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IoT-based Smart Baby Swing with an Android Mobile Application

Nanthakumar Ganasan[1], Nurfarina Zainal[1]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

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Abstract: Female employment has increased considerably in developed countries in recent years, influencing newborn care in many families. The careless and busy working environment raises the number of milk-choking incidents and Sudden Infant Death Syndrome (SIDS). At present, an automated swing has a restricted swing speed function, and the system is always turned on. It also lacks a real-time monitoring mechanism. To solve these problems, an IoT-based smart baby swing that works in parallel with an Android mobile application was developed in this project. The smart baby swing system consists of hardware devices such as ESP8266 NodeMCU microcontroller, sound sensor, Wi-Fi camera, motor, Blynk cloud server, and internet. The graphical user interface (GUI) layout for the Android Mobile application was designed using Blynk, and the Arduino IDE program is used to control the hardware part. This smart baby swing can control and monitor the baby swing via a smartphone that has a selection of speeds and delay mode functions. It also equips with an alert and push notification to the user when the system senses a baby crying at the sound between 80 and 100 decibels. The ESP32 camera is used to live stream the baby's condition, hence allowing users to monitor the baby in real time. Thus, this smart baby swing can potentially minimise milk-choking and SIDS issues.

Keywords: Milk-Choking, SIDS, ESP8266, Blynk, ESP32 Camera, Smart Baby Swing, Alert Notification

1. Introduction

Females in the labour force in developed countries have risen dramatically in recent years, influencing newborn care in many families [1]. Both parents are required to work due to the high cost of living. Working parents are not always able to care for their children. They either send their children to their parents or hire a babysitter to look after them while they work. Some parents are concerned about their children's safety while in the care of others. In Malaysia, the number of choking on milk cases increased due to the careless and busy working environment [2]. There are increasing numbers of

**Corresponding author: nurfarina@uthm.edu.my*

milk-choking cases occurring when a baby is under the care of a babysitter which causes death cases. The major deaths that occur next after choking on milk are Sudden Infant Death Syndrome (SIDS) cases. Most SIDS deaths occur in infants under the age of six months [3]. Milk-choking and SIDS often occur during the baby’s position in the crib or swings [2], [3]. In the case of milk choking, it usually happens when the baby is fed with milk using a bottle in the swing. The babysitter or caregiver will leave the baby with the bottle in the swing for a while, and at the same, she/he attain the other baby or do some other chores. While for SIDS cases, it can happen due to the position of the baby in the swing, whether the baby is in an awake, or sleep condition [3].

A traditional cradle or swing does not have any electrical components, such as a battery or an adapter, to automate the cradle. The disadvantage of this type of cradle is that it requires labour to care for a baby, and a youngster may not be safe or comfortable in a traditional cradle. Manual and traditional swings cause a problem such as the monitoring person cannot do other tasks or work due to it needing full-time monitoring to swing the cradle. This type of manual swing requires more energy and time; hence, it may be causing difficulty for working women or babysitters. Recently, automated baby swings have been developed and are now available in the market. For example, a smart baby swing that monitors the infant's heartbeat and body temperature [4], a swing has manual and automatic swing operating modes utilising the Android application [5] and a swing with a music feature, which can monitor the baby's temperature, and can communicate with the infant [6]. However, the automated available swing still lacks a real-time monitoring system. There are no notification alert features on the swings that can notify the user when the baby is crying through a smartphone. The existing swings also are constrained by real-time monitoring technologies that cannot livestream the baby's status in mobile applications. An Arduino-based resonant cradle designed with infant cry recognition [7] will be proposed to be used in this project. A ball bearing design is adopted to reduce system damping and allows the cradle to swing freely even without electricity.

NodeMCU is a physical programmable circuit board that operates like Arduino and Raspberry Pi. ESP-8266 outcomes are good if used briefly [8]. The NodeMCU ESP8266 chip is highly integrated for the connected world. It provides a self-contained Wi-Fi networking solution that may host the application or offload all networking functions to another application processor [9]. Next, the LM393 sound sensor is utilized to monitor sound pollution [10]. The microphone is used to capture the audio signal in this system. A sensitive material that turns sound into electrical energy is sound. The amplifier is used to magnify the electrical signal generated by the PM358. The system is designed with specific sound range detection. A sound pollution monitoring system is designed to keep measuring the noise level [11]. The LM393 sound sensor measures the noise level and is used to report it. The sound sensor will detect sound based on the programmed range. ESP32-CAM is a programmable camera, a cheaper and low-power module with extensive programmability. This paper explains how the ESP32-CAM had to be modified so that it could be used in a range of different experimental cameras [12]. For instance, some of these cameras do not use the lens that is bolted and bonded onto the OV2640, and replacing this lens showed several faults that ranged from spectrum response to modification of lens corrections.

In this project, an automated and real-time Internet of Things (IoT)-based smart baby swing together with an Android mobile application was built to solve and minimise the problems of milk choking as well as SIDS. It is expected that this smart baby swing will assist the parents or babysitter in swinging the baby automatically while simultaneously monitoring the baby in real time. This smart baby swinging system will come along with a Wi-Fi camera and a sensor for monitoring the baby. It is also coupled with the Android smartphone application, which can ease the parents or babysitters to control the swing and carefully monitor their child in real-time. It is anticipated that the swing has the benefit of energy saving because a delay function was applied to it.

