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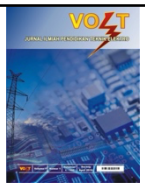

Design and development of child monitoring track bag using arduino

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Abstract

This research aims to design and develop a smart bag system for monitoring children using GPS modules, SIM800L modules, and Arduino as hardware components. The main benefit of this system is its capacity to be immediately and instantly monitored through the website, enabling parents to oversee their children effectively. The study employed an experimental method that utilized a literature approach to build the hardware features and websites of a GPS tracker-based track bag monitoring container. After conducting 10 functioning tests, the gadget performed effectively. Tests are conducted both indoors and outdoors, and the findings can accurately determine the position and display the coordinates. The tool demonstrates good accuracy at a range of 8 meters during indoor testing, while outside testing reveals its maximum accuracy at a distance of 21 meters. The utilization of trackers is effectively accomplished through bags, however, this approach may not be appropriate for those with specific requirements and the elderly.

Keywords: Arduino, GPS tracker, monitoring track bag, SIM800L

INTRODUCTION

The parental role in monitoring children's activities are crucial, particularly in light of the ongoing prevalence of child abduction instances in different regions of Indonesia (Fafirani & Lukitasari, 2022). According to the Indonesia Child Protection Commission (KPAI), there has been a steady rise in the number of child abduction and trafficking cases in recent years. The highest number of instances was recorded in 2022, with 35 cases. Although there was a decrease in 2023 to 6 cases, this figure is still concerning. However, the National Police data from the e-MP Robinopsal Bareskrim POLRI indicates a discrepancy. The data, released on Thursday, February 2, 2023,

states that there were 28 cases in January 2022. In this particular situation, it is crucial to exert genuine endeavors in order to enhance the efficacy of child monitoring.

The purpose of this research is to develop a new and efficient child monitoring system by utilizing existing technologies such as GPS (Ambagapuri, Putra, Thahira, & Fadlilah, 2018; Segara & Subari, 2017), GPRS, and GSM systems (Sembiring & Muliono, 2019; Kirana, Yudhanata, & Apriana, 2019), along with microcontrollers. The aim is to offer practical and measurable solutions for enhancing real-time supervision of children (Sembiring & Muliono, 2019). Not only hardware, but software implementation can also enhance tracking accuracy (Anggrainy & Mingparwoto, 2015; Ranjith, Sherays, Kumar, & Khartik, 2017).

Designing a feasible tracking device for children's daily use, such as purses or bracelets, has issues in hardware application (Kirana, Yudhanata, & Apriana, 2019; Sembiring & Muliono, 2019). Furthermore, keeping track of location information necessitates the use of an online web server in addition to monitoring devices on the Android platform (Juansyah, 2015; Putri, Tentua, & Sari, 2018). This solution has the ability to address child abduction situations and also promote public awareness of child protection, as well as foster the advancement of technology that benefits the well-being and safety of children.

METHOD

The study employed an experimental approach to assess the product output, which involved the development of a prototype device for children's bags. The subsequent section provides a comprehensive description of the research methodology.

This study aims to address the functional requirements of the track bag, which include the ability to read input data from the website, process each input, and deliver the output data based on the user's design specifications on the website. Meanwhile, the examination of non-functional requirements encompasses multiple elements, which encompass hardware. The hardware utilized in this study refers to tangible components that must meet specific criteria to effectively generate and execute animations. The hardware components included in this study are presented in Table 1.

Table 1. Required hardware

No	Hardware	Total
1	Lenovo Ideapad 320-14ISK Laptop	1
2	Arduino Uno	1
3	Holder Battery 18650 Single Battery	1
4	Sim800l module	1
5	GPS Ublox NEO-6M modul	1
6	18650 2000Mah battery	1

Furthermore, the development of this device needs the use of software, shown in Table 2.

