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RESEARCH ARTICLE

Analysis of GPS and GSM with GPRS-Based Vehicle Tracking and Monitoring System

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ABSTRACT - Vehicle security has become a major concern in today's world. Due to the increasing number of vehicle thefts, GSM and GPS-based vehicle tracking systems have gained attention to help users keep track of their vehicles. The main objective of this study is to develop an accurate and reliable device to support vehicle owners in tracking the whereabouts of their vehicles. Such devices will allow vehicles to be tracked remotely from a distance by utilizing the already available mobile networks. Specifically, the system will use the GPS (Global Positioning System) Module to collect the vehicle coordinates (latitude and longitude) and send them to the user's mobile upon request, which also allows for the expansion of knowledge on GPS (Global Positioning System), GSM (Global Systems for Mobile) and GPRS (General Packet Radio Service) technology, as well as the SIM interface. It will take some analysis to make this endeavour succeed. A Google Spreadsheet will be used as a database to store the location data from GPS sensors, and information will be sent to it via a connection to the General Packet Radio Service (GPRS) network system. The information will be synced and shown on a visual map so that the user can simply access and track the whereabouts of the vehicle. There is a discussion concerning the accuracy of the GPS sensor being utilised over several places, including urban and rural areas, to determine the device's accuracy. The system's dependability and ability to perform well based on the data collected also have both been studied and analysed. As a result, this paper offers a well-presented study to develop a tracking system to determine the time and position of the monitoring vehicle.

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1.0 INTRODUCTION

A tracking device, also known as a locating system, keeps track of moving people or things in a timely sequence of position data. Nowadays, vehicle tracking systems are widely used by fleet management and regular people. The primary reason is for safety and security, as well as for services like fleet monitoring and onboard data. In Malaysia, although the number of vehicle theft claims records have been decreasing over the past years [1], the number of stolen vehicles continues to be alarming [2] According to the Vehicle Theft Reduction Council of Malaysia (VTREC), in 2020, one vehicle is stolen every 75 minutes, resulting in 20 vehicles being stolen per day [3]. Therefore, extra precautions must be taken by vehicle owners to ensure the safety of their property by knowing the location of their vehicle at all times. A tracking device, demanding the requirement for precision and accuracy, portable GPS tracking gadget. An Arduino is used in the hardware design, as well as the SIM800L GSM module and NEO-6M GPS module. Such knowledge can be provided through the integration of Global Positioning System (GPS), Global System for Mobile Communication (GSM) and GPRS (General Packet Radio Service) technology. The idea of getting information about the location of the vehicle using Global Positioning System (GPS) and store the information gained in a cloud database so that the user will easily monitor the current location of their vehicle with the help of map visualisation. The information is delivered through GPRS network to a Google Spreadsheet using the Hypertext Transfer Protocol (HTTP), which the Spreadsheet is then acts as a database to store the location data for both past and present tracks. Investigations were done on system dependability of GPS tracking data in determining the real location.1.1

2.0 RELATED WORK

The development of GPS and GSM based tracking devices is no longer new. Many studies have considered the development of this device as a great way to deal with the problem of lost automobiles that may never be recovered again [4]. A tracking device is an electronic device that can determine or monitor the whereabouts of a person or any property to which it is attached [2]. The primary goal of the development of GPS and GSM based tracking devices is meant to

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determine the exact location of any vehicle and notify the appropriate authorities using the preferred approach. It provides a better security system for all vehicles [5].

The major goal of this project is to develop a dependable, and accurate vehicle tracking system that should be affordable enough for general people to have it. Many studies have been done considering the development of this tracking device using many types of microcontrollers, GSM Module, and GPS Module [6]. The overarching goal of this study is to design and develop an affordable vehicle tracking system that uses GPS and GSM technologies. To achieve this goal, specific objectives are defined, which include:

I. To develop the vehicle tracking device, which includes both the hardware and software required for the device.

II. To analyze accuracy in different location (rural vs. urban).

III. To analyze reliability of the tracking device based on interval time

3.0 METHODOLOGY

The study's research methodology is an essential part of the project generation process because it includes a precise strategy to develop the project on track, ensuring a smooth, efficient, and controlled procedure. The Figure 1 shows the overall flowchart of the project. It shows the planning of the project from the beginning until the end of the project.

