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A Prototype for Securing Suitcase Travel using RFID and GPS Tracker

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Abstrak−Beberapa tahun ini, sebagian besar orang memanfaatkan waktu luang untuk melakukan perjalanan wisata atau yang sering disebut *travelling.* Banyak orang melakukan travelling menggunakan koper dan tas ransel untuk menyimpan barang bawaan mereka. Setiap orang menginginkan keamanan dan kenyamanan saat perjalanan mereka, sebab keamanan merupakan hal yang sangat penting bagi *traveler.* Kejadian kehilangan barang sering kali membingungkan seseorang untuk dapat menemukan kembali barang hilang tersebut. Sistem keamanan pada koper sendiri juga masih konvensional dimana orang menjaga dalam isi koper hanya dengan menggunakan gembok kunci sebagai keamanannya ada juga yang sudah menggunakan angka namun masih bisa kehilangan. Seperti yang pernah tercatat di *lost and found* bandara kejadian kehilangan atau barang tertinggal sering terjadi hingga pembobolan koper dengan menggunakan benda yang berujung lancip. Oleh sebab itu, untuk mengatasi permasalahn tersebut dibuat sebuah sistem yang mampu menjadi solusi untuk menjaga keamanan koper. Sistem pengamanan koper ini menggunakan RFID yang dapat membuka kunci koper dan menggunakan GPS Tracking untuk mengetahui letak koordinat koper berada. Sistem ini dapat memberikan informasi saat koper terbuka dan juga dapat mengetahui lokasi koper saat ini ke perangkat *smartphone.*

Kata Kunci: RFID, GPS Tracking, Magnet Switch, Android, Koper.

Abstract−In recent years, most people use their free time to visit several places, namely traveling. People travel using suitcases and backpacks to keep their luggage. Everyone requires security and comfort when they travel because security is very important for the Traveler. However, losing items often confuse a person since the person must be worried and wants to be able to find the lost items as soon as possible. The security system in this suitcase is also still conventional where people still maintain the contents of the suitcase only by using padlock as security some are already using a combination of numbers but can still lose. As reposted by many Lost and Founds facilities airports, incidents of loss of goods often occur and the found suitcases are broken into using pointy objects. Therefore, to overcome these problems, a system is created to become a solution to secure suitcases. This suitcase security system uses RFID which can open the suitcase lock and use GPS Tracking to find out the coordinates of the suitcase. This system can provide information when the suitcase is opened by force and can also find out the current location of the suitcase to the smartphone.

Keywords: RFID, GPS Tracking, Magnet Switch, Android, Suitcase.

1. INTRODUCTION

The occurrence of items that someone neglects to be able to recover the lost items [1]. As has been recorded in air transportation, there are about 61 items per month that are often left behind or lost in the airplane cabin or the trunk of the plane [2]. Besides, according to 2015 statistical data, tourists from the United States (US) have the most theft or loss of goods in the form of cell phones, credit cards, permits, and also passports [3]. Sometimes the safety of transportation service providers is lacking for passengers [4]. Therefore, a suitcase security system was created that can be monitored from anywhere via a smartphone that can provide information on the location of the suitcase using GPS Tracking and if the suitcase is opened without using an RFID card, the buzzer alarm will send information to the application.

As for how the prototype of this suitcase security system works using Arduino Uno as an open-source electronic circuit board that can be used to process data, RFID is used as a key for the suitcase, a GPS module as a location tracker, a magnet switch as a sensor which is used also with a buzzer that makes it as an alarm. This system can also provide information to suitcase owners via smartphone software [5], [6], [7], [8]. Good seen from the condition of the suitcase. The use of this tool is expected to minimize the incidence of breaking into the suitcase while walking.

2. RESEARCH METHODOLOGY

As a whole, this tool is composed of important parts that are related to one another. This section must be in sync with one another so that the goals and objectives of the author can be achieved and as expected. This section consists of a series of Ublox Neo-7m GPS modules and also uses the SIM800L GPRS module as a device for sending and providing coordinates, while the other part consists of a suitcase application as a data receiver for a series of modules.

2.1 GPS

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The GPS uses several satellites in earth orbit, which transmit the signal to the earth and captured by a receiver. Apart from satellites, 2 other systems are interconnected, so there are 3 important parts in the GPS. The three parts consist of the GPS Control Segment, GPS Space Segment, and GPS User Segment.

