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Location alert device for child safety using Arduino Pro Mini

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Abstract

This study aimed to develop a location alert device for child safety using Arduino Pro Mini as a method of helping ensure child safety. The researchers utilized an applied quasi-experimental research design to develop and test the device. The materials used in the study include the Arduino Pro Mini, SIM800L GSM module, Cn3065 mini-USB solar lithium charger board module, Li-Ion battery, slide switch, 2-pin push buttons, 2-pin condenser microphone, wirings, clear fiberglass, plywood, leather, reused watch strap, and gluing materials. The developed location alert device encoded a program for the intended function. To gather the data, the researchers constructed a questionnaire that was validated by the advisers and experts. They distributed it to the 14 users who participated in the experimental stage of the study. Based on the results and data gathered through the questionnaires, it can be concluded that the location alert device is convenient, wearable, user-friendly, has a long-lasting battery life, fast speed, and is accurate. Furthermore, the device's text and call functions are consistent in any type of location in terms of speed and accuracy, proven by the analyses of variance on the data gathered directly by the researchers. The researchers then recommend that future researchers further improve the device by enhancing its existing features and adding a speaker to make the call function a two-way method of communication instead of just one-way.

Keywords: location alert device, child safety, Arduino Pro Mini, SIM800L GSM module, applied quasi-experimental research design

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1. Introduction

In today's society, the safety of children should remain a priority. According to Ismael (2023), the Philippine National Police (PNP) has recorded 102 kidnapping cases and other crimes related to Philippine offshore gaming operators (POGO) from 2019 to Jan. 30, 2023. The problem of children getting lost or kidnapped has not disappeared from the present. Thus, the researchers aim to minimize the risk of related incidents. The main goal of this study is to support and enhance child safety by creating a location alert device in the form of a watch using Arduino Pro Mini and associated parts. This solution uses the capabilities of the Arduino Pro Mini when paired with related technologies to increase child safety by sending predefined text alerts and phone calls to numbers registered in the encoded program of the device. The intention of these features includes helping parents and guardians stay informed of their child's location through the mentioned text and call functions. The goal of the study is to make the location alert device as wearable, convenient, and user-friendly as possible, along with ensuring that it has a long-lasting battery life, fast speed, and accuracy. The developed device has a non-conductive housing consisting of clear fiberglass, plywood, and leather attached to a reused watch strap. Parents or guardians are likely more comfortable when they are aware of their child's location. To further enhance this peace of mind, the device has three easily accessible push buttons that children can use to send predefined text message alerts or phone calls. Upon receiving these text messages and calls, parents or guardians can be made aware of their child's whereabouts and be alerted in case of the need for assistance.

As mentioned by Robb (2019), by the age of 11 years old, 53% of kids own cellular phones. The device was designed for children ages ten and below because although some parents might not want or are unable to give their child access to cellular devices yet, they could still want to be aware of their child's location to be sure of their safety. The researchers conducted their experiment at the Grade School Department of the Divine Word College of San Jose by assisting 14 students aged 10 in interacting with the device and answering the questionnaire. The main objective of this study was to develop a location alert device that provides children with a way to alert their parents or guardians of their location and need for assistance, along with hopes of helping enforce child safety.

Statement of the Problem - This study aimed to develop a location alert device using Arduino Pro Mini. Specifically, this research sought to answer the following questions: (1) What is the level of effectiveness of the location alert device as assessed by its users in terms of convenience, wearability, and user-friendliness? (2) What is the level of performance of the location alert device as assessed by its users in terms of battery life, speed, and accuracy? (3) Does the type of location affect the performance of the text function of the location alert device in terms of speed, and accuracy? (4) Does the type of location affect the performance of the call function of the location alert device in terms of speed and accuracy?

