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GLOBAL POSITIONING SYSTEM AND GLOBAL SYSTEM FOR MOBILE COMMUNICATION MODEM APPLICATION AS CAR POSITION AND FUEL MONITORING SYSTEM

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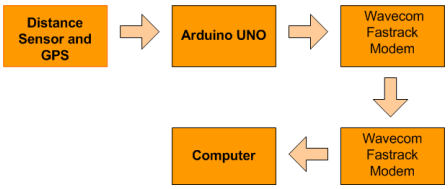
Graphical abstract



Abstract

The distribution of fuel oil carried by the tanker to the Fuel Stations is hard to be monitored. There are cases where the driver, who steals the fuel from the tank, harder to be tracked down. To overcome this problem, researchers used Global Positioning System and Global System for Mobile Modem Communication as an application. The research integrates multiple electronic Global Positioning System device, ultrasonic sensor, Arduino and mobile modem in the system. The device is placed in the carriage fuel tank of the tanker. This system aims to determine the car's position and content of the fuel tank. It will retrieve current car position and carriage content and send it over Short Message and voice call over Mobile modem. A program, built with Delphi will retrieve the message and point out the car position and tank level accurately on Google Maps. The results obtained indicated that the error is approximately ± 0.05 and deviation is 0 latitude and 0.00362 longitude. For further development, we plan to improve two parameters by increasing warnings with the increase in the capacity of the sensors. From the overall discussion in this study, it can be concluded that the equipment content monitoring system can be well applied.

Keywords: Global positioning system, global system for mobile communication, ultrasonic sensor, short message service

1.0 INTRODUCTION

With the current technological developments, the navigation system called the Global Positioning System (GPS) can be used to track the position of an object.

GPS capability can provide information about the position, velocity, and time quickly, accurately, anywhere on this earth, regardless of the weather. To take advantage of the GPS, then it must be supported by additional equipments like GPS antenna and GPS receiver. By adding devices such as GPS receivers, ultrasonic sensor, Arduino UNO, and Wavecom Fastrack modem which has been integrated in such way in the car, we can figure out the position of the car and fuel level at all times as long as the car stays in the range of a GSM provider used in this research and testing [1].

Reference of previous studies that smart girls Journal of security systems in the journal International Journal of Innovation in the Application or Engineering & Management (IJAIEM) in India in 2014 by Basavaraj C.

This study addressed the issue of data security systems. Another Reference Data Program Development Communication Between GPS With

Microcontroller AT89S52, which has been included in the National Seminar V HR Nuclear Technology in 2009 in Yogyakarta (Indonesia) by A. Muhtadan.

Some researchers used the reference for comparison only. But the discussion of different investigators with this reference. Researchers formulate problems on Application of Global Positioning System, the Global System for Mobile modem and Ultrasonic sensors as a monitoring system to determine the location of the car and the contents of the fuel in the tank car.

2.0 EXPERIMENTAL

2.1 Global Positioning System (GPS)

The Global Positioning System is a satellite navigation and positioning system owned and managed by the USA, with the official name of the NAVSTAR GPS (Navigation Satellite Timing and Ranging Global Positioning System). GPS was first developed by the US Department of Defense in1978 and the GPS was formally declared operational in 1994 [2]. In figure 1 is shown the relation of each segment.

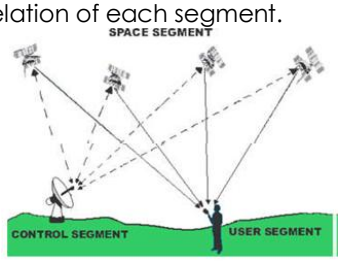


Figure1 Ilustrasi Segmen GPS [2]

Some of the characteristics that make it interesting to us is that the GPS system is designed to provide position data, which refers to a global datum, and the speed of data transmission as well as information regarding the time continuously throughout the world, without relying on time and weather for many people simultaneously. In general, there are three segments in the GPS system, the Control Segment, Space Segment, and User Segment. There are communications between the control segment and space segment, while the user segment merely as a receiver [2].

2.2 National Marine Electronics Association

National Marine Electronics Association NMEA 0183 is a standard protocol used to communicate with devices such as GPS navigation [1].