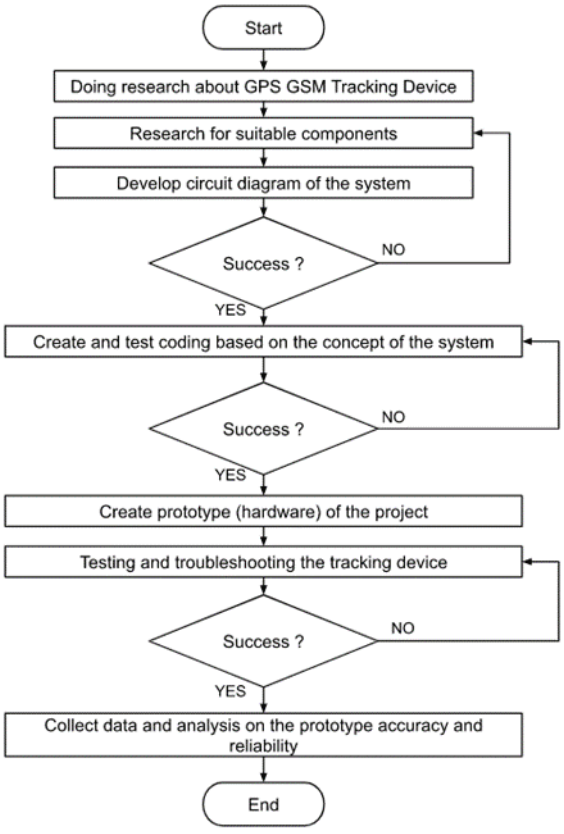

Figure 1. Methodology flowchart

4.0 SYSTEM ARCHITECTURE OF THE PURPOSE SYSTEM

For the system architecture, latitude and longitude of the vehicle are obtained by a GPS sensor from GPS satellites, as illustrated in Figure 2. Following that, the microcontroller uses the GPRS modem to deliver these coordinates in an HTTP request. The GPS position data was immediately provided to Google Spreadsheet and saved there as a webserver and database. A visual map is created in Microsoft Power Bi to make sure that the vehicle's continuous journey may be observed and located the current location of the vehicle [7].

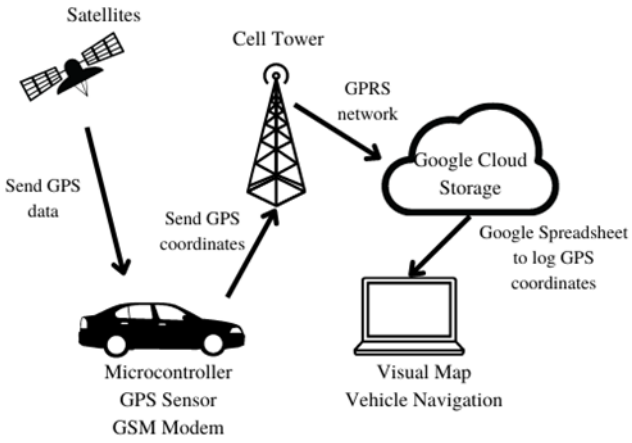

Figure 2. System architecture[8]

The Arduino Nano acts as a mediation device used to connect both of these sensors, GSM/GPRS and GPS module. GSM/GPRS Sim 800L has a GSM sim slot as well as other communication pins for sending and receiving data. To power up the whole system, two 3.7v Lithium-Ion batteries are being used. The GPS and GSM modules will be powered via the Arduino nano board's power output pin. In order to increase the circuit's stability, a capacitor is connected in parallel between them. GPS Rx (receive) is connected to the Arduino Uno Tx (transmit) D9, and GPS Tx (transmit) is connected to the Arduino Uno Rx (receive) D8. GSM Rx (receive) is connected to the Arduino Uno Tx (transmit) D5, and GSM Tx (transmit) is connected to the Arduino Uno Rx (receive) D6. This is because the Nano (Tx transmits to the GPS and GSM (Rx) and conversely the Arduino Nano (Rx) receives from the GPS and GSM (Tx). Two buttons were added on Arduino Nano on both digital pins D2 and D3 to add some functionality on the device.

