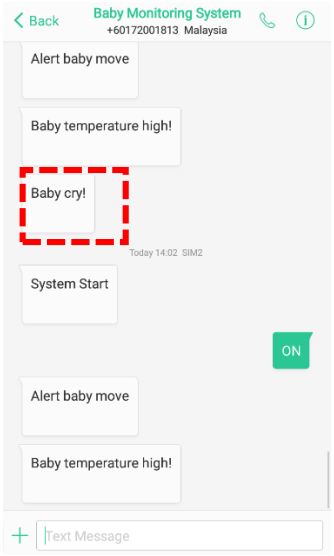

Figure 8: Alert received by user after sound sensor testing

Figures 9 (a), 9 (b) and 9 (c) show the frequency pattern of the baby cries for better understanding in where the value for the pattern was obtained.

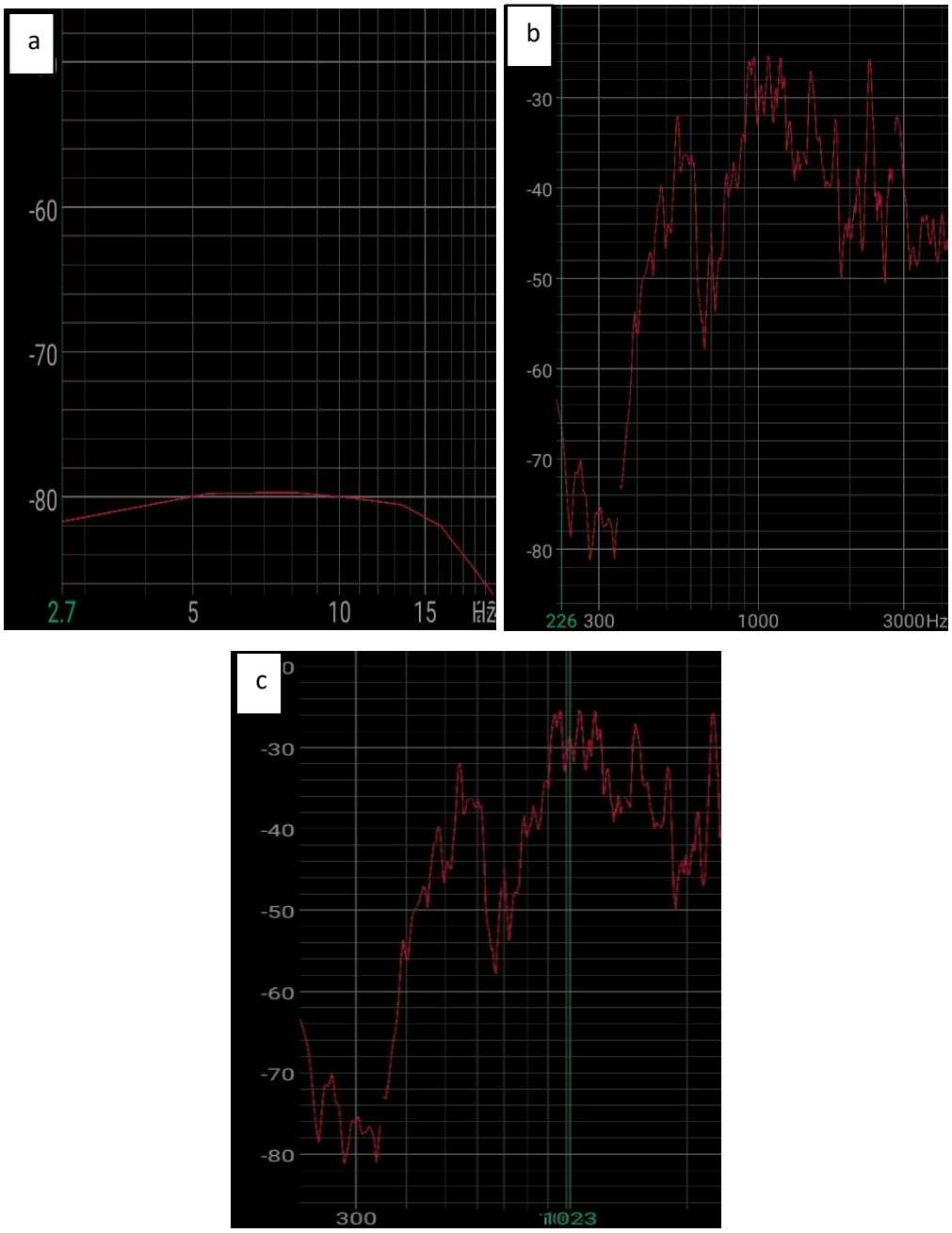

Figure 9: (a) Min value of the pattern, (b) Mid value of the pattern,

(c) Max value of the pattern

4. Conclusion

In conclusion, the objectives for this project managed to be achieved in time which the first objective was to develop an Iot based smart baby monitoring system. Temperature sensor managed to detect high temperature that exceeds the limit that was set and sent out alert to parents. Sound sensor also work perfectly which it managed to detect baby cries and sent out alert to parents' mobile phone. Lastly, video monitoring through ESP32-camera work without a problem since it can detect baby presence in video frame and sent out message and a call to parents when the baby was not detected in frame. With the three monitoring components working successfully, the second objective for this project managed to be achieved in time which is to monitor the baby's condition through temperature, sound, and camera and give an alert to parents through notification on a mobile phone. A working prototype managed to be developed with all the requirement and objectives fulfilled.

Acknowledgement

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