2. Methodology

2.1 Overview of the system

The whole system architecture of the IoT-based Smart Baby Swing with an Android mobile application is depicted in Figure 1. An Android smartphone will be used to control an IoT-based smart baby swing that has an Android mobile application. IoT-based Smart Baby swing can be divided into two main parts which are hardware and mobile application. The hardware part consists of a microcontroller ESP8266 NodeMCU, LM393 sound sensor, DC Geared Motor, IBT_2 DC motor driver, ESP32 Wi-Fi camera and 11.1 V battery are the components of the smart baby swing. Microcontroller ESP8266 NodeMCU is the main control element of the baby swing. It is programmed by using Arduino IDE to control the baby swing as the execution function that has been selected. LM393 sound sensor is utilized to pick up the baby’s cry to send an alert notification to the user by push notification. DC geared motor is used to rotate the swing with an IBT_2 DC motor driver for controlling the speed of the swing. The motor is powered by an 11.1 V battery. The monitoring system is fully controlled by an ESP32 Wi-Fi camera and it is used for real-time monitoring. The second part of the smart baby swing is the mobile application. The specific mobile application is designed to control and monitor the baby's swing with a notification alert when the baby cries. The graphical user interface (GUI) is designed by using the Blynk application for mobile applications. The baby swing and mobile application are integrated using Blynk Cloud with an internet connection. The mobile application layout consists of speed and delay mode selection with real-time monitoring. It has two speed functions which are low and medium speed and three delay mode selections. Mode A swing for 10 minutes and delay for another 10 minutes while Mode B swings for 15 minutes and delay for 15 more minutes. Mode C swings for 20 minutes and delays for another 20 minutes.

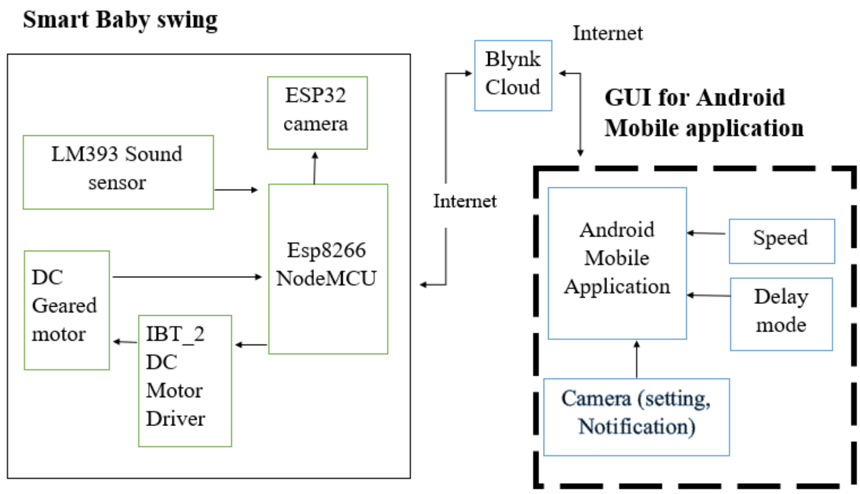


Figure 1: Block diagram of the IoT Smart Baby Swing with an Android Mobile Application

The wiring connection of the smart baby swing system is depicted in Figure 2. A DC-geared motor, IBT_2 DC motor driver, LM393 sound sensor, and ESP32 camera make up the system. NodeMCU is the main control element for the system. The DC geared motor is powered by an 11.1 V battery. The DC geared motor is used to swing and the IBT_2 DC motor controls the speed and direction of the motor. The LM393 sound sensor is used to pick up the baby’s cries to send a notification alert in the mobile application.

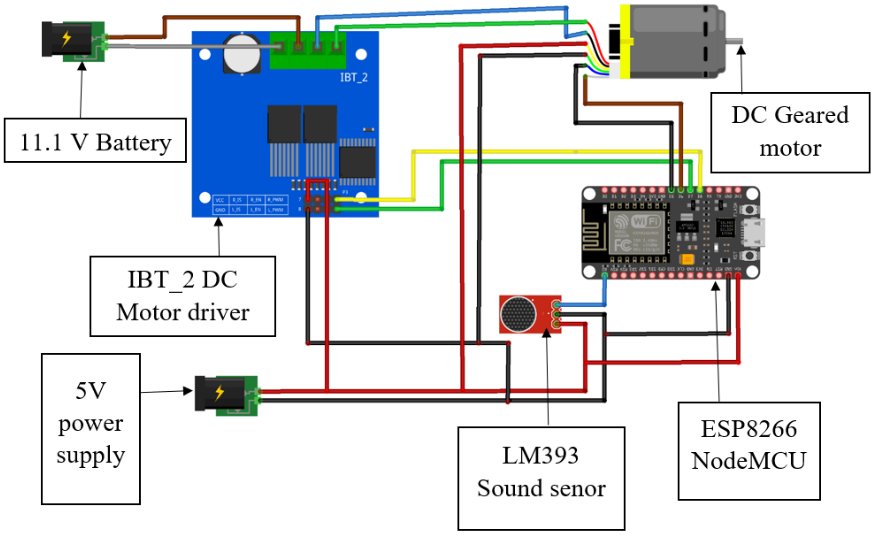


Figure 2: Wiring diagram of the swing

Figure 3 shows the monitoring system that consists of an ESP32 camera and USB to TTL serial adaptor. ESP32 camera is utilized for real-time monitoring of the mobile application and is powered by 5 volts.

