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Design and Development of Automatic GPS Tracking System Using Arduino

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ABSTRACT.

The increasing incidence of vehicle thefts poses a significant concern for vehicle owners. To address this issue, this study aims to design and develop an Automatic GPS Tracking System using Arduino. The proposed system allows vehicle owners to locate their vehicles by sending a trigger SMS text to the GSM module. The design process involves producing device layouts and selecting the best sketches using the Pugh Chart method. The main program for the tracking system is implemented through Arduino coding. After successful completion of the tracking device, rigorous testing is conducted to ensure its proper functionality.

1. Introduction

Vehicle tracking technology not only aids in locating stolen vehicles but also finds applications in transportation companies for monitoring vehicle status, including current location, estimated destination, and route optimization. The system relies on the Global Positioning System (GPS) module to provide real-time location data by communicating with multiple satellites [1]. Alongside, a GSM/GPRS module facilitates communication between the system and a GSM-GPRS network, allowing the system to send Short Messaging System (SMS) texts containing vehicle whereabouts once programmed [2]. The central component of the system is the Arduino Uno module, functioning as a microcomputer to process data from connected devices or sensors. This data includes location information acquired from the GPS module, which can be accessed by sending a specific text or call to the GSM module, triggering the system to respond with the vehicle's location via a simple SMS text [6-7].

2. Hardware Requirement

1. Arduino Uno R3 (microcontroller)

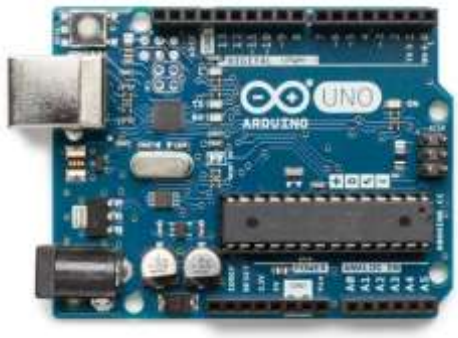

Figure 1. Arduino Uno R3.

Arduino Uno R3 is a microcontroller board based on ATmega328, featuring 14 digital input/output pins (including 6 PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, USB connection, power jack, ICSP header, and a reset button. It is designed to support the microcontroller, easily connecting to a computer via USB cable or powering it with an AC-DC adapter or battery.

2 NEO-7N GPS Module.

Figure 2 shown the NEO-7N GPS Module is compatible with Arduino and operates at voltages between 3.3V to 5V. It provides location and time information in all weather conditions by receiving data from 4 or more satellites within line of sight on Earth. The module's specifications include an output frequency of 1Hz, an output baud rate of 9600Bps, and adherence to the NMEA-0183 protocol.

Figure 2. NEO-7N GPS Module.

3 Sim800L GSM Module.

Figure 3. Sim800L GSM Module.

The Sim800L GSM Module is a miniature cellular module supporting GPRS transmission, SMS communication, and voice calls. Operating at voltages of 3.4V to 4.4V, it offers UART communication with a microcontroller and supports baud rates from 1200bps to 115200bps. Additionally, the module is quad-band, accommodating GSM850, EGSM900, DCS1800, and PCS1900 frequencies.

3. Methodology

The development of the vehicle tracking device involves creating a source code using Arduino IDE software. The critical aspect of the source code is the implementation of a working function loop for the system (Figure 4). Ensuring the proper functionality of individual functions before combining them into a loop is essential for the system's overall operation [3-5]. Achieving synchronization between the GPS and GSM modules is challenging, as it requires accurate programming sequencing.

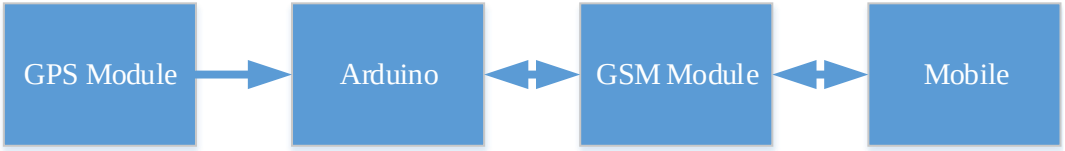

Figure 4. Block Diagram of the cycle of the vehicle tracking device.

From Figure 5, **t**he GPS and GSM modules establish fixed connections with satellites and the carrier network, respectively. The GPS module collects raw NMEA sentence data, which is processed into desired information by the function loop. When the vehicle owner sends a pre-defined SMS trigger phrase to the GSM module, it serves as a signal to determine the vehicle's location. Subsequently, another function detects the trigger SMS and sends the vehicle's Google Maps link via SMS to the owner.