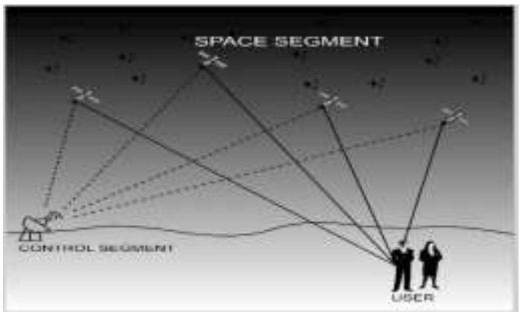

Figure 1. GPS System Schematic

Since GPS works using satellites, it is recommended to use it in the open. The use of GPS indoors or in places that are blocked by walls and also in very densely populated areas will prevent the satellites from working optimally and accurately. The condition of the clear sky and free from weather obstacles can be easily accepted by the GPS, so the accuracy given will also be higher. The U-blox neo-7m GPS module is a type of GPS that has fairly high sensitivity and low power. This GPS is designed for various applications and is based on the single search capability of GPS itself [7].

2.2 GPRS

GPRS provides a GSM service package for data transmission with a packet model in a PLMN (Public Land Mobile Network). In the packet-switched model, no permanent connection is established between the cellular and the external network during data transfer. In contrast, in circuit-switched mode, a connection is established during the transfer period between the calling entity and the called entity. In packet-switched mode, data is transferred in blocks of data, which are called packets. One of the goals of GPRS is to facilitate the interconnection between cell phones and other packet enabled networks, which opens the door to the world of the internet. So, GSM can access GPS to get the location of the desired coordinate location. Sim800L GPRS Module is a GSM module that can be used for microcontroller projects such as monitoring via SMS, turning on or controlling the power switch via SMS, and so on. This module can also function as an SMS gateway when connected with a microcontroller. Sim800L is used as data communication between servers and clients that can access GPRS to send data to the internet with the M2M system. AT-Command used in Sim800L is similar to AT-Command for other GSM modules [12].

2.3 GPS Tracker

GPS Tracker is an AVL (Automated Vehicle Locator) technology that allows users to track the position of the vehicle in real-time. GPS is a device or system that can be used to inform users where they are (globally) on the earth's surface based on satellites [11]. GPS Tracking utilizes a combination of GPS and GSM technology to determine the coordinates of an object, then translate it into a digital map. Data sent from the satellite is in the form of radio signals with digital data. This system is designed to provide three-dimensional position and speed as well as information about time. GPS consists of 3 segments, namely the space segment, control/controller, and user. The celestial segment consists of 24 satellites operating in 6 orbits at an altitude of 20,200 km with a period of 12 hours. The control/controller segment has the main control center. On the user side, a GPS receiver is required which usually consists of a receiver processor, and antenna [7], [11].

2.4 Great-circle Formula

The great-circle distance or orthodromic distance is the shortest distance between two points on the surface of a sphere, measured along the surface of the sphere. The distance between two points in Euclidean space is the length of a straight line between them, but on the sphere there are no straight lines. In space with curvature, straight line are replaced by geodesics. Geodesics on the sphere are circles on the sphere whose centers coincide with the center of the sphere, and are called great circles. Between two points that are direcly opposite each other, called antipodal points, there are infinitely many great circles, and all great circle arcs between antipodal point have a length of half the circumference of the circle, or πr, where r is the radius of the sphere. The shape of the Earth closely resembles a flattened sphere (a spheroid) with equatorial radius α of 6378.137km distance b from the center of the spheroid to each pole id 6356.752km. when calculating the length of a short north-south line at the equator, the circle that best approximates that line has a radius of b^2/α, or 6335.439km, while the spheroid at the poles is the best approximated by a sphere of radius α^2/b, or 6399.594km, a1% difference. So as long as a spherical formula using the mean earth radius, $R_1 = \frac{1}{3}\,(2\alpha + b) \approx 6371\ km$ means that in the limit of small flattening, the mean square relative error in the estimates for distance is minimized [14].

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2.5 System Overview

In this research, a prototype of a suitcase security system using RFID, magnet switch, and GPS Tracker was built using an android application. The following is an overview of the suitcase security system.