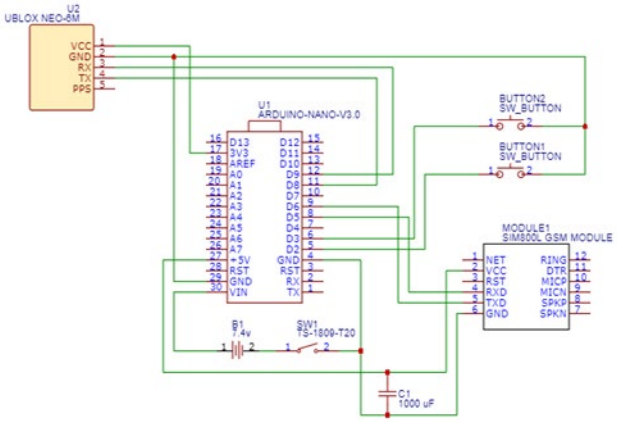

Figure 3. The circuit of the system

Figure 4 The block diagram shows the relationship between the components of the project. The GPS (Global Positioning System) module, GSM Module, and an Arduino Nano are the three major components in this vehicle tracking device. Using the GSM/GPRS module, the live coordinates are being sent acquired by the GPS receiver module. Therefore, this will be broken into three sections: input, control, and output. The system's input part includes the power supply, GPS, and GSM/GPRS modules, which collect data and store it in computer memory. The Arduino nano, the system's control unit, uses an ATmega328p microcontroller.

Figure 4. Hardware interfacing of component

5.0 RESULTS AND DISCUSSION

Once all the network connection setting has been done, the information is directly being sent to Google Spreadsheet. The position updates are being sent to the Google Spreadsheet in terms of latitude, longitude, altitude, speed and no of satellites GPS Sensor could detect at the time to pinpoint the location as seen in Figure 6.

	Timestamp	Latitude	Longitude	Altitude	Speed	No of Satellites
2	12/23/2022 1:00:08	3.537834	103.42857	62.335957	0.540866	3
3	12/23/2022 1:01:25	3.537767	103.42864	75.131233	0.391265	4
4	12/23/2022 1:02:40	3.53775	103.4286	124.34383	0.126586	4
5	12/23/2022 1:03:56	3.537811	103.42835	95.472443	0.598405	5
6	12/23/2022 1:05:12	3.537761	103.42838	120.07874	1.519029	5
7	12/23/2022 1:06:29	3.537763	103.42842	131.88977	0.31071	6
8	12/23/2022 1:07:46	3.537754	103.4285	88.582672	0.322218	5
9	12/23/2022 1:09:02	3.53774	103.42837	78.740158	1.024194	5
10	12/23/2022 1:10:19	3.537757	103.4286	108.92389	0.529359	5
11	12/23/2022 1:11:34	3.537761	103.42856	83.989502	0.345234	4
12	12/23/2022 1:12:52	3.537714	103.42834	73.818893	0.920624	6
13	12/23/2022 1:14:07	3.537757	103.42847	129.92126	1.66863	6
14	12/23/2022 1:15:24	3.537754	103.42844	92.847771	0.264679	6
15	12/23/2022 1:16:40	3.537738	103.4285	83.005257	0.368249	6
16	12/23/2022 1:17:55	3.537749	103.42854	69.881889	0.78253	6
17	12/23/2022 1:19:12	3.537778	103.4285	70.538055	0.517851	5

Figure 5. Spreadsheet as database to store the location data

The visualisation of the tracking device is being monitor by using Microsoft Power Bi Software. The Microsoft Power Bi provide a function of route map. this visualisation will be updated if the data of the tracking device is updated. The data is being linked with Google Spreadsheet which act as the cloud data storage. Thus, by using Microsoft Power Bi we could see all the data collected is being visualized. The efficiency of the suggested approach is demonstrated in Figure 7, which displays real-time results of GPS coordinates on a map.