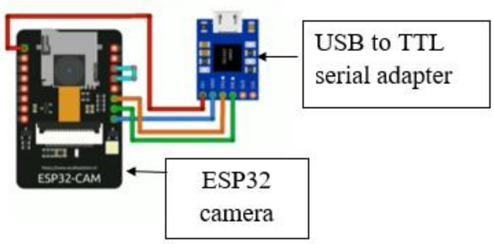


Figure 3: Wiring diagram for monitoring system

2.2 Android mobile application

The process flow for the Android mobile application is shown in Figure 4. The graphical user interface (GUI) program of the Android Blynk IoT System opens with the user logging in, and after a successful login, the user's home page is displayed. Three execution options are available on the user's home page, which are speed, delay mode, and Wi-Fi camera. The speed selection function is used to select the swing's speed. The smart baby swing is built with two speed selections which are low speed and medium speed. The DC geared motor will rotate at 4 rpm at low speed and 13 rpm at medium speed. The system was designed with three delay mode options to save energy. Mode A has a 10-minute swing and a 10-minute delay, whereas Mode B has a 15-minute swing and a 15-minute delay. Mode C will swing for 20 minutes and then delay for another 20 minutes. For the control part using the mobile application, the user will choose the swing speed function, either low or medium speeds as a selection. Then, the selection of delay mode is either A, B, or C. When the speed and delay mode are set, the selection data will be sent to the microcontroller ESP8266 and it will control the motor rotation of the system. The mobile application also is integrated with a monitoring system, where a user can activate and select the video in the application by turning on the Wi-Fi camera and allows for real-time surveillance of the baby.

