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GPS and GSM-Based Vehicle Tracking System

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Abstract

The ability to monitor and handle physical assets and personal data with some degree of flexibility has recently become crucial. Even though physical transportation systems have made it simpler for people to move, it has also become hazardous in several ways. Therefore, in this study, a real-time vehicle tracking and monitoring system has been suggested. Additionally, a system using the Arduino Uno R3 is being developed, including a global system for mobile (GSM) devices and a global positioning system (GPS) to track the precise and accurate position of the car at any given time. The gadget also has a display that may inform the user of the vehicle's whereabouts at any time. The system uses an Arduino microcontroller to manage and process the GPS data that has been received, connect to a GSM module, and send the location data to a distant server or monitoring station. As a result, the main processing unit, the Arduino MCU gathers GPS data from the receiver, conducts any necessary computations or data processing, and facilitates connection with the GSM module. The function of GSM is to connect to the cellular network and send the location data that has been processed to a tracking server or cloud-based platform. However, this GSM module does not allow the system to connect to a cellular network due to blockage from the service provider. Real-time tracking is made possible by the tracking server, which receives and retains the data.

1. Introduction

The demand for vehicles as a basic necessity of life has increased proportionally to the enormous increase in global population. News of fatalities from traffic accidents has become quite prevalent due to the abundance of vehicles on the roadways. Similar to how crime has increased, more vehicles are being stolen now [1].

Since it is designed to keep the user informed about the location of the car through telecommunication, vehicle tracking systems are an essential precaution that should be taken into account for safeguarding life and vehicle security. There are two categories of vehicle tracking systems: passive and active. The simplest trackers that record a vehicle's position are passive systems. These trackers can then be taken off and moved to a computer for archiving and analysis. The more popular active car trackers are those that are discussed in this paper. The real-time location of the vehicle can be transmitted to a central location by these technologies. Active vehicle tracking systems are versatile and provide many useful purposes. It can be used for apprising the user through text messages about the location of the vehicle which can be saved at a central repository to keep the history of the vehicle’s movements. Many companies use this technology to monitor their vehicles to make sure that the employees are performing their duties hence it contributes to better management of a company’s workforce.

The vehicle tracking system described in this paper includes a vehicle system that transmits the GPS location of the vehicle.

2. Materials and Method

This subsection gives an in-depth explanation of the methods and materials used for this project. It includes information on the project's process flows, block diagrams and software & hardware. The figure of a system flow diagram shows the connections between each step and provides an overall picture of how it all fits together. This is a guide to understanding the design of the project. The hardware and software components in this section are necessary for realizing results.

2.1 Materials

In this project, the primary focus is on achieving Real-time vehicle tracking using GPS + GSM based vehicle tracking system using GPS modules Neo-6m, GSM module sim900A, and Arduino Uno. By integrating the Arduino with GPS and GSM modules, the system can acquire the vehicle's location coordinates, transmit tracking data, and enable communication with the server or monitoring center. The key components and software employed in this project are:

- Arduino Uno
- GPS module Neo-6m
- GSM module SIM900A
- Battery li-ion 3.7v 6800mAh

The Arduino Uno plays a pivotal role as the central command hub within a GPS + GSM tracking system. Serving as the system's microcontroller, it undertakes several critical functions. Firstly, it processes incoming data from the GPS module, extracting vital location specifics like latitude, longitude, and time. Secondly, it manages the communication between the GPS and GSM modules, facilitating the transmission of this GPS-acquired data to a designated recipient or central server using various communication protocols like SMS or GPRS.

GPS module Neo-6m is main role revolves around pinpointing precise location information. Specifically, the Neo-6m module receives signals from satellites to determine latitude, longitude, altitude, and time data. This module essentially acts as the eyes of the system, continuously gathering location details.

The GSM module SIM900A is a pivotal element within a GPS + GSM tracking setup. Its primary function revolves around communication. Specifically, the SIM900A module enables the transmission of data collected by the GPS module to an external device or server. It does this by utilizing cellular networks to send information, such as location data obtained from the GPS module, through SMS or GPRS (General Packet Radio Service). This module acts as the communicator of the system, relaying critical location details to a designated recipient, like a phone or a computer, allowing for real-time tracking or storage of the location information.

The Li-ion 3.7v 6800mAh battery is the powerhouse in a GPS + GSM tracking system. Its primary function is to provide reliable and long-lasting power to keep the system running.