Significance of the Study - This study aimed to develop a location alert device using Arduino Pro Mini to help reduce child-related accidents, injuries, and disappearances. The results of this study will not only provide valuable insights into the validity and effectiveness of location alert devices and highlight any shortcomings in the current systems. The device developed through this study can effectively ensure children's safety even if the child does not possess a cellular phone. The findings may impact regulations governing child safety in public spaces, influence product development, and help drive necessary changes in standard operating procedures for the safety of children. To This device can provide parents with a way to help keep their children safe. It allows parents to be informed of their child's location by receiving text alerts and calls from their child. The device is presented as an alternative to cellular phones for parents who can or do not wish to allow their child to have access to such devices yet. This device can help children feel more secure by making them aware that their parents or guardians are aware of their location through the text function. Although the call function only allows for the parent or guardian to hear

the child, it can give a sense of security to the child by providing a way to communicate their needs. Also, as the device is in the form of a watch, it can be worn and accessed easily. To the school, the data generated by this device can be utilized to optimize school safety protocols, identify potential vulnerabilities, and implement targeted preventive measures, thereby contributing to creating a safer and more secure educational environment for all. To the community implementing this device in communities is crucial for enhancing overall safety measures for children. It can help ensure quick responses to emergencies and minimize risks of abduction or accidents in various settings. Their presence fosters a culture of vigilance and collective responsibility, reassuring parents, enhancing law enforcement capabilities, and promoting community engagement in safeguarding children, thus fortifying communal safety efforts. This study can provide future researchers with the data collected from the tests so they can determine deficiencies and further explore ways to ensure the safety of children. Data and findings from the study could also lead to the development of more child-friendly designs for public spaces. Future researchers can leverage this technology to develop more advanced safety features that could improve how children are kept safe.

Scope and Delimitation of the Study - This research used Arduino Pro Mini to develop a location alert device for child safety. The three 2-pin push buttons serve as the interactive component that allows the text and call functions to be operated. The device's performance may be impacted by battery life, signal strength, and network coverage. The text and call functions may have difficulty working in places with poor signal and network coverage. Furthermore, the SIM card being used with the SIM800L GSM module requires the load to be able to operate. Thus, the load balance of the used SIM card should be checked often. Two cellular phone numbers can be encoded in the program: the primary receiver that receives the text alerts immediately and can be called, and the secondary receiver that receives text alerts after a delay and cannot be called. The device's text function depends on predefined text messages. Because of this, only two locations may be set in the encoded program; thus, the child may only send either. The call function of the device is only a one-way method of communication. Although the device can relay the audio to the receiver through the 2-pin condenser microphone, the device does not have a speaker that allows the child to hear the receiver. Additionally, while the text function can be used continuously, the call function can only be used once every few minutes, requiring the device to be restarted for the call function to work again. The device's design is compact and assembled so the child may not break or take it apart. The electronic device is enclosed in a clear fiberglass casing attached to a wide watch strap that should be worn on the child's wrist. It is not waterproof. The device is strictly for humans and must not be used on other animals. It is intended for children aged 10 and below. Only 14 out of the 36 students that were 10 years of age could test the device and answer the questionnaire due to either the child's parent or guardian refusing to sign the consent form or the child forgetting the consent form despite their parent or guardian signing it. The experiment was conducted in March 2024 at the Divine Word College of San Jose, San Jose, Occidental Mindoro.

2. Methodology

Research Design - This study utilized an applied quasi-experimental research design to develop the location alert device for child safety using Arduino Pro Mini. This research method uses existing scientific knowledge to develop an effective product in this context. The researcher manipulates or observes an independent variable in this design, but participants are not randomly assigned to groups. Instead, participants are divided into groups based on things they already have in common, such as age and grade level. This study utilizes a quantitative research approach.

Participants of the Study - The study included 14 students who were 10 years old at the time of the experiment. These students were from the Grade School Department of the Divine Word College of San Jose, belonging to the fourth and fifth-grade classes. They were chosen purposively as the experimental group in this study since the researchers wanted to collect data more naturally. As Robb (2019) mentioned, by age 11, 53% of kids own cellular phones. The device was designed for children ages ten and below because although some parents might not want or cannot give their child access to cellular devices, they could still want to be aware of their child's location to ensure their safety. They tested the functions of the device with the assistance of the researchers. The researchers also helped clarify any questions from the participants regarding the questionnaire.