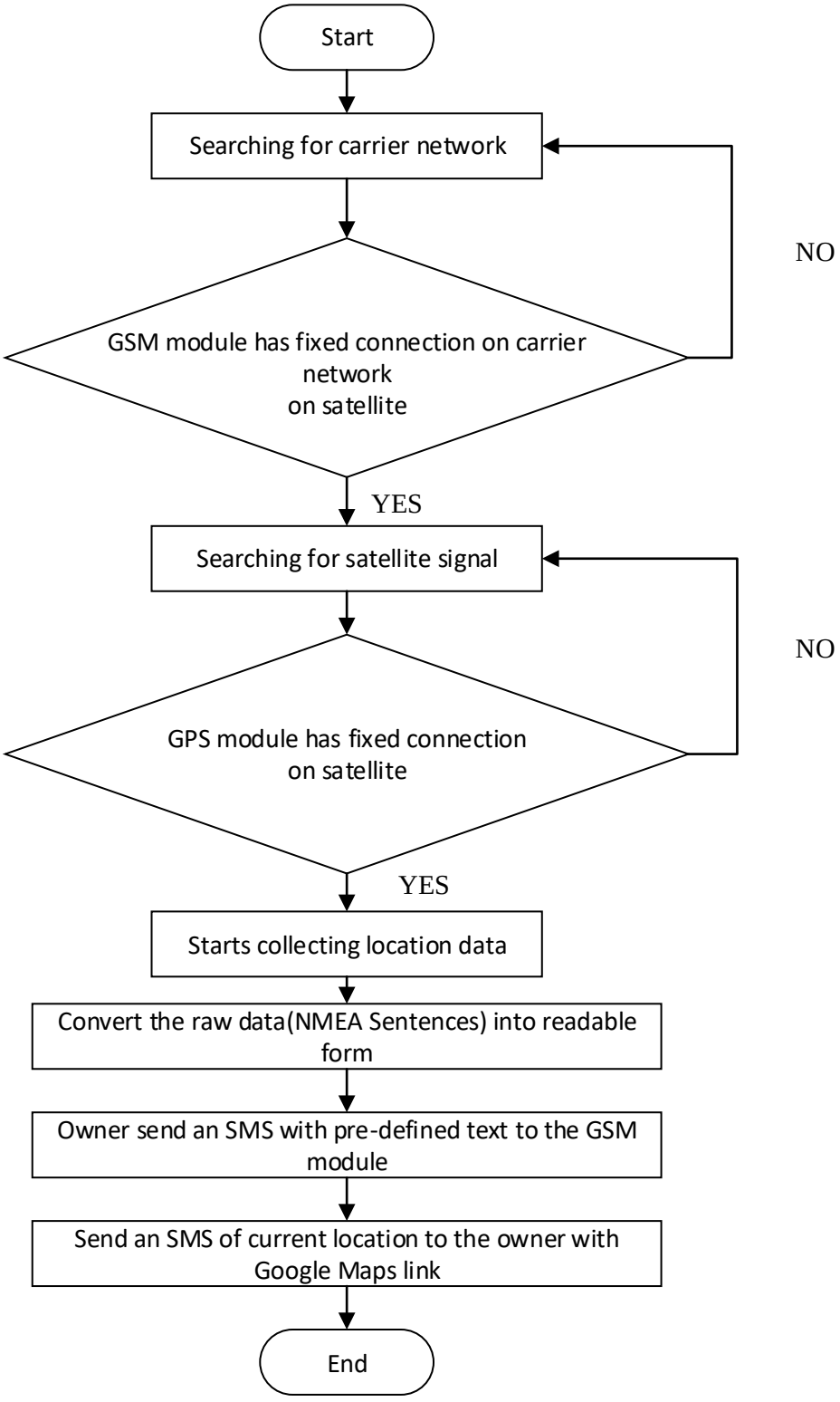

Figure5. Flow chart tracking system.