2.2 Method

Figure 1 below shows the flowchart system for the GPS+GSM tracking system. This transmission embarks on its journey through the GSM module, serving as the conduit for communication. The GSM module diligently receives the message data and promptly transfers it to the Arduino Uno, a pivotal hub orchestrating the device's functionalities. Within the Arduino Uno, the received GPS location coordinates find their destination, becoming accessible and ready for the next phase.

The GSM module assumes its function once more with precise precision, transmitting the revised position data to a specified mobile device. Seamlessly, the mobile device's display mirrors the culmination of this process, showcasing the current location succinctly as "latitude and longitude." This visual representation serves as a testament to the intricacies and interconnectedness of each component, encapsulating the journey from satellite-acquired coordinates to the comprehensive display of geographical positioning on the user's mobile interface.

This meticulously crafted chain of actions symbolizes a harmonious collaboration between hardware and software, epitomizing the streamlined integration of GPS and GSM technologies. The culmination of this process manifests not just as a mere display of geographical coordinates but as a testament to the intricate dance of data transfer and interpretation, showcasing the marvels of modern technology in delivering precise and accessible location information.

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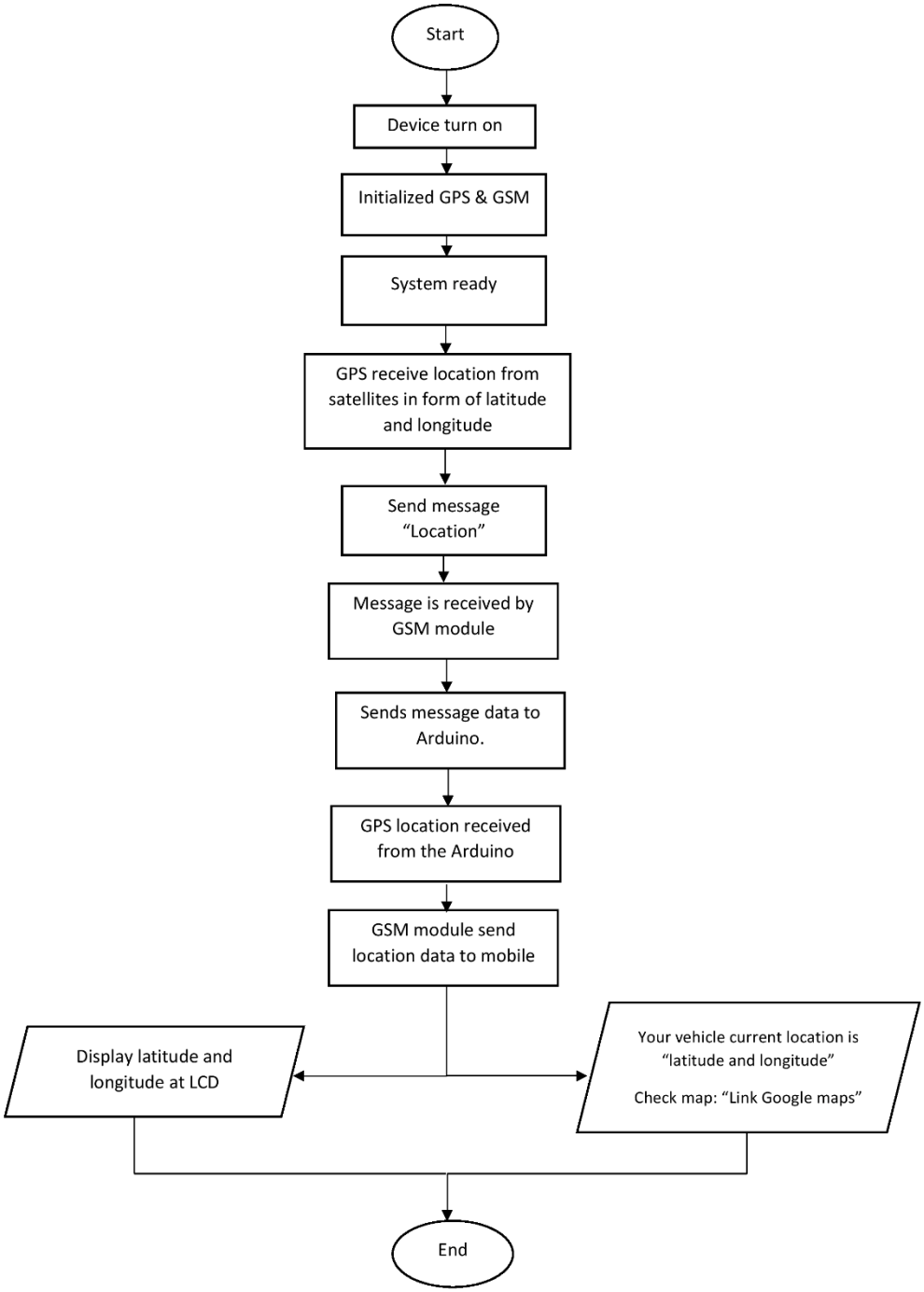
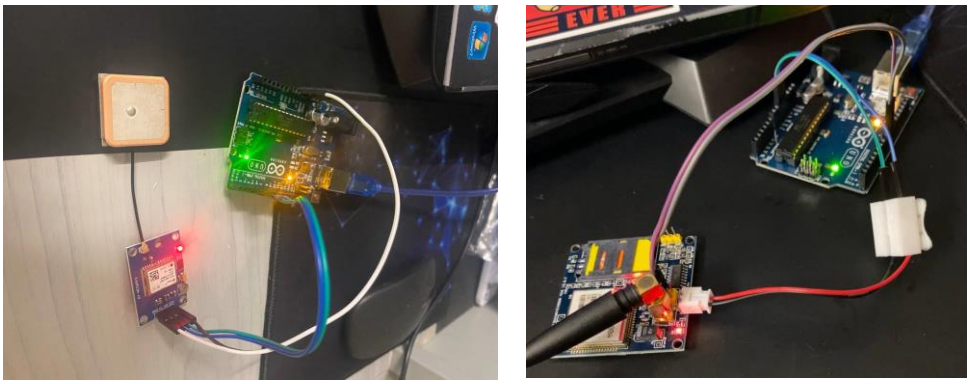