Data Gathering Procedure - The following data-gathering procedures were conducted to develop a location alert device using Arduino Pro Mini: First, to determine the level of effectiveness and performance of the device, the researchers prepared a researcher-made questionnaire featuring a Likert scale. The questionnaire was based on the tested factors: convenience, wearability, user-friendliness, battery life, speed, and accuracy. Due to the intended users being minors aged 10, the researchers presented a letter to those in charge of the Grade School Department of the Divine Word College of San Jose, along with consent forms for the potential users' guardians to sign. As soon as the letters were approved and a schedule for the experiment was set, the researchers experimented with the users whose consent forms were signed by their guardians for almost a week. The researchers assisted the users, fourth and fifth graders of the Divine Word College of San Jose, aged 10, one by one, in interacting with the device. The researchers also assisted the users in answering the questionnaires given to each user after testing the device. The questionnaires were retrieved personally right after the users finished answering them. To answer whether the type of location affects the performance of the device's text and call functions, the researchers tested the device at four different combinations of indoor and outdoor locations with the location alert device and the primary receiver. The locations are classified as Location 1 - Indoors Device - Indoors Receiver; Location 2 - Indoors Device - Outdoors Receiver; Location 3 - Outdoors Device - Indoors Receiver; and Location 4 - Outdoors Device - Outdoors Receiver.

Research Process; Stage 1 Preparation and Gathering of Materials - This study utilized electronic components to develop the product. The researchers ordered the materials online after determining the most appropriate parts for the proposed product. The total cost of these materials amounted to Php. 1277. The device's housing was constructed using non-electronic materials. The following is the materials used to create the location alert device for child safety.

- For the electronic device: Arduino Pro Mini, SIM800L GSM module, Cn3065 mini-USB solar lithium charger board module, and Li-Ion battery
- For the device housing: clear fiberglass, plywood, leather, reused watch strap, and gluing materials

The researchers used the Arduino Pro Mini as the main component for the product, which controls the other device components. A notable component is the SIM800L GSM module, which allows the device to provide location alerts through the text and call functions. The Cn3065 mini USB solar lithium charger board module, Li-Ion battery, and slide switch are responsible for the device's power. The 2-pin push buttons are the interactive component allowing the user to operate the device. Using the call function, the 2-pin condenser microphone captures the user's audio input. The wiring is responsible for the connections of the electronic components to each other. The non-electronic components were assembled and glued to encase the electronic device once the encoded program was tested to be successful.

Stage 2: Building and Development of the Project - First, the researchers used Arduino Pro Mini to gather the materials needed for the location alert device for child safety. Next, they soldered and connected all the electronic components. Then, they encoded the program and tested it through the electronic device. Once the program was tested and functioned as intended, the electronic device and non-electronic materials for the housing were assembled and glued together.

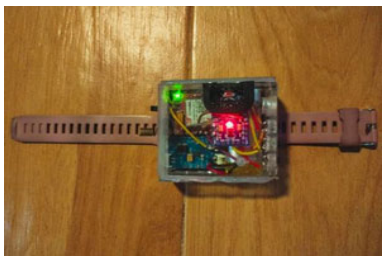

Figure 1. Actual Product of Location Alert Device

Stage 3: Experimental Stage, Observation, and Data Recording - The researchers developed the location alert device using Arduino Pro Mini. The development of the device was done from January until March of 2024. The researchers evaluated the developed device based on its expected output. The notable components of the electronic device were tested to see if they worked the way they should with the encoded program. Lastly, the researchers checked whether the electronic device was adequately attached to the device housing. The. The experiments were conducted for almost a week with four different locations and 14 participants from the grade school department, using 10 trials to gather the needed data to evaluate and test the device. Moreover, to assess the level of effectiveness of the device, the researcher-made questionnaire was presented. It was validated by the adviser and Science Teachers, experts in the field using face and content validation. The questionnaire was designed to determine if the device is working and effective

Statistical Treatment of the Data - The researchers used weighted mean and single-factor analysis of variance (ANOVA) to analyze the data gathered from the experiments. The data gathered were arranged in a tabular manner for a comprehensible presentation. The data gathered from the questionnaires, which featured a Likert scale, were analyzed using the weighted mean to determine the levels of effectiveness and performance of the device as assessed by its users. The data gathered to determine if the type of location affects the performance of the text and call functions of the device, which the researchers directly gathered, were examined using single factor analysis of variance (ANOVA). This analysis was used to determine whether the type of location of the device affected its performance.