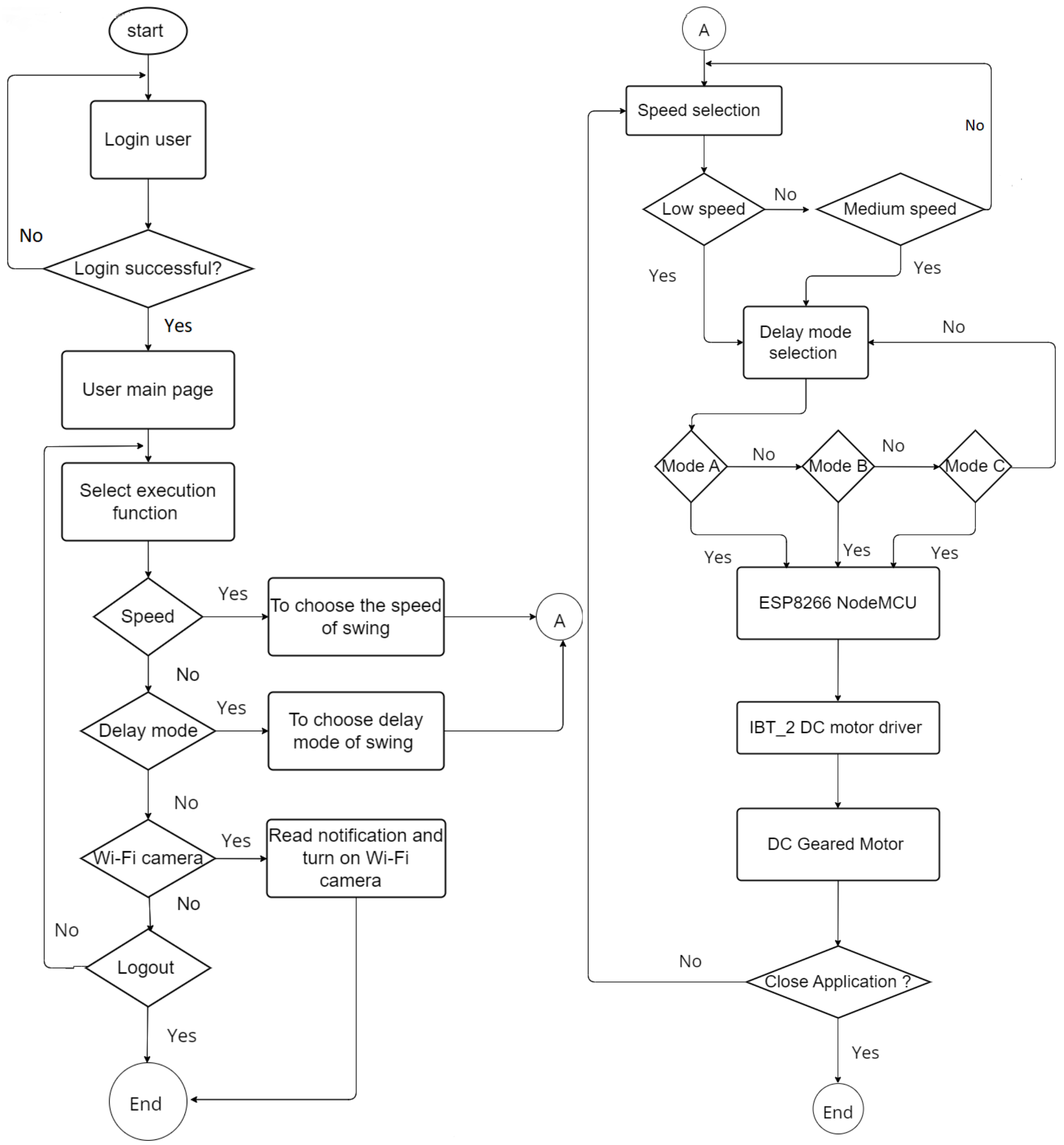


Figure 4: Android mobile application for smart baby swing system.

2.3 Sound sensor and monitoring system

The sound sensor and monitoring smart baby swing system are shown in Figure 5. It consists of the sound sensor LM393, which is used to identify baby cries between 80 and 100 dB. The mobile application integrates the notification alert. The sound sensor will collect the sound level in decibels and transmit it to the ESP8266 NodeMCU microcontroller. When the ESP8266 NodeMCU detects different decibel ranges of sounds, it will begin to integrate with the programmed condition. When the sound level is below 80 dB or above 100 dB, the system does not send an alert to the user. The user will receive an alert notification when the sound sensor detects a volume between 80 and 100 dB. Once a sound is identified, data is sent to the ESP8266 NodeMCU, which notifies the Android mobile application. When the user receives a notification that the baby is crying, they have the option to use the mobile application to monitor the child in real-time. The monitoring system activates the ESP32 camera and streams live video of the baby to an Android application.

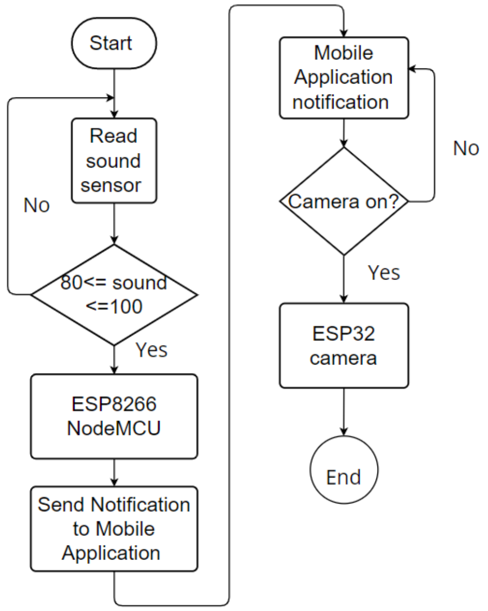
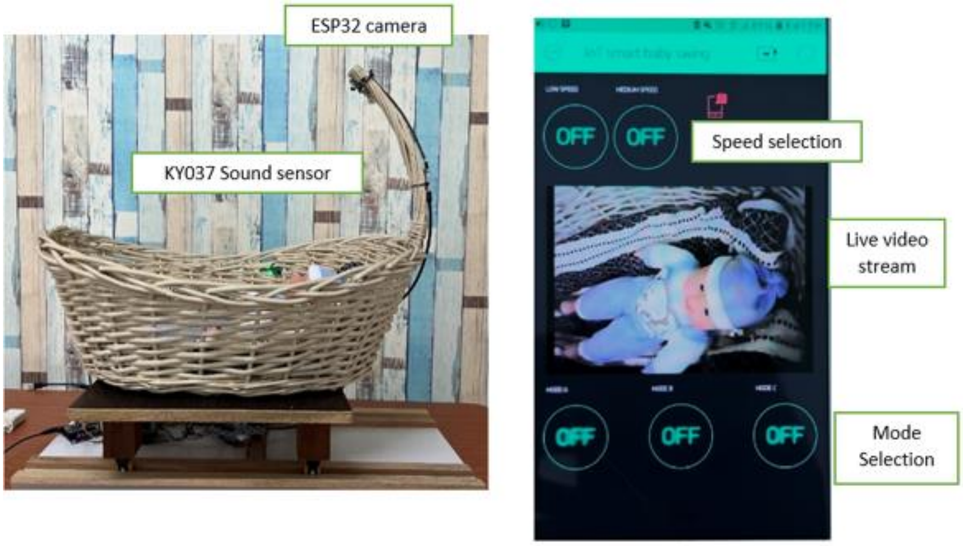


Figure 5: Flow chart of the sound sensor and ESP32 camera

3. Results and Discussion

The prototype and mobile application of an IoT-based smart baby swing are shown in Figure 6. For the smart baby swing to fully operate, it must be connected to the power supply. The system consists of an LM393 sound sensor to detect the sound if the baby is crying and send a notification to the user. The ESP32 camera operates as a live stream medium for real-time monitoring in the mobile application. To control the swing, the system is supported with an Android mobile application. The application consists of speed and delay mode selection features. A live stream widget is available for monitoring the baby with the application.