Fig. 1 *System flowchart of GPS + GSM based vehicle tracking system*

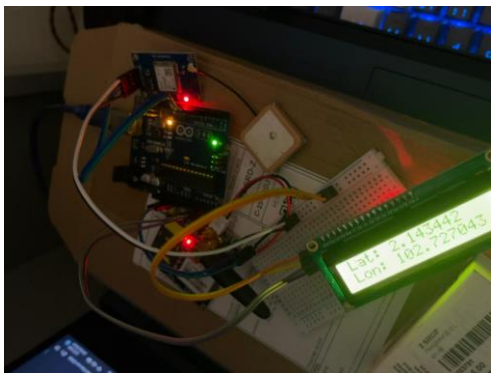
3. Result and Analsysis

This section focuses on the analysis and discussion of collected results and findings obtained from several experiments conducted with reference to the aims of the project. For GPS module testing, four separate locations in Pagoh, Johor are recorded. The first location is in UTHM campus Block A18. The second location is at the waqf hut near Block A5. The third location is Pusat Sukan EDU HUB Pagoh and lastly at Pagoh Jaya.

3.1 Project Hardware



(a) **(b)**



(c)

Fig. 2 (a) *Hardware for Arduino UNO and GPS Module;* ***(b)*** *Hardware for Arduino UNO and GPS Module;* ***(c)*** *Hardware for GPS+GSM-Based Vehicle Tracking System*

3.2 Actual Hardware

(a) **(b)**

Fig. 3 (a) *Front view hardware* ***(b)*** *Back view hardware*

Figure 3 below show the front and back view of actual hardware of GPS and GSM based vehicle tracking system. On top of the box is the GPS antenna to receive signal from satellites. In front of the box is LCD to display the coordinate of longitude and longitude location. Back side of the box is GSM antenna to receive signal.

3.3 Coordinate GPS

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Figure 4 and figure 5 shows that based on the Google Maps link in the serial monitor given is the link to the current location of the coordinate. The coordinate shows the location near Pagoh Jaya near Community College Pagoh. The output coordinate for latitude is 2.132669 and longitude is 102.717018 in the serial monitor on Arduino IDE.