Tabel 2. Input and Output Features

No	Software	Description
1	IDE Arduino	programming software using Arduino
2	Visual Studio Code	Software for website programming
3	Canva	Software utilized for designing of products and websites

Figure 1 shows the configuration of a 9V battery linked to the power port on the Arduino to supply power to the Arduino. The Arduino is connected to an Ublox NEO-6M GPS module in order to ascertain the precise latitude and longitude coordinates. The wiring setup is provided in full. The SIM800L module is interfaced with the Arduino to facilitate the transmission of data from the GPS module to the database via GPRS. The specific wiring

instructions are included. A 2000 mAh type 18650 battery is utilized alongside a battery holder to provide supplementary power to the SIM800L module.

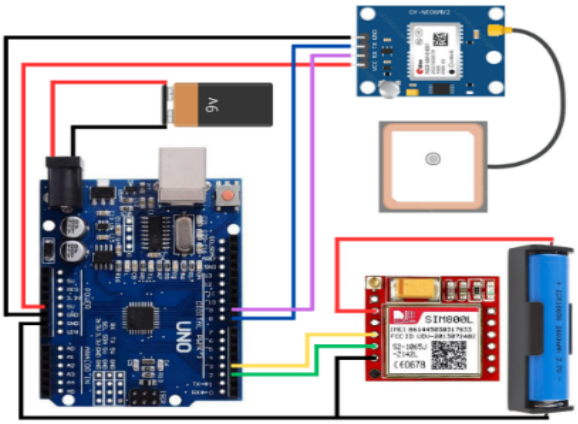


Figure 1. Track Bag Tool Design

Furthermore, the design outcomes of the webpage layout can be seen in Figure 2. The web page includes a button labeled "Update" that allows the user to update the most recent 5 coordinates stored in the database, which were transmitted by the track bag. The Live button enables real-time tracking of route movements on a web page map. This feature additionally refreshes the last coordinate history table automatically at intervals of 1 minute. The Navigation function enables users to be instantly sent to the Google Maps app in order to obtain the path to a specified coordinate point. This website is highly significant as it serves as a platform for facilitating access and distributing content (Saputra & Subektiningsih, 2023).

The website is constructed with the PHP programming language, which is a server-side programming language capable of interfacing with a database for data storage. A syntax is established in the PHP programming language to establish a connection between PHP and the database (Hadinegoro, & Ikramillah, 2023).

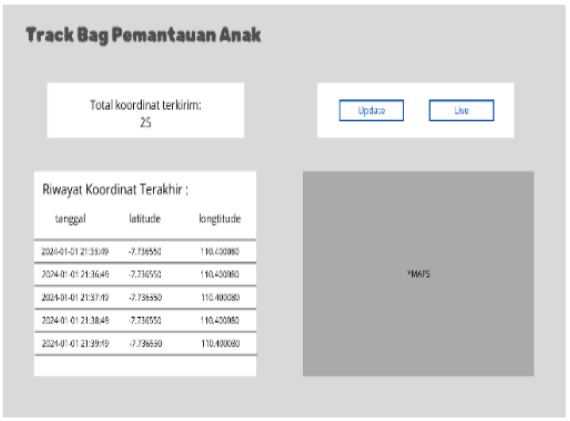


Figure 2. Website design

RESULT AND DISCUSSION

Figure 3 displays the track bag that has been carefully designed and developed. The track bag contains Arduino Uno components, including a SIM800L module connected to the Arduino Uno, a NEO 6M GPS module connected to pins 0 and 1 of the Arduino Uno, a single battery holder for 18650, and a 9-volt 1000mAh battery.

Figure 3. Track Bag

Signal testing was conducted both indoors and outdoors utilizing the black box methodology (Sianturi, et al., 2021). Indoor testing was conducted at the residence of Mister X on Jl. Belah Ketupat, Depok District, Sleman Regency, Special Region of Yogyakarta.

Figures 5 and 6 show the coordinate points displayed on the website and the measurement of the precision of these geographical coordinates using the Google Maps.