(a) (b)

Figure 6: (a) Image of prototype IoT-based smart baby swing and (b) the graphical user interface (GUI) of Android mobile application.

Figure 7 depicts the results of a graphical user interface (GUI) layout for an Android mobile application that was designed using the Blynk IoT interface system. The developed GUI mobile layout was divided into three sections that represent the controlling and monitoring system. It contains features such as two swing speed selection button functions, namely low and medium speeds, three delay modes A, B and C, and live stream video which can provide the capabilities to watch the child using the ESP32 camera. The video can be activated when the alert notification is sent to the mobile device.

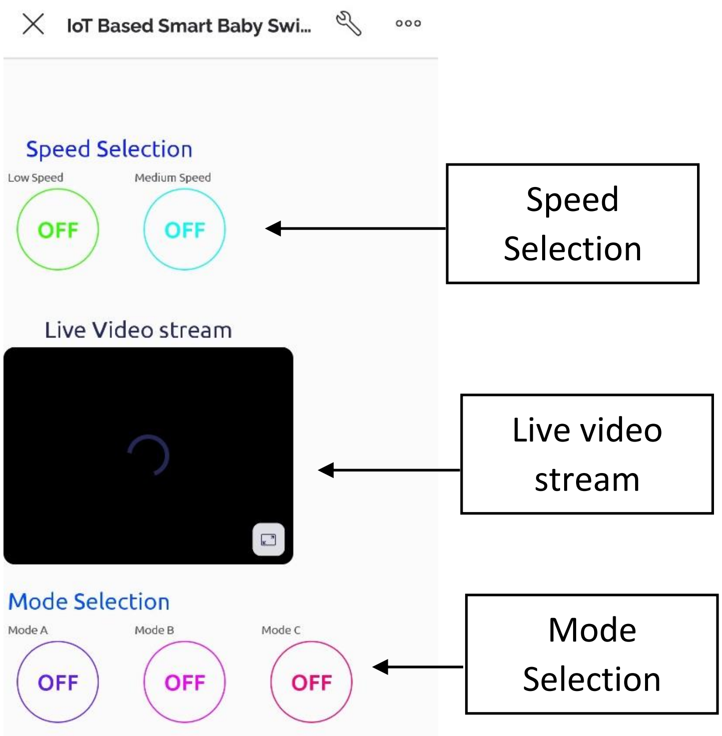
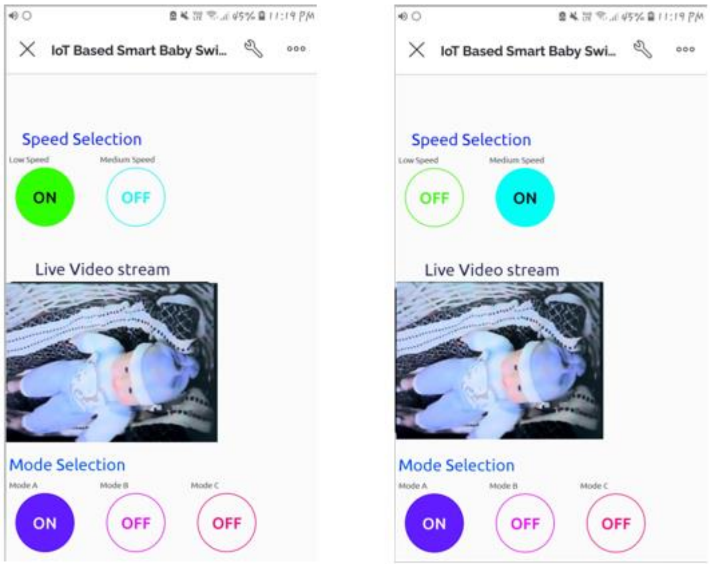


Figure 7: Android mobile application

Figures 8 (a) and (b) show the images of the GUI layout system when the mobile application was functional in controlling and monitoring the swing system. For example, the image in Figure 6 (a) shows the smart baby swing was controlled and set up in a low-speed condition and with mode A delay selection. In this selection, the system will swing slowly for 10 minutes and then delay for another 10 minutes. Whereas Figure 6 (b) shows the condition that was selected at medium swing speed. In this case, the swing will pause for 10 minutes before swinging at a medium speed for 10 minutes. The procedure will carry on until the user shuts off the device. The user can also use a smartphone to monitor the baby in the live stream where it shows the present scenario after selecting the live video stream on the mobile setting mode.



(a) (b)

Figure 8: Results from the GUI mobile layout with a swing at (a) low speed and (b) medium speed

Once the speed and mode are set via a mobile application, the smart baby swing system is activated. It will swing according to the desired selection for example with the selection of low speed and Mode A. The system will swing for ten minutes before pausing for another ten minutes. The process continues until the user stops the swing in the mobile application. It swings at a rate of 4 revolutions per minute (rpm). The result of the speed versus time graph is shown in Figure 9. The graph depicts the swing oscillation for 10 minutes, followed by a 10-minute delay. The highlighted region indicates that the system is in an interval state for specific time intervals as expected. The rpm is unstable only at 1 rpm for a duration of time which is believed due to the motor moving at that prototype swing stage.

