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Design and Construction of Smart Vehicle Security System Using GPS and Spy Cam

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: Vehicle security is critical in today's world because car thefts are on the rise. robbery, and impersonation are among the crimes committed against automobiles. As a result, keeping track of and safeguarding vehicles has grown to be a significant problem in modern life.
Study Design: The system combines GPS (Global Positioning Service), GSM (Global System for Mobile Communications), and Spy Cam technologies interfaced with an Arduino UNO to track the location of a car in real time.
Methodology: Short Message Service (SMS) messages are sent to the user or Vehicle authority mobile phone together with images of the current vehicle operator when SMS with the word "Track" is composed and sent to the SIM number inserted into the GSM module. BLYNK Android application serves as database for storing and retrieving cloud information when requested.
Results: The vehicle current location and the image of the current user will be displayed on Google Maps application of the sender. This technology enhances mobile vehicle security and avoid loss and impersonation. An SMS security warning is also sent to the owner when there is a lot of movement in front of the camera.
Conclusion: This system helps in detection and reporting of vehicle theft in real time. It can be employed in individual cars since it is affordable; also vehicle safety authorities can employ this technology to help them secure vehicles better.

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Keywords: GSM (Global system for mobile communications); arduino UNO; GPS (Global positioning system); SMS (Short message service); spy cam.

1. INTRODUCTION

As technology progresses, vehicle tracking systems become more valuable. With this system, the vehicle's owner may keep tabs on and track the vehicle's whereabouts, as well as learn about its past activities and whereabouts. Real-time car tracking systems, as they're known informally, have proven effective for ensuring vehicle security [1-3]. The architecture of the car tracking system enables Google Maps to show the location of a vehicle and image of current user. GPS and GSM/GPRS modules are mounted inside the car and interfaced with Arduino MEGA. As a result, every 10 seconds, the vehicle's location is updated. It is employed as a covert unit that sends location data to the monitoring unit constantly or when the system goes down [4-7]. Using the tracking system's location data and image of the present user, the police or vehicle safety authority may quickly find a stolen car and take appropriate measures. Users can request the GPS coordinates of a car and have them transmitted to their mobile devices when they make a request [8-11]. The user will be able to see the vehicle's location on Google Maps after receiving the latitude and longitude. When the driver presses a button, the system activates an SOS function that allows them to ask for help in an emergency its common for this service to be offered at a cheap price point. Authorized system users have access to this data.

2. LITERATURE REVIEW

The "Car Tracking and Locking System Based on GSM and GPS" was developed by [12] for vehicle security and theft prevention. In the car, a tracking and locking system was placed to keep tabs on the driver's location while also locking the engine. The GPS system and global mobile communication system were used to pinpoint the vehicle's location (GSM). Systems like these kept tabs on a moving car all the time and reported back to the driver when something went wrong. When the thief was caught, he or she sent an SMS to the microcontroller, which subsequently sent out control signals to shut down the engine. An authorized individual had to communicate the password to the controller in order to restart the car and open the door. This company's system was superior in all respects: it was safe, dependable, and affordable.

The GPS and GSM networks were developed by [13]. There are two parts to the proposed GPS/GSM-based system. Mobile and command and control are two different things. Data transmission and reception are fully functional between mobile units and control stations. The mobile unit is fully functional. These findings support the use of GPS systems.

According to [14], drivers' faces are detected and compared with a predefined face using a Face Detection System. The car was stolen while the owner was sound asleep. After that, the Face Detection System uses a small web camera that can be hidden almost anywhere in the vehicle to capture images. The Face Detection System compared the captured images with the previously collected ones in order to identify the person in each one of them. If the images don't match, an MMS message is sent to the owner with the relevant information. The thief is captured on the owners' mobile phones, and the location is tracked using GPS. The owner receives SMS updates on the vehicle's location and speed. The owner can easily identify the images of the robbers and the location of the vehicle.

Ramya et al. [15] created a Vehicle Embedded Controller. GSM and GPS were used to build a tracking and locking system. This system was designed to keep cars safe from being stolen. As a result, the car had a location tracking and engine locking system installed. GPS and GSM were used to pinpoint the location. The thief may have escaped because the system failed to utilize the camera.

A Real Time Vehicle Tracking System employing GSM and GPS Technology-An Anti-Theft Tracking System was proposed by [16], this electronic gadget allows its owners and third parties to track the vehicle's whereabouts using GPS and GSM technology. This makes it versatile in its use and has proven invaluable in the identification of vehicle theft over time. When a thief or intruder was caught on camera, the system failed to capture their face.

3. MATERIALS AND METHODS

To locate the stolen vehicle, this study used a novel vehicle tracking and accident alarm system that combined the use of a spy camera and GSM technology. The vehicle is put into sleep mode by this system while the owner or authorized person is active elsewhere. Changes to the mode of operation can be made either manually or remotely. In the event of an accident, the air bag's push button detects a signal and sends an SMS to the microcontroller, which acts accordingly. The controller reports the accident to the vehicle's owner or an authorized person.

3.1 Selection of Components

Several components were used to develop this system; some of the components are discussed below:

3.1.1 Arduino UNO

An ATMEGA 328p was used to interface with the Arduino UNO. On the board you'll find 20 pins (0-19), including 6 analog inputs, a ceramic