Fig. 4 GPS latitude and longitude of the GPS module at Pagoh Jaya

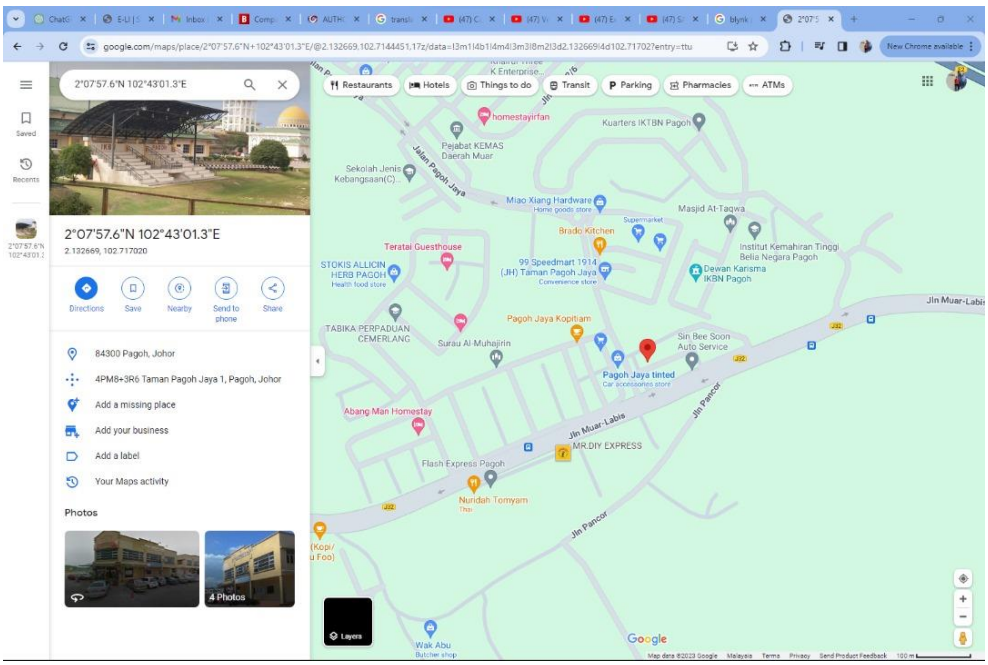

Fig. 5 *Location of Pagoh Jaya near to Community College Pagoh on the Google Maps*

3.4 Accuracy of Location Tracking

To determine the positioning accuracy of the proposed system, field test and compare the results from the proposed system and commercial GPS units. The commercial units used in the field test are GPS modules with Arduino IDE and Google Maps. The field test has been performed in four locations within the Pagoh area. The results are shown in Table 1 the result shows the GPS from this design produces accurate locations as actual routes. Result shown in Table 2 is measurement of the distance is used by the app Google Maps on mobile phones.

Table 1 Result coordinate of GPS location and Real location

Location	GPS Location	Real Location
Block A18	2.143640, 102.726971	2.143499, 102.726882
Waqf hut near Block A9	2.143640, 102.726971	2.144893, 102.727658
Pusat Sukan EDU HUB	2.156388, 102.730303	2.156281, 102.730451

Pagoh Jaya	2.132669, 102.717029	2.132659, 102.716998

Table 2 Difference distance for GPS location And Real location

Location	Distance
Block A18	10m
Waqf hut near Block A9	10m
Pusat Sukan EDU HUB	20m
Pagoh Jaya	1m

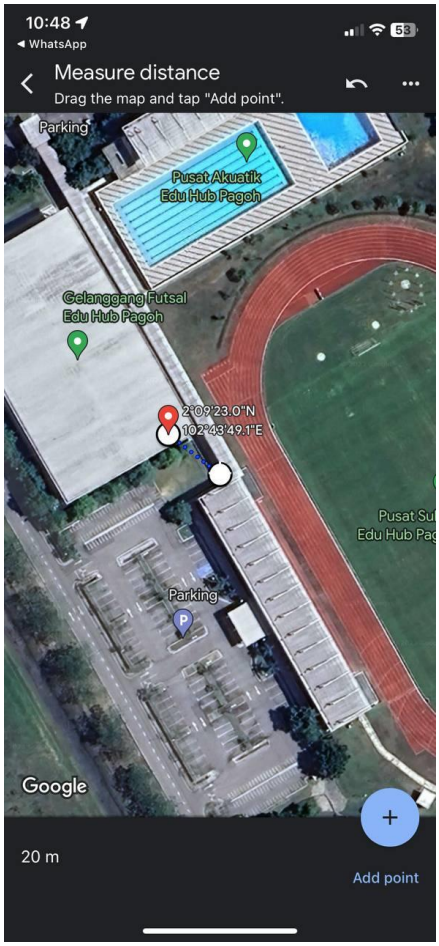

Fig. 5 *Distance between GPS location and actual location of Pusat Sukan EDU HUB Pagoh*

3.5 Consistency evaluation

Based on figure 6 show that all locations is tested three times to get the similar coordinate and can see on the Google Maps the same location as coordinate given. All four locations shown consistent result. The value 1 means the testing is the same and value 0 is not same.