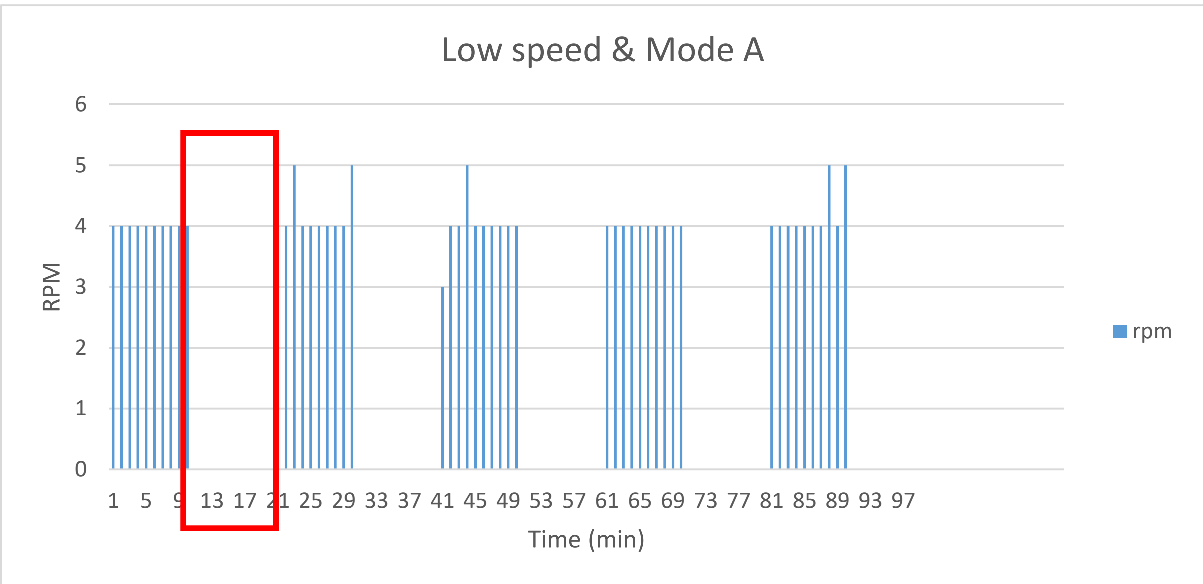


Figure 9: Mode A at low speed

Figure 10 shows the graph of speed versus time with medium speed and the Mode A delay function. The swing will initially swing at a medium speed of 13 revolutions per minute (rpm). The system will swing for ten minutes, then come to a delay for another ten minutes while moving at a medium speed. Based on the graphs in Figures 9 and 10, show and confirms that the system works according to the desired selection that was designed for this project.

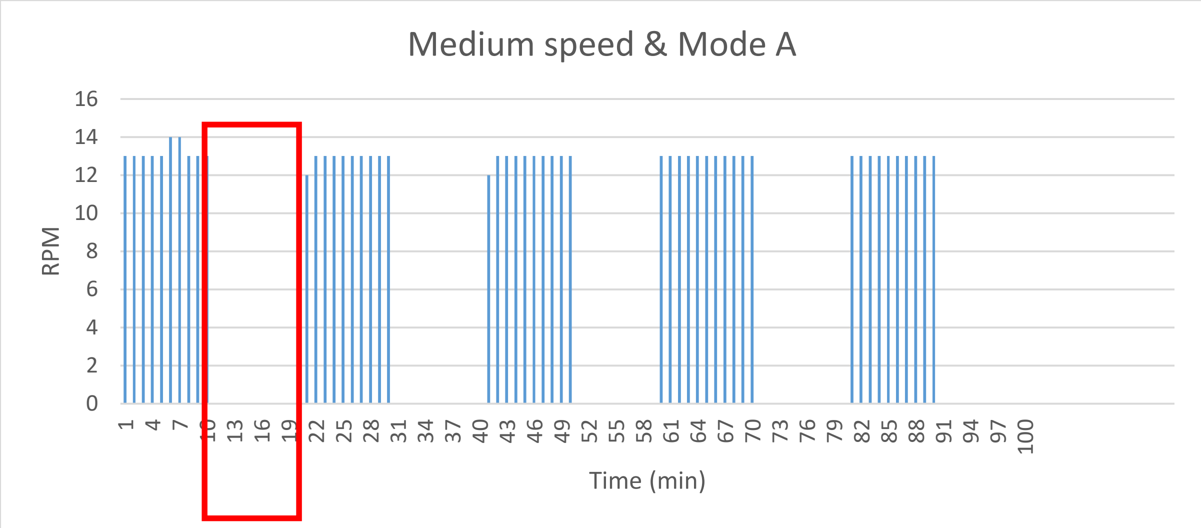


Figure 10: Mode A at medium speed

The LM393 sound sensor allows one to hear the baby when it screams. A connection has been made between the sound sensor and the ESP8266 NodeMCU. The mobile applications will receive a notification when the sensor detects the sound of crying. The sound sensor is programmed with sound detection in a range of 80 dB to 100 dB. The sound sensor has a total of two green LEDs built into it. The On or Off states are represented by LED 1, while the indicator for sound detection is represented by LED 2, as shown in Figure 11. The sensor will be able to pick up on a baby's screams, and when it does, the green LED 2 will flash. When the sensor is supplied by a supply of voltage equal to or greater than 5 volts, the green LED 1 will light up to indicate that the sound sensor has been switched on.