This standard contains the electronic signal used, data transmission protocol, timing and composition of a specific message. Generally, standard NMEA communication is using the RS232 with 4800 serial data baudrate [1]. The NMEA 0183 data format is shown in ASCII text beginning with a '$' followed by two letters Talker ID (for GPS receiver using code 'GP') and Sentence ID. In Sentence ID message type codes followed by a number of information data is separated by commas and ended with Optional Checksum which are two-digit hex code behind the sign asterisk (*). At the end of the composition there is a Carriage Return and Line Feed is a <CR> and <LF>. Table 1 shows some examples of the NMEA output messages by different protocols. Description of the data on each protocol is different [1].

At the equator, one degree of latitude (latitude) has a conversion value in meters by 110.067 meters (68.392 miles), while the degrees of longitude (longitude) have a conversion value in meters by 110.321 meters (68.550 m) [3]. Latitude and longitude in meters distance (D) can be calculated using the formula [3]:

$$D= \sqrt{(\text{latitude1} - \text{latitude 2})^2 + (\text{longitude1} - \text{latitude2})^2}$$

To calculate the standard deviation of the amount of data is defined as the root of the sum of all the squared deviations divided by the number after the reading. Mathematically written as follows [4]:

$$\sigma = \sqrt{\frac{\sum dt^2}{n-1}}$$

By at is the difference between the value of the deviation is reduced by the value of the average deviation, n is the number of test data and σ is the standard deviation [4]

2.3 SMS System

Message menu on a mobile phone is actually an AT Command 2x which has a function to send and receive data to and from the SMS center. AT SMS commands may vary on every device, but basically the same [5].

SMS Format in GSM Mobile phone (GSM modem) has a facility of accessing data over a serial connection or infrared interface. To access the data, sequence of instructions is required in a mobile phone interface, the European standard instructions specified on the engineering document GSM 7:07 and GSM 7:05, in which every mobile phone should refer to those instructions. As in the instruction manual interface on the modem, mobile phone instruction under the AT characters and ends with the enter or 0Dh. The command received will be responded with the receipt of the data 'OK' or 'ERROR'. Instructions will be received by hand phone and processed by other instructions, so that any incoming instruction must wait for a response from a new mobile phone ended with following instructions [6]:

1. *AT+CMGS* to send SMS
2. *AT+CMGL* to check for SMS
3. *AT+CMGD* to erase SMS

AT Command in SMS followed by data input / output units are represented by the PDU. Data

flowing to and from the SMS-Centre must be in PDU form. The PDU contains hexadecimal numbers that reflect the language of input / output. PDU consists of a header. This header that has function to send SMS to the SMS Centre is different from the SMS received by SMS Centre [5].

Table 1 SMS Centre Number [5]

No.	Cellular Provider	SMS-Centre
1.	Telkomsel	0811000000
2.	Satelindo	0816124
3.	Exelcom	0818445009/08184450095
4.	Indosat-M3	0855000000
5.	Axis	08315000032/08315000031
6.	Flexi	080980000
7.	Three	089644000001

2.4 Wavecom Fastrack Modem

Wavecom Fastrack Modem is a GSM which is widely used as a Short Message Service gateway using the serial communication with a 9600 bps baud rate. The Protocol must be used to be able to communicate with Wavecom Fastrack Modem. Wavecom Fastrack is a Modem that uses AT-Commands. AT-Commands is a set of commands used to control modems that begins with AT (attention) SIM [7].

Figure 2 Wavecom Fastrack Modem [7]

The following is Wavecom Fastrack Modem specifications [4]:

1. EGSM 900/1800MHz
2. Supports voice / data / fax / SMS (text and PDU modes) / GPRS class 10
3. Open AT capable for embedded applications
4. Optional TCP/IP stack permitting direct UDP/TCP connectivity and OP3/SMTP/FTP services
5. 3V SIM Interface
6. 15-pin sub-D connector for voice and RS-232 serial interface
7. Fully type-approved
8. 25mm shorter than M1206B predecessor
9. Serial port shutdown, power saving feature
10. Two general-purpose input/output pins built into Molex power connector
11. Band: Dual-band EGSM900/1800 MHz
12. Dimensions: 73x54x25mm
13. Weight: 82g
14. Input Voltage: 5.5 to 32v DC

Wavecom Fastrack Modem is an electronic device that functions as SMS sender and receiver. Depending on its type, generally this device is small enough, the same size as a GSM mobile phone. A GSM modem consists of several parts, among which are the indicator lights, power terminals, terminal cable to the computer, the antenna and SIM card [7]. The use of GSM and GPS technology allows the system to track the object and provide the most up to date information about the ongoing journey [8].