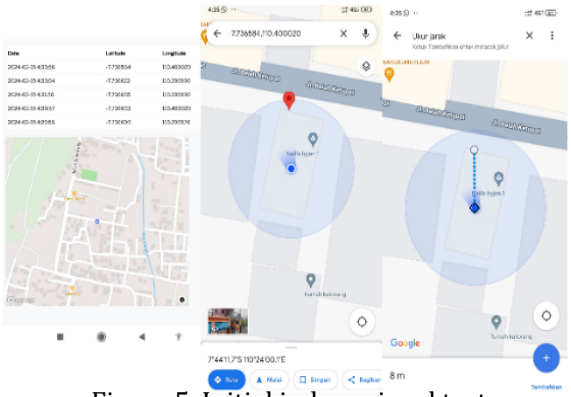


Figure 5. Initial indoor signal test

Figure 5 shows the initial indoor signal test, where the device transmits latitude and longitude data to follow the location through the website. The data is transmitted to the Google Maps application via the website functionality. The instrument sent the coordinate position as -7.736633, 110.400020, with an accuracy level of 2 meters from the researcher's location.

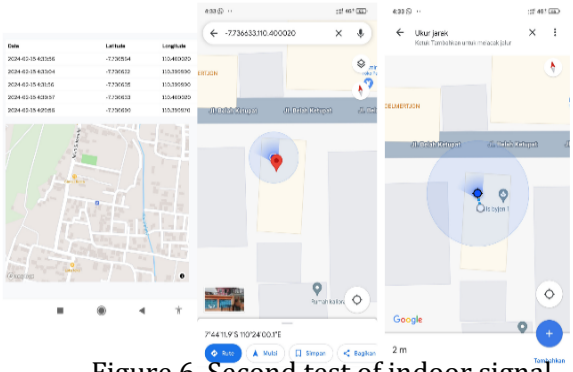
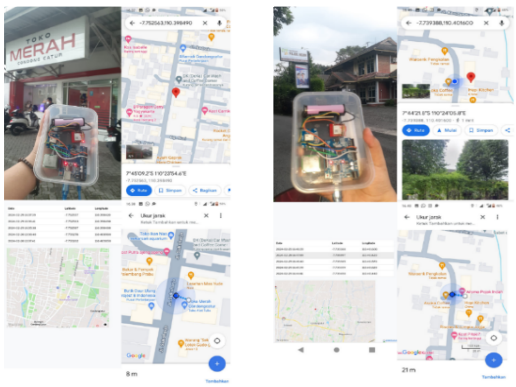


Figure 6. Second test of indoor signal

In figure 6, the second test was conducted at the identical location. The researcher once again recorded the latitude and longitude data from the track bag, which was -7.736584, 110.400020. Nevertheless, there was a discrepancy in the precision of the position coordinate, which diverged by 8 meters from the researcher's intended spot.

During the outdoor signal test, Mr. X moved a tracking bag from point A, specifically located at Jl. Sukoharjo No.5 as depicted in Figure 7a, to point B, Jl. Kubus No.15 as shown in Figure 7b. Figure 7a shows the geographical coordinates of the position spots on the website, the precision measurement of these coordinates, and an image of the track bag tool carried by Mister X. The location coordinate point, represented by latitude and longitude data (-7.752563, 110.398490), has an accuracy level of 8m from the actual location of mister x. Figure 7b depicts the act of following or monitoring at the specific time of 16:48. The bags are equipped with tracking devices that transmit location coordinates every minute. These coordinates can be accessed and examined on the website's coordinate table. This demonstrates that the track bag requires 1 minute to communicate data in the form of latitude and longitude (-7.739388,110.401600), with a permissible error of 2 seconds. The location sent from the track bag had a deviation of 21 meters from the location of the mister x.



(a) (b)

Fig 7. Outdoor signal testing: first (a) and second (b)

The accuracy level was compared by conducting three trials of accuracy testing. Upon

conducting measurements, it was determined that the location point transmitted by the track bag tool was consistently inaccurate, deviating by an average distance of 3.3 m across all three tests. The track bag has a typical data usage rate of 625 kB/minute when the gadget is powered on. Using a track bag for 80 minutes typically consumes approximately 50 MB of internet data.