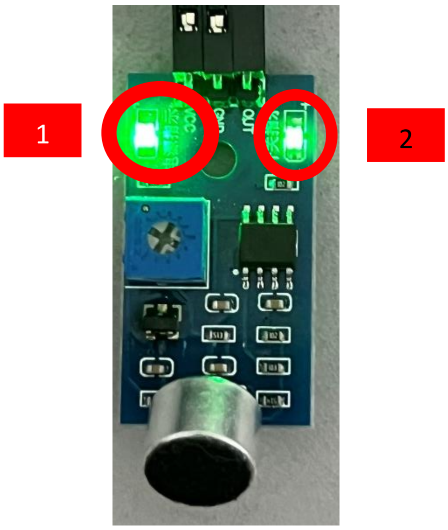
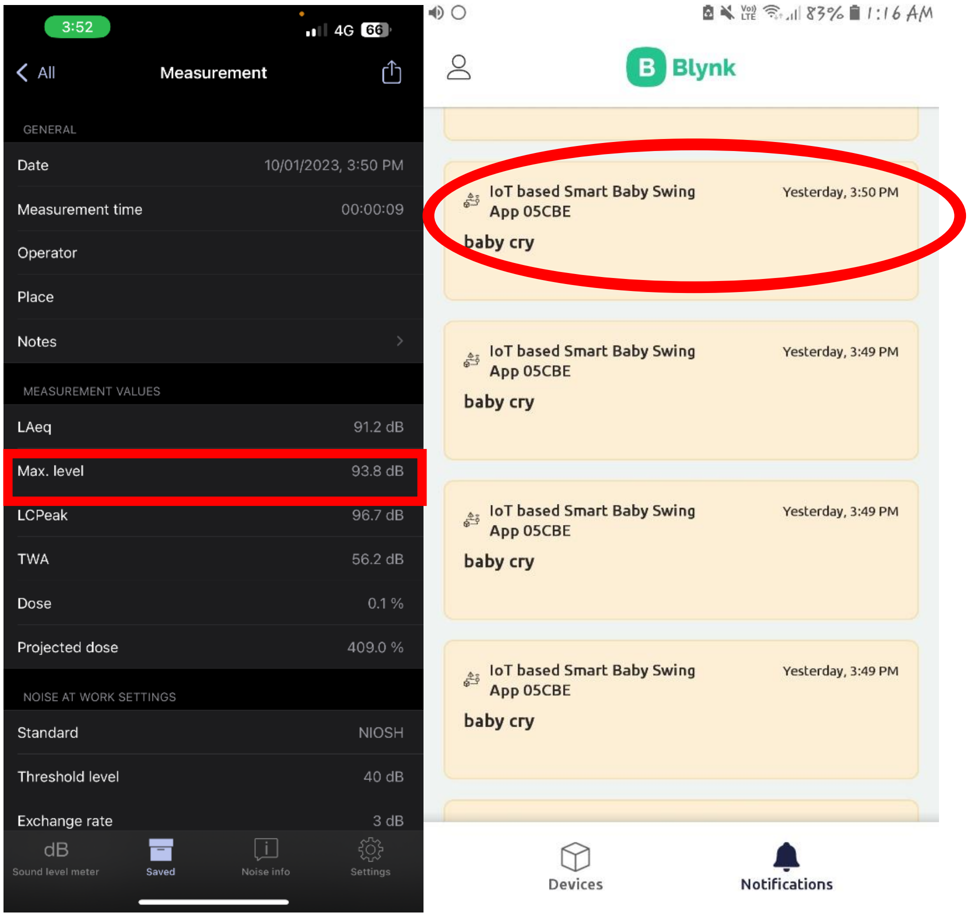