For the hardware connections, shown in figure 6 the positive and negative terminal of the SIM800L GSM module will be connected to the +5 volt and GND of the Arduino Uno pin respectively. After that, the transmit(TX) and the receive(RX) of the SIM800L GSM module will be connected to digital pin 2 and 3 of the Arduino Uno respectively. Furthermore, connect the other GND terminal of the SIM800L GSM module to the pin 14 (GND) of the Arduino Uno. Then, the positive and negative terminal of the NEO-7N GPS module will be connected to the +3.3 volt and GND of the Arduino Uno pin respectively. Lastly, connect the transmit(TX) and the receive(RX) of the NEO-7N GPS module to the digital pin 0 and digital pin 1 of Arduino Uno respectively.

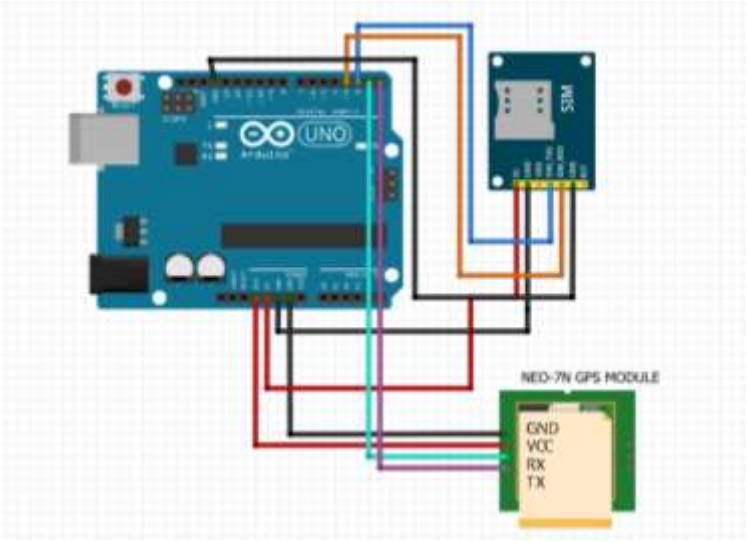

Figure 6. Wiring diagram circuit of tracking system.

4. Result And Discussion

The successful completion of the vehicle tracking device prototype, named V-Track, allows power input from both a power bank with 5V and 2.1A and an 11.1V Li-Ion battery (Figure 7). During testing, V-Track powers on and sends an SMS indicating its online status to the user. The GPS module takes approximately 3 minutes to cold start and establish connections with satellites, while the GSM module establishes connections faster, within seconds. Once all modules are connected, the device enters standby mode, continuously collecting location data of the vehicle.

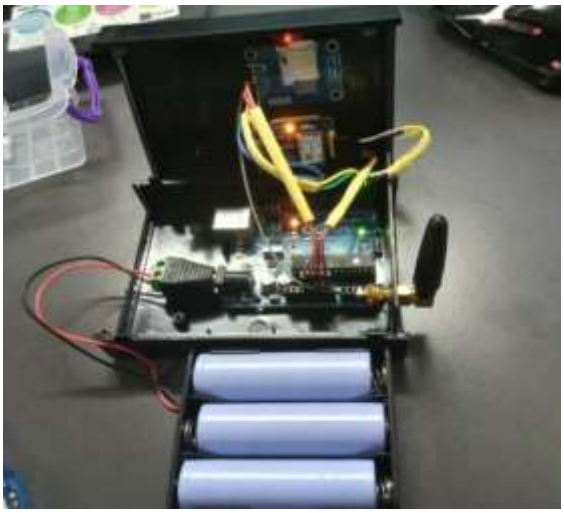

Figure 7. Prototype Automatic GPS Tracking System using Arduino

Analyzing the location data sent by the device reveals slight deviations from the actual location. This discrepancy can be attributed to the number of satellites fixed on the GPS module, as it directly affects location data accuracy. Increasing the number of fixed satellites can improve accuracy.

Apart from the accuracy of the location data received from V-Track, the Table 1 below shows comparison when powering the device with powerbank and Li-Ion battery.

Table 1. Comparison of power source for the device

Power source	Power bank	Li-Ion battery
Voltage	5V	11.1V
Current	2.1A	1.5A
Power consumption	10.5W	16.65W

5. Conclusion

The successful development of the V-Track vehicle tracking device has fulfilled all project objectives, including designing and developing a functional vehicle tracking system. The device provides an affordable solution for vehicle owners to track their vehicles effectively. Future improvements may involve the use of smaller microcontrollers, compact GPS and GSM modules, power-efficient batteries, and custom-made casings, ultimately enhancing the product's efficiency. The project has been a success, and with continuous advancements in technology, further enhancements are possible.

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