2.5 GPS Module

GPS Module is a GPS Receiver (5V Serial) with high gain which has four 2.54 mm pins with 4 Strip lines. The third generation POT (Patch Antenna on Top) is used by the receiver to the GPS module. It can be connected to the 5V Microcontroller with assistance in providing a voltage of 3V - 5V. Interfacing is made easier with the help of pin count (4 pin) Line. This module has 4 pins which are 5V, TX, RX, and GND. GPS Module rated voltage 5 V requires no external components. It consists of a Real Time Clock for back up internal battery and can be directly connected to the serial of the microcontroller [9].

Figure 3 GPS Module GY-GPS6MV2 [9].

GPS Module can determine the current date, time, longitude, latitude, altitude, speed, and direction of travel/ heading among other data, provided by the module and can be used in various applications including navigation, fleet management, tracking systems, mapping and robotics. This module can support up to 51 channels. GPS solution enables small form factor devices that provide major advancements in GPS performances, accuracy, integration, computing power and flexibility [9].

2.6 Arduino UNO

Arduino UNO Module contains ATmega328 microcontroller and equipped with a 16 MHz oscillator, 5V regulator, 0 to 13 pins, with A0 through A5 pins is used for analog signals [9]. 2 KB Static Random-Access Memory (SRAM), 32 KB flash

memory, erasable programmable read-only memory (EEPROM) [10].

Arduino is an open-source electronics platform based on an easy to use hardware and software. It is intended for anyone who makes an interactive project [11]. Arduino is an open source physical computing platform. First of all it should be understood that the word "platform" is an appropriate word choice. Arduino is not just a development tool, but the Arduino board is a combination of hardware, programming language and Integrated Development Environment (IDE) that is advanced. IDE is a software that was instrumental to write a program, compile it into binary code and upload it to the microcontroller memory. There are many projects and tools developed by academics and professionals using Arduino, but it is also a lot of support modules (sensor, display, driving, etc.) Made by the other party to be connected to the Arduino. Arduino evolved into a platform because it is an option and reference for many practitioners. One that makes Arduino to be liked by many people is because it is open source, both for hardware and its software. The Arduino electronic circuit diagram is free to everyone. The design of hardware, programming language and the Arduino IDE are of high quality and very classy [11].

Arduino was developed by a team of people from various parts of the world. The core members of this team are [10]:

- Massimo Banzi Milano, Italy
- David Cuartielles Malmoe, Sweden
- Tom Igoe, New York, US
- Gianluca Martino Torino, Italy
- David A. Mellis Boston, MA, USA

In Figure 4, we can see Arduino UNO [11].

Figure 4 Arduino UNO [11]

3.0 RESULTS AND DISCUSSION

The results of the test consist of:

A. Hardware
B. Software
C. Performance testing

The purpose of testing is to determine the performance of each part of the circuit and the system as a whole.

The testing conducted in two stages:

- The first stage is done in the electronics engineering laboratory
- The second stage of data collection is done in a certain position

3.1 Hardware

The hardware consists of three parts, which are the height and position measurement, data transmission system in the form of SMS and receiving data in the form of SMS displayed through the computer.

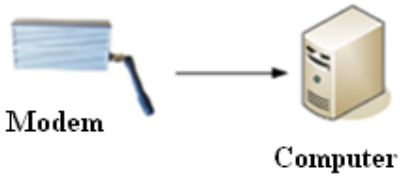


Figure 5 GPS and ultrasonic sensor data retrieving system through Wavecom for PC

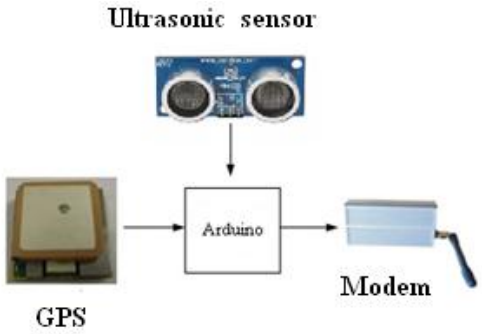


Figure 6 GPS transmitting system and ultrasonic sensor through Wavecom Fastrack modem.