The website trackperson.000webhostapp.com is utilised for input and output testing. Below are the inputs and outputs of the three website features: update, live, and direct. The update feature presents input data, expected results, observations, and conclusions reached. The input and output results are displayed in Table 3

Tabel 3. Input dan Output Fitur Update, Live, and Direct

Feature	Cases and Test Results (Data Sent)			
	Input	**Expected results**	**Observation**	**Output**
Update	Latitude and longitude were delivered from a track bag	Displays the latest 5 data on the coordinate table on the website page of the database	Displays the latest 5 data on the coordinate table on the website page of the database	√ accepted
	Cases and Test Results (Data Not Sent)			
	Latitude and Longitude not delivered from the track bag	Displays the latest 5 data on the coordinate table on the website page of the database	Displays the latest 5 data on the coordinate table on the website page of the database	√ accepted
	Cases and Test Results (Data Sent)			
	Input	**Expected results**	**Observation**	**Output**
Live	Latitude and longitude were delivered from a track bag	The website's map view displays coordinate points that dynamically update every minute in real-time, based on the position point of the track bag tool.	The website's map view displays coordinate points that dynamically update every minute in real-time, based on the position point of the track bag tool.	√ accepted
	Cases and Test Results (Data Not Sent)			
	Latitude and Longitude not delivered from the track bag	The map view on the website does not display dynamic coordinate points that update in real-time based on the location of the track bag tool every minute.	In the map view on the website, there are coordinate points that do not move according to the location point of the track bag tool every minute in real-time.	× rejected
	Cases and Test Results (Data Sent)			
	Input	**Expected results**	**Observation**	**Output**
Direct	Latitude and longitude were delivered from a track bag	The position will be transferred to Google Maps in order to obtain navigation instructions to the specified coordinate destination.	The position will be transferred to Google Maps in order to obtain navigation instructions to the specified coordinate destination.	√ accepted
	Cases and Test Results (Data Not Sent)			
	Latitude and Longitude not delivered from the track bag	The location is not being transferred to Google Maps in order to obtain navigation to the specified coordinate destination.	Provide the final location point to Google Maps in order to obtain navigation instructions to the specified coordinate destination	× rejected

The process of determining signal measurement results and accuracy involves categorizing them into three distinct accuracy levels. Precision is deemed inadequate if the coordinate point diverges by more than 10 meters, satisfactory if it diverges between 5-10 meters, and excellent if it diverges by less than 5 meters. The objective is to enhance the clarity of classifying the precision of each test. Table 4 displays the outcomes of signal testing, with the output generated in compliance with the specified requirements. The results of track bag tests carried out indoors and outdoors can be seen in Table 5.

Table 4. Signal testing output

Input	Expected results	Observation	Output
Cases and Test Results (Data Sent)			
Latitude and longitude were delivered from a track bag	Data is displayed on the website page	Data can be displayed on the website page	√ accepted
Cases and Test Results (Data Not Sent)			
Latitude and Longitude not delivered from the track bag	Displays the message "Make sure the track bag is on"	Doesn't display messages	× rejected

Table 5. The results of track bag tests

	Testing	Location	Coordinat	Distance	Accuration category
Indoor	1	Jl. Belah Ketupat, Kec. Depok, Kab. Sleman, DIY	-7.736633, 110.400020	2 Meter	Excellent
	2	Jl. Belah Ketupat, Kec. Depok, Kab. Sleman, DIY	-7.736584,110.400020	8 Meter	Good
Outdoor	1	Toko Merah Jl. Sukoharjo No.5	-7.752563,110.398490	8 Meter	Good
	2	Wisma Pojok Indah, Jl. Kubus No.15	-7.739388,110.401600	21 Meter	Not Good

CONCLUSION

The child tracking device, consisting of a SIM800L module, NEO6M GPS module, and Arduino Uno microcontroller, was effectively built and tested to ensure proper performance, yielding positive outcomes. Furthermore, the utilization of the website as a tracking mechanism has demonstrated its simplicity and efficacy in capturing data, with automatic updates occurring every one minute. This is demonstrated through the use of both indoor and outdoor testing, which is capable of identifying specific sites and providing their corresponding coordinates. During both indoor and outdoor testing, it is observed that the detection varies depending on the distance. The tool's accuracy is deemed satisfactory when tested inside at a distance of 8 meters. However, during outside testing, the maximum detection range is limited to 21 meters due to the diminished accuracy beyond this distance. Trackers are effectively utilized via bag media, although this approach may not be appropriate for individuals with special needs and the elderly.

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