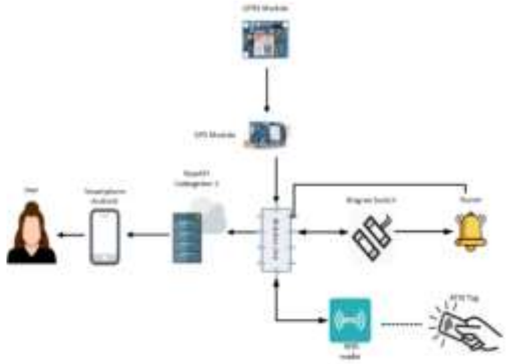

Figure 2. System Overflow

Figure 2 describes that there are an RFID tag and RFID reader, Magnet Switch, Buzzer, GPS module, GPRS module, and smartphone. The magnet switch is the key to the security system that makes the buzzer turn on and can be turned off again by RFID and also through applications. This image explains the condition where after the magnetic sensor is released, the buzzer will turn on and the GPS will send the current location after connecting to GPRS and send information to the application that was previously saved to the database.

2.6 Hardware Design

Figure 3 is the hardware result of a suitcase that has been drawn in the general description above.

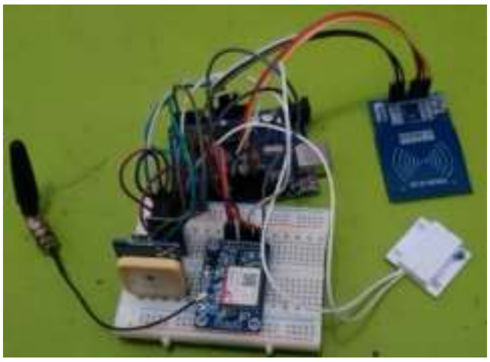

Figure 3. Suitcase Hardware

After the device is complete, it will be implemented into a suitcase as shown in Figure 4, where the added power from the 9v battery is 2 which functions to replace the power from the experiment using a laptop. The device is attached to the suitcase and the antenna of the GPS will be placed outside the suitcase by the way the suitcase is slotted.

Figure 4. Hardshell Suitcase

Figure 5. Implementation tools into a suitcase

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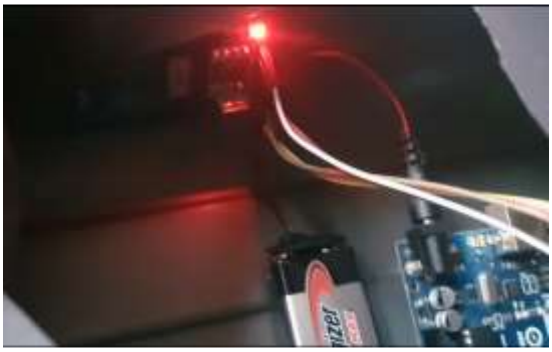

Figure 6. RFID into a suitcase

2.7 Software Design

Software design, there are general system algorithms and subsystem algorithms. The system algorithm is designed to be shown in the form of a flowchart. In designing this system using Arduino IDE and Virtual Studio software. Arduino IDE is used to program the Arduino Uno microcontroller and Virtual Studio is used to design android applications that use HTML and JavaScript languages.

2.8 System Workflow

In the research design of this suitcases security system, the workflow of the security system is explained by the flowchart in Figure 7.