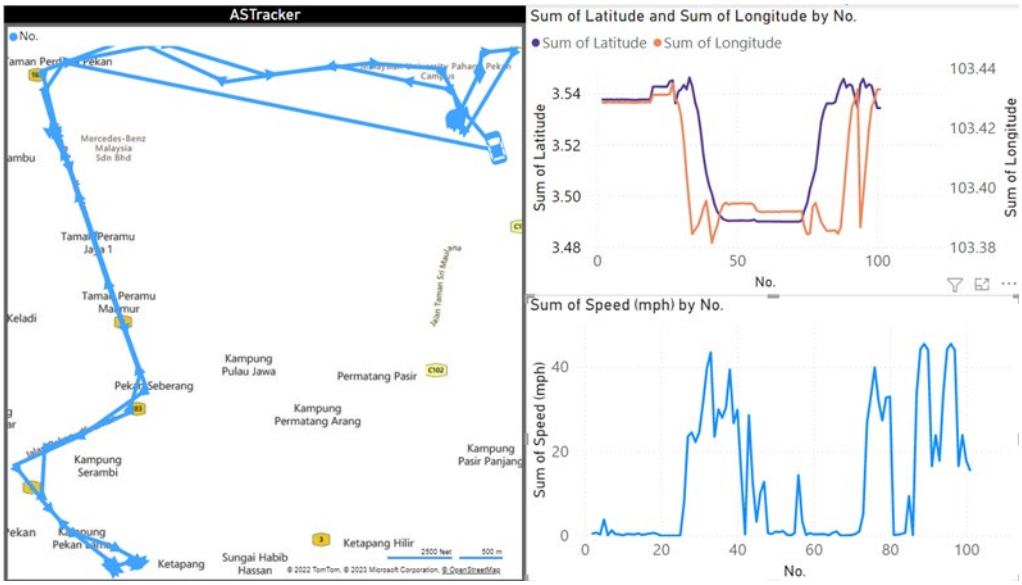

Figure 6. Visualisation on tracked vehicle using Microsoft Power BI

Table 1. Accuracy data analysis

No of collected data = 10	Urban Area (Jalan Engku Muda Mansor, Taman Merdeka, 26600 Pekan)	Rural Area (Kampung Pulau Keladi, Pekan)
	Latitude	Longitude
Average (mean) of data collected	3.490636	103.3931
Real value coordinate (Google Maps)	3.490711	103.393169
Coordinate difference	7.5×10^{-5}	6.9×10^{-5}
Error (diff) %	<0.01%	<0.01%

Figure 8 We try to calculate the error send by the GPS Sensor with the actual position which is using Google Maps as reference actual point. The precision was determined using the mean of the geometric distance between the position data obtained by the tracking devices. The error between the actual location and the measure location is very small for both latitude and longitude value. The sensor provides a very accurate result and thus be a reliable to be implemented as a tracker device. The accuracy between the mean distance gained and the actual figure is just had less than 5 metres error in accuracy in the urban area. The accuracy test distance for rural areas is 3 metres. This measure shows a great accurate between result between gained value and the real value. Additionally, the user accuracy is dependent on a mix of user range error, satellite geometry, and regional elements including signal obstruction, weather, and receiver quality/design elements.

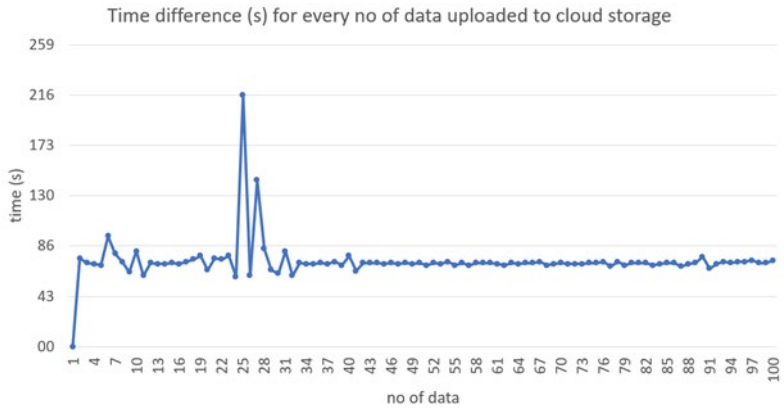

Figure 7. Graph depicting the variance in upload time for 100 data locations

6.0 CONCLUSIONS

The Internet of Things (IoT) is a technology that allows any equipment to be controlled remotely over the internet. IoT devices are becoming increasingly small and portable in terms of size, shape, and functionality. For various purposes, Arduino may be utilised in various versions. Arduino Nano is the greatest option for more compact and tinier application. The GPS Neo 6m provides precise GPS coordinates, and the refresh rate is also appropriate to keep up with the movement of the satellites. The GSM/GPRS Sim800L module as an internet gateway. It should be equipped with a functioning SIM card and valid data plans. The tracking system for vehicles has been discussed in this study. In order to acquire the current location and transmit it to the developed tracking system for vehicles combines a GPS sensor and a GPRS modem. HTTP request utilising internet connectivity, and GAS analyses the latitude and longitude column in a Google spreadsheet to save history of the movement of the missing vehicle on route maps[9].

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