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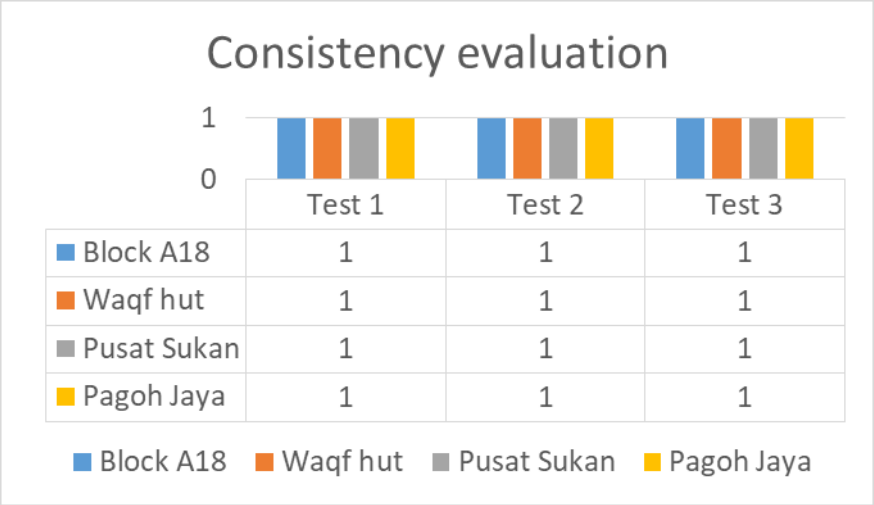

Fig. 6 *Consistency evaluation of GPS module.*

3.6 Data Transmission Speed

For Data Transmission Speed, the time taken for the system to transmit location data from GPS to the Arduino IDE serial monitor. The results are shown in Table 4.3 the result shows the time taken to send and receive signals for all four locations.

Table 3 Time taken of send and receive signal for all location

Location	Send Signal	Receive Signal	Time taken (ms)
Block A18	23:00:04	23:00:21	17
Waqf hut near Block A9	17:14:28	17:14:36	8
Pusat Sukan EDU HUB	17:27:44	17:27:49	5
Pagoh Jaya	17:43:39	17:43:46	7

The time taken for Block A18 is 17ms and takes a longer duration than other locations because the testing was conducted indoors in Block A18 while other locations conducted outdoors. The strength of the signal GSM can be affected by various factors, such as the distance from cell towers, obstructions such as buildings or natural terrain, and local interference. The GPS receiver needs a clear line of sight to multiple satellites. Tall buildings, dense forests, deep canyons, or being indoors can interfere with GPS reception, potentially reducing accuracy or preventing reception altogether.

3.7 Problem encounter and countermeasure for GSM Module

The problem with the GSM module SIM900A is that it must be used in conjunction with a 2G card. When interfaced with a 4G SIM card, however, it does not work properly. The module only supports 2G networks, so it cannot send or receive messages if paired with a 4G SIM card. In addition, certain telecommunications companies have introduced censorship that prevents messages containing links of any sort including those linking to Google Maps access. Thus such content cannot be transmitted, and the module becomes even more complex in its operation when using these particular SIM cards. To make sure the message is delivered smoothly, need to use a 2G SIM card and avoid content that the carrier prohibits.

Table 4 Problem encounter and countermeasure

Problem Encounter	Countermeasure
SMS Sending/Receiving Failures	Ensure the module is properly configured to send and receive SMS. Verify that there's adequate signal strength for

	SMS transmission.
SIM Card Issues	Ensure the SIM card is inserted correctly and supported by the module. The SIM card should be 2G SIM card.
Power Supply	Ensure the GSM module receives an adequate and stable power supply according to its specifications.
No Network or Signal Issues	Ensure the module is placed in an area with good network coverage.
	Ensure the SIM card is inserted correctly and not damaged.

4. Conlusion

This report has presented the development of a vehicle tracking system's hardware. The system can get the GPS coordinate of a vehicle and relay it to the user's phone using GSM modem. The following developed vehicle tracking system shown clearly that the near real-time or even live monitoring of vehicles is indeed feasible, which can be applied for protection (convenience operation) of personal cars, public transportation systems and many other industries such as fleet management. The system consists of many parts, such as the GPS module, GSM modem, and microcontroller and input devices. This system provides advantages including real-time location tracking, and route optimization. Through the combined GPS and GSM technologies, users can retrieve real-time location information as well as monitor their cars in ways that make security measures more efficient and convenient.

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