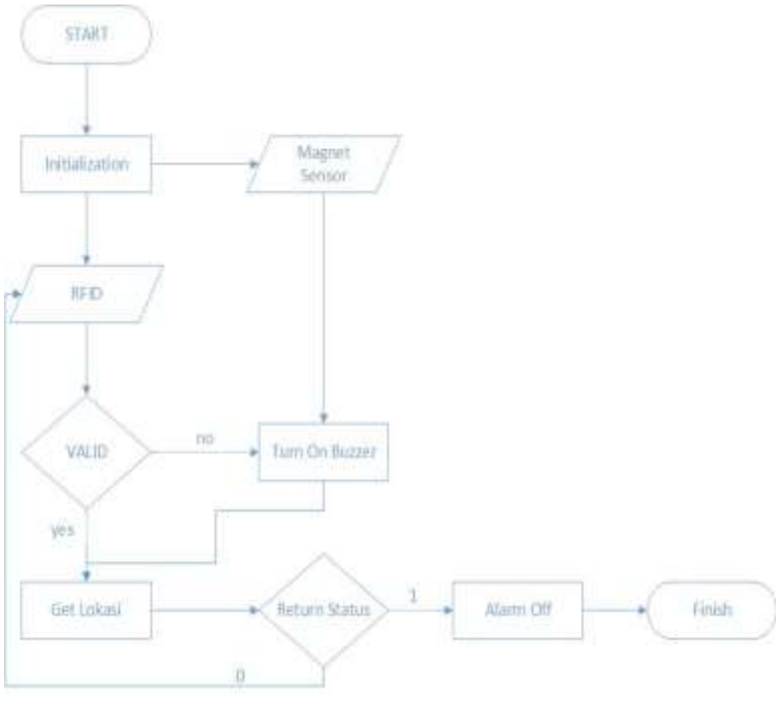

Figure 7. Flowchart of The proposed System

Figure 7 explains the workflow of the security system, which starts from the initialization of the process obtained if the suitcase opens immediately, it will get input into the magnet switch then the buzzer will turn on and get the location. If RFID is inputted, it will first check whether the card used is valid or not. If valid, it will immediately get the location and if not then the buzzer will also sound and provide the location as well after all the data is obtained, it will be checked again on the status of the data whether the data is true or false. If true, the alarm will be turned off and if false it will return to RFID, check again whether the card entered is correct to turn off the alarm and if the alarm is dead then the process will be complete.

3. RESULTS AND DISCUSSION

In this study, 3 test scenarios were carried out on the classification model, namely as follows:

3.1 Results and Analysis of Testing on RFID and Magnetic Switch

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Table 1. Result of Closed RFID and Magnet Switch Testing

CARD TYPE	MAGNET SWITCH CONDITION	BUZZER CONDITION	STATUS	EXPLANATION
KTP	Close	Beep	Unregistered RFID	Noisy Buzzer and UID Code not registered
ATM	Close	Buzzer Quiet	No response	The card is not detected to have RFID
KOPER	Close	Buzzer Quiet	Registered RFID	RFID Detected and UID Code registered
KTM	Close	Beep	Unregistered RFID	Noisy Buzzer and UID Code not registered
SIM	Close	Buzzer Quiet	No response	The card is not detected to have RFID

Table 2. RFID Test Result with An Open Magnetic Switch

CARD TYPE	MAGNET SWITCH CONDITION	BUZZER CONDITION	STATUS	EXPLANATION
KTP	Open	Beep	Unregistered RFID	UID code is not registered
ATM	Open	Beep	No response	The card is not detected to have RFID
KOPER	Open	Buzzer Quiet	Registered RFID	RFID Detected and UID Code registered
KTM	Open	Beep	Unregistered RFID	UID code is not registered
SIM	Open	Beep	No response	The card is not detected to have RFID

Based on table 1, the experimental model for RFID and Magnetic Switch provides information that when the magnetic switch is closed it is inputted with a different type of card - the different buzzer will give an output in the form of a sound "bib" if the card is inputted incorrectly and will issue an unregistered RFID status in the serial monitor. on the Arduino application, and if the card that is inputted matches the registered UID, the buzzer will not make a sound and the status will issue. RFID is detected - registered RFID.

Table 2 explains where the test is carried out when the magnet switch is open or forced open. When the magnet is already in an open condition, the suitcase is also in an open condition, in that condition the buzzer will continue to light and make a long sound so that to stop the sound you have to use a card that has registered its UID code in the table, only the type of suitcase card can change the condition buzzer from sound becomes silent or the buzzer accepts the input given.

From the experiment of the two conditions above, it can be seen that RFID works as the author wants, RFID can read the UID that has been registered and provide the desired output with a buzzer.

3.2 Results and Analysis of Security Systems

Table 3. The Results of Security Testing

Sample–n	Last position coordinates		Move position coordinates		Incident	Place	Condition	Status
	Latitude	**Longitude**	**Latitude**	**Longitude**				
1	-6.974028	107.6305287	-6.974028	107.6305287	Stay, outside the room	Danau Galau Tel-U	Fine Weather	Opened with true card
2	-6.974028	107.6305287	-6.974028	107.6305287	Stay, outside the room	Danau Galau Tel-U	Fine Weather	Forced Open
3	-8.681319	115.2150565	-8.681331	115.2172450	Stay, in the room	Dauh Puri	Cloudy	Safe
4	-8.655997	115.220076	-8.644322	115.223497	Walk, outdoors	Jln Kepundung - Hotel Sooly	Fine Weather	Broken suitcase

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Sample–n	Last position coordinates		Move position coordinates		Incident	Place	Condition	Status
	Latitude	**Longitude**	**Latitude**	**Longitude**				
5	-8.667638	115.235598	-8.673186	115.239598	Walk, outdoors	Jln.Ir H. Juanda – Jln. Raya Puputan	Fine Weather	Forced Open
6	-8.657666	115.218323	-8.650314	115.224526	Walk, outdoors	Jln. Mayor Wisnu 1 (Puputan Field) – Jln. Kamboja	Fine Weather	Safe