3.2 Software

The programs made in this study were built with the Arduino IDE 1.0.1 for the program in the Arduino UNO, while the computer program was built in Delphi 7.0.

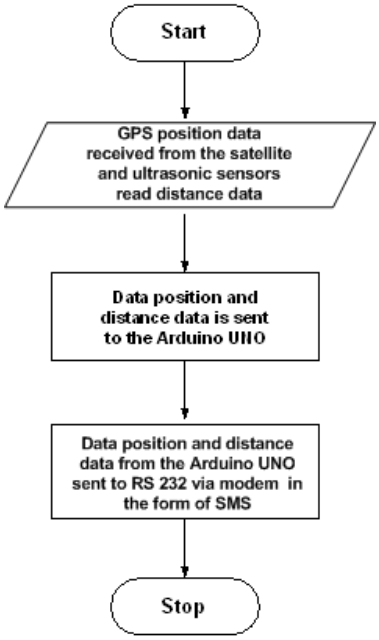


Figure 7 Position and height data sending through Wavecom Fastrack modem flowchart

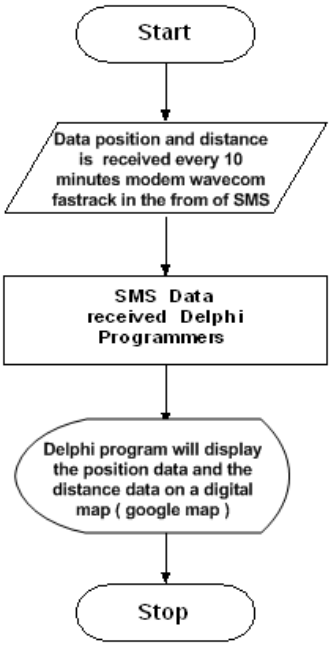


Figure 8 Position and height data retrieving through Wavecom Fastrack modem flowchart

3.3 Performance Testing

The software consists of two parts:

1. Preparation of the program for the Arduino UNO board, ultrasonic sensor and a GPS that will be placed in a specific position, namely in Electrical Engineering Laboratory of Sriwijaya State Polytechnic. The Arduino programmed using the Arduino IDE 1.0.1. The purpose of making this program is to take the height and position of the data from the GPS, then send the position data and the height data to the Arduino UNO through Wavecom modem Fastrack (modem transmitter) then send data in the form of SMS.
2. A Delphi program on a computer that will be connected to Wavecom Fastrack modem that will receive data in the form of SMS and then the data is processed at Delphi that will show you a location in Google Maps.

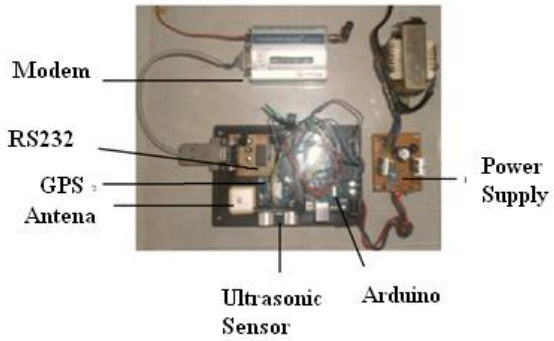


Figure 9 Device 1 Arduino UNO connected to Wavecom Modem used to send data through SMS

Figure 10 Device 2 Wavecom modem connected to a PC Used to receive data sent from device 1

Testing Results No. 1: The GPS data and sensor data are processed by the Arduino UNO board, then displayed through Hyperterminal as shown in Figure 11.

Hyperterminal Data:
A9+CMGS=085325117596
B-2.98340008532511759 6
C104.732269
Details:
A Value:
- The A Value shows the value of the height. It's valued 9, it means 9 cm
- CMGS=085325117596 means the number of *Wavecom fat rack modem*.