Figure 11: LM393 Sound sensor

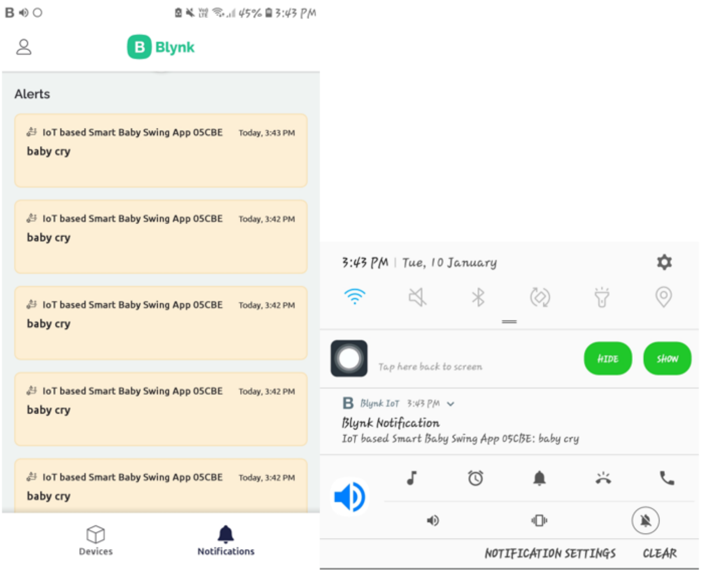
The system is set to produce a sound range of 80 to 100 dB. The system will send an alert notification when the sound sensor detects sound in a specific range. Figure 12 depicts an alert notification sent at a set time when the LM393 sound sensor detects a sound within the specified sound range. The third-party application NIOSH SLM was used to determine the loudness of the sound played. Figure 12 depicts a comparison of the sound sensor value between the notification alert and a third-party application. Based on the sound measurement using the NIOSH SLM device, it was tested that the sound level detected 93.8 dB as shown in Figure 12(a). Once the LM393 sound sensor detects sound within the set range, it transfers the information to the ESP8266 NodeMCU. As the baby cries, the microcontroller sends an alert notification to the user as shown in Figure 12(b).



(a) (b)

Figure 12: Comparison between the notification and the loudness (a) NIOSH SLM sound measurement results and (b) notification on mobile application

A notification function is available in the system. The app is alerted when it detects the baby crying since the sound sensor is listening for it and picking it up. As may be seen in Figure 14, it will display a message that says, "baby cry." When the user's phone screen is off, they will still be informed with a sound notice as well as a push notification that will be delivered to their device.



(a) (b)

Figure 14: Image of Android smartphone (a) notification in Blynk application and (b) push notification

4. Conclusion

This project was successful in developing the concept of an IoT-based smart baby swing that integrated with android mobile application. The mobile application was built by utilising the Blynk application as well as the Blynk Cloud to do development. The baby was soothed to sleep by this device, which offered a variety of speeds and settings to choose from. The speed and mode selection can cause the system to swing at different speeds and delays. The real-time monitoring system, which is implemented in the form of a mobile application and is connected to a swing, has been designed and is operating effectively. Once the sound sensor identifies the sound of a baby crying in the range of 80 - 100 dB, the user will get a notification alert through the mobile application on their device. This system can be beneficial in minimising the risks of milk choking and SIDS, which are the primary factors contributing to the infant's passing away. The method also lessens the need for constant human supervision when it comes to the care of babies. Therefore, the mother or users will save time, and they will be able to finish other work without waiting at the side of the baby. The delay mode functions also can contribute to energy saving.

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References

[1] Jabbar, W. A., Shang, H. K., Hamid, S. N., Almohammedi, A. A., Ramli, R. M., & Ali, M. A. (2019). IoT-BBMS: Internet of Things-based baby monitoring system for smart cradle. IEEE Access, 7, 93791-93805.

[2] Erda Khursyiah Basir & Soon Li Wei, Pilih Pengasuh, Taska Bertauliah Jamin Keselematan Kanak-kanak. Bernama. [Accessed: 23 July 2021] https://www.bernama.com/bm/rencana/news.php?id=2026032

[3] Horne, R. S. (2019). Sudden infant death syndrome: current perspectives. Internal medicine journal, 49(4), 433-438.

[4] Saude, N., & Vardhini, P. H. (2020, October). IoT based Smart Baby Cradle System using Raspberry Pi B+. In 2020 International Conference on Smart Innovations in Design, Environment, Management, Planning and Computing (ICSIDEMPC) (pp. 273-278). IEEE.

[5] Shahadi, H. I., Muhsen, D. H., Haider, H. T., & Taherinia, A. H. (2020). Design and Implementation of a Smart Baby Crib. In IOP Conference Series: Materials Science and Engineering (Vol. 671, No. 1, p. 012050). IOP Publishing.

[6] Ramesh, S., Hanidia Misbah, S. S., Bhavani, P., & Mamtha, H. L. (2019). A smart baby cradle. Global Journal of Computer Science and Technology.

[7] Chao, C. T., Wang, C. W., Chiou, J. S., & Wang, C. J. (2015). An arduino-based resonant cradle design with infant cries recognition. Sensors, 15(8), 18934-18949.

[8] Kommuri, K., & Ratnam, V. (2020). Real Time Implementation and Comparison of ESP8266 vs. MSP430F2618 QoS Characteristics for Embedded and IoT Applications. International Journal of Advanced Computer Science and Applications, 11(9).

[9] Parihar, Y. S. (2019). Internet of Things and Nodemcu. Journal of Emerging Technologies and Innovative Research, 6(6), 1085.

[10] Reddy, M. R. (2020). IoT based Air and Sound Pollution Monitioring System using Machine Learning Algorithms. Journal of IoT in Social, Mobile, Analytics, and Cloud, 2(1), 13-25.

[11] Gaikwad, V., Bagati, S., Patil, S., Salunkhe, R., Mehra, S., & Sonje, S. SOUND POLLUTION MONITORING SYSTEM.

[12] Dietz, H., Abney, D., Eberhart, P., Santini, N., Davis, W., Wilson, E., & McKenzie, M. ESP32-CAM as a programmable camera research platform. Imaging, 232, 2.