3. Results and Discussions

Table 1

*Mean Level of Effectiveness of the Location Ale*rt Device

Indicators	4 (SA)	3 (A)	2 (DA)	1 (SDA)	Weighted Mean	Descriptive Indicator
The device is convenient.	10	4	0	0	3.71	Strongly Agree
The device is wearable.	9	5	0	0	3.64	Strongly Agree
The device is user-friendly.	10	4	0	0	3.71	Strongly Agree
Overall Mean					3.69	Strongly Agree

Legend: 3.26 - 4.00 Strongly Agree, 2.51 - 3.25 Agree, 1.76 - 2.50 Disagree, 1.00 - 1.75 Strongly Disagree

Table 1 presents the mean level of effectiveness of location alert device, along with their respective weighted means and descriptive indicators. Based on the results, the device is rated to be convenient (3.71), wearable (3.64), and user-friendly (3.71) on the highest positive response anchor: “strongly agree.” This implies that the Location alert device developed by the researchers was convenient, wearable, and user-friendly. The overall mean is calculated to be 3.69, which falls within the range of the indicator for “strongly agree.” Thus, the effectiveness of the location alert device is strongly agreed upon in terms of its convenience, wearability, and user-friendliness as assessed by the study participants. These results are consistent with prior research by Jiang et al. (2015), highlighting the importance of these attributes in wearable gadgets. Their study emphasizes the advantages of small and lightweight designs in enhancing ease of use and transport. Moreover, Ferreira et al. (2021) proved that wearable technology in their experiment has grown rapidly and has become essential in many consumer products and service sectors, such as children's healthcare. Building upon this literature, our analysis of user feedback further illustrates how the device's convenience, wearability, and user-friendliness directly contribute to its adoption, usability, and overall satisfaction among users.

Table 2

Mean Level of Performance of the Location Alert Device

Indicators	4 (SA)	3 (A)	2 (DA)	1 (SDA)	Weighted Mean	Descriptive Indicator
The battery life of the device is long-lasting.	10	4	0	0	3.71	Strongly Agree
The speed of the device is fast.	6	7	1	0	3.36	Strongly Agree
The device is accurate.	12	2	0	0	3.86	Strongly Agree
Overall Mean					3.64	Strongly Agree

Legend: 3.26 - 4.00 Strongly Agree, 2.51 - 3.25 Agree, 1.76 - 2.50 Disagree, 1.00 - 1.75 Strongly Disagree

Table 2 shows the location alert device's mean performance level, along with their respective weighted means and descriptive indicators. Based on the results, the device is rated to have a long-lasting battery life, a fast speed, and accuracy on the highest positive response anchor: “strongly agree.” The mean for the indicator speed, 3.36, is the lowest of the three, while the mean for the indicator accuracy, 3.86, is the highest. The mean for the indicator battery life, 3.71, is between these two means. This means that the battery life, speed, and accuracy of the device are strongly agreed and were proven and tested by the participants of the study. With an overall mean calculated to be 3.64, These results resonated with the insights from Seneviratne et al. (2017), who underscored the importance of battery performance in wearable devices. Their study highlighted the necessity for batteries to be compact, efficient, and long-lasting, particularly in wearable technology. The optimal balance of battery life, speed, and accuracy is crucial for enhancing the reliability and functionality of safety devices, ultimately ensuring the well-being and security of users.

Table 3

Analysis of Variance of the Accuracy of the Text Function of the Location Alert Device

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.5	3	0.166667	0.697674	0.55959	2.866266
Within Groups	8.6	36	0.238889			
Total	9.1	39				

Legend: P-value ≤ 0.05 Significant; reject H0.

Table 3 displays the analysis of variance based on the data on the accuracy of the text function of the location alert device as observed by the researchers. These data were collected through five trials of pressing button 1 (school alert) and pressing button 2 (home alert) at four locations for the device and the primary receiver. For location 1, both the device and receiver were indoors. For location 2, the device was indoors while the receiver was outdoors. For location 3, the device was outdoors while the receiver was indoors. For location 4, both the device and receiver were outdoors. The mean for location 3 is 5.58, the highest among the four locations. Thus, the text function of the device is the slowest when the device is outdoors and the receiver is indoors. The mean for location 1 is 5.09, which is the lowest. Thus, the text function of the device is the fastest when both the device and the receiver are indoors. Moreover, ANOVA analysis reveals the F value of (0.697674), which is less than the critical value (2.866266), and the P-value (0.55959) is greater than 0.05, the null hypothesis is accepted. Thus, the type of location does not affect the performance of the text function of the location alert device in terms of its accuracy. These results are supported by the findings of Prabha et al. (2014) on alert systems with SMS functionality, which shows that higher sensitivity and accuracy are achieved using their proposed project. Considering the location-independent nature of text message delivery within these systems, the text function of the device should be accurate.