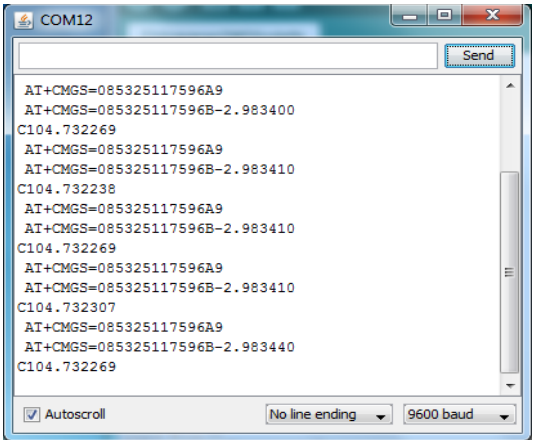


Figure 11 Data displayed through Arduino Hyperterminal

By Value:
B-2.983340085325117596
Seven first digits mean longitude while the last twelve digits show the modem number

C Value:
C104.732269Meanslatitude data of104. 732269.

From date: A9+CMGS=085325117596, B-2.9834000853251175 96and104.732269, we can know that the ultrasonic sensor detected 9 cm of height while manual measurement in Electrical Engineering Laboratory of Sriwijaya State Polytechnic results in height of 10 cm.
3rd Test Results: Data retrieving and displaying through a Delphi program as shown in Figure 12.

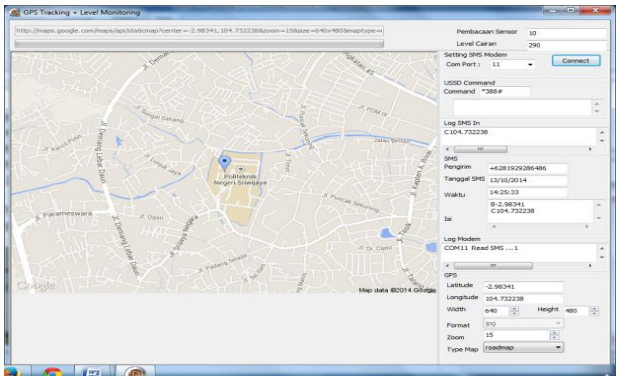


Figure 12 Data collecting on the receiver position on the 3rd test Displayed on Google Maps

For examples, In google map through a Delphi program that shows the position of the GPS is in Microprocessor Laboratory of Sriwijaya State Polytechnic on longitude = -2.92648 and latitude = 104.732238 with a height of 9 cm.

Table 2 1st – 5th data Test (On Transmitter)

Test Number	Longitude	Latitude	Height	Tank Volume (Liters)
1.	-2.983400	104.732269	9 cm	1099
2	-2.983410	104.732238	9 cm	1099
3	-2.983410	104.732269	9 cm	1099
4	-2.983410	104.732307	9 cm	1099
5	-2.983440	104.732269	9 cm	1099

On table 3 1st test, the volume of the fuel in the tank is 1099 liters.

On table 3 2nd test, the volume of the fuel in the tank is 1099 liters.

On table 3 3rd test, the volume of the fuel in the tank is 1099 liters.

On table 3 4th test, the volume of the fuel in the tank is 1099 liters.

On table 3 5th test, the volume of the fuel in the tank is 1099 liters.

Block diagram of the processes of the system as shown in Figure 13.

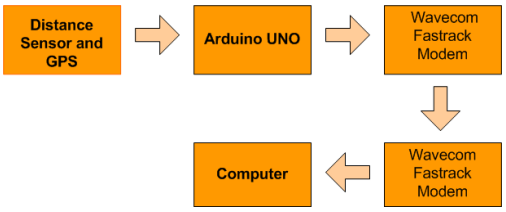


Figure 13 Block diagram of the processes of the system

4.0 CONCLUSION

It can be concluded that in the application of GPS and Ultrasonic Sensor, the contents and location of the fuel car monitoring system can be applied because the tank content data and the position coordinates of the GPS satellites can be determined correctly by the data received via SMS Delphi program and displayed in Google map and this works fine as long as the Wavecom Fastrack modem signal from the SIM card provider works well.

Acknowledgement

We are grateful for the Polytechnic of Sriwijaya, Palembang, Indonesia

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