Based on table 3, the experimental model for the security system can be seen that from the last position and the moving position there is a movement which means the tool works quite well under certain conditions. In the 1st and 3rd tests, there is a difference where the first test conditions are carried out outside the room which is located at "Situ Techno TELKOM University" and the third is carried out indoors at the "Tri Eka Jaya Bookstore". In the first test, it can be seen that the coordinates of the last position of latitude and longitude are the same as the coordinates of changing positions, which when tested are in a stationary condition or do not move places and are carried out outside the room, namely around the jogging track lake and supported by sunny weather conditions. This experiment focuses on the status generated by its security system against 3 conditions that can be tested, namely, when RFID uses a registered card, which has not been registered and is also in a state of the breach. The first result shows the use of registered RFID cards and produces fixed position coordinates in both experiments then forwarded into the application which shows a gold open padlock logo on the history as shown in Figure 8. The second result is shown when the RFID card is not registered and the suitcase is forced open as shown in Figure 9.

Figure 8. Application History

Figure 9. Application History

In the next test condition, it is carried out with unfavorable weather conditions, and the test is carried out in the Tri Eka Jaya bookstore. Testing in cases like this usually gives results that the GPS cannot work properly and cannot provide test data results when the weather is cloudy or rainy. As in Table 3, the 3rd test, it can be seen that the test carried out is the same as the first test but in unfavorable weather conditions the data obtained is not the same as the first test. This makes the status "safe" because there is no update data captured by GPRS to be sent to the database and bring up into the application. So that the application only displays the status of suitcases that are obtained "safe" as shown in Figure 10.

Figure 10. Application History

In this test condition, it is carried out in favorable weather conditions but with the condition that the suitcase is broken into or stolen. This test has an initial location on Jl. H. Juanda and will continue to sound until the last position of the suitcase updates the location as in the example of Figure 11 and Figure 12 which shows the tracking results of the last location update during the break-in.

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Figure 11. Initial Location

Figure 12. Update current location after suitcase broke

3.3 Results and Analysis of GPS

Table 4. GPS Accuracy Results

Sample – n	Weather Condition	Position coordinates using the suitcase application		Position coordinates using the google maps application		Distance Comparison
		Latitude	Longitude	Latitude	Longitude	
1	Fine Weather	-6.974028	107.6305287	-6.974028	107.6305287	0m
2	Cloudy	-8.681319	115.2150565	-8.6813310	115.2172450	240.6m
3	Fine Weather	-8.644322	115.223497	-8.6442137	115.2234097	15.4m
4	Fine Weather	-8.673186	115.239598	-8.673200	115.239700	11.32m
5	Fine Weather	-8.650314	115.224526	-8.650500	115.224500	20.88m

Based on table 4, testing was carried out regarding the accuracy of the coordinates of the security system that the author made, and the google maps application made by Google. The differences that are loaded are not too far from the suitcase application and the google maps application. It can be seen from the first test, which has a distance ratio of 0 because when the test was carried out quietly or not moving or walking, while the second test was quite far from the first experiment, this was because when testing the results of the application could not provide the right coordinates in the weather conditions. does not support as described in table 3. The next test results in a close distance, this is because when testing the GPS works well and is supported by friendly weather or sunny weather.

The results of measuring the percentage of accuracy can also be seen from the formula:

$$\frac{\sum the\ difference\ obtained}{amount\ of\ data}\ X\ 100\% \qquad (1)$$

Based on the data in table 4, the difference between the data used in the application and also on google maps can be calculated the accuracy percentage using the formula above.

$$\frac{0+240{,}6+15{,}4+11{,}32+20{,}88}{5}\ X\ 100\%$$
$$=\frac{281{,}8}{5}\ X\ 100\%$$
$$=\ 57.64\ \%$$

The accuracy percentage is still relatively small due to the influence of the operator used and also the GPRS module that is used and is supported by unfavorable weather so that the results can be influenced by the weather. The module used still takes only 2G signals and cannot pick up 4G or LTE signals.

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4. CONCLUSION

Based on the results of testing and data analysis on the making of the final project entitled Prototype for securing suitcase travel using RFID and GPS Tracker, the following conclusions can be drawn:

1. The system is designed to work as desired, that is, it can anticipate or prevent baggage break-ins while traveling. The RFID sensor can run properly, namely reading or detecting a card that has a registered UID.
2. Users can still find out the whereabouts of the suitcase even though the suitcase is closed by looking at the current location in the application.
3. GPS cannot run properly if it is blocked by unfavorable weather or rain and also GPS cannot provide location information while indoors.
4. The GPRS module cannot work properly to pick up signals because it still uses 2G signals.
5. Lack of accuracy that is obtained when the weather is less supportive and indoors.

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