Table 4

Analysis of Variance of the Speed of the Call Function of the Location Alert Device

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	13.18783	3	4.395943	1.630971	0.199288	2.866266
Within Groups	97.03047	36	2.695291			
Total	110.2183	39				

Legend: P-value ≤ 0.05 Significant; reject H0.

Table 4 shows the analysis of variance based on the data gathered by the researchers through the testing of the call function of the device. These data were collected through ten trials of pressing button 3 (call) at four different combinations of locations for the device and the primary receiver. For location 1, both the device and receiver were indoors. For location 2, the device was indoors while the receiver was outdoors. For location 3, the device was outdoors while the receiver was indoors. For location 4, both the device and receiver were outdoors. Based on the ANOVA analysis, the F value (1.630971) is less than the critical value (2.866266), and the P-value (0.199288) is greater than 0.05; the null hypothesis is accepted. Thus, the type of location does not affect the speed of the call function of the location alert device. These results are strengthened by Giwa et al. (2024), who assert that GSM technology significantly impacts call functionality, including quality. While location type might not directly affect call connection speed, weaker signals can cause delays as the device searches for a stronger signal to initiate the call. With a usable GSM signal, the call function of the location alert device should operate for its core purpose.

Table 5

Analysis of Variance of the Accuracy of the Call Function of the Location Alert Device

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.3	3	0.1	1	0.403993	2.866266
Within Groups	3.6	36	0.1			
Total	3.9	39				

Legend: P-value ≤ 0.05 Significant; reject H0.

Table 10 presents the analysis of variance based on data as observed and recorded by the researchers. The location was divided into the following: Location 1 - Indoors Device - Indoors Receiver, Location 2 - Indoors Device - Outdoors Receiver, Location 3 - Outdoors Device - Indoors Receiver, Location 4 - Outdoors Device - Outdoors Receiver. The mean for location 1 is 2.8, the lowest among the four locations tested by the researchers. Thus, the call function of the device is the least accurate when both the device and the receiver are indoors. The mean for locations 2, 3, and 4 are the same and the highest. Thus, the call function of the device is the most accurate when the device is indoors, the receiver is outdoors, when the device is outdoors, when the receiver is indoors, and when both the device and the receiver are outdoors. Moreover, the F value (1) is less than the critical value (2.866266), and the P-value (0.403993) is greater than 0.05, so the null hypothesis is accepted. Thus, the type of location does not affect the performance of the call function of the location alert device in terms of its accuracy. With these results, the ability of GSM technology to facilitate remote functionality is further emphasized by Rakib et al. (2021), who developed a system for controlling home appliances from anywhere in the world. Moreover, the type of location does not significantly affect the performance of the call function in location alert devices, assuming sufficient cellular coverage.

4. Conclusions

Based on the summary of findings, the following were concluded about the research problems stated: The effectiveness of the location alert device assessed by its users is strongly agreed upon as convenient, wearable, and user-friendly. The level of performance of the location alert device, as assessed by its users, is strongly

agreed upon to have a long-lasting battery life, have a fast speed, and are accurate. The type of location does not affect the performance of the text function of the location alert device in terms of speed and accuracy. The type of location does not affect the performance of the call function of the location alert device in terms of speed and accuracy.

4.1 Recommendation

The researchers recommend the following: To increase the effectiveness of the location alert device as assessed by its users, the researchers recommend that the users may take measures to enhance the wearability of the device. To further increase the performance of the location alert device as assessed by its users, the researchers recommend that users take measures to enhance the speed of the device. To further improve the performance of the text function of the location alert device in terms of its speed and accuracy, the researchers recommend that users take measures to enhance the speed and accuracy of the device when it is outdoors and the receiver is indoors. To further improve the performance of the call function of the location alert device in terms of its speed and accuracy, the researchers recommend taking measures to enhance the speed and accuracy of the device when both the device and the receiver are indoors. The researchers recommend that future researchers add an output component, such as a speaker, to the device to make the call function a two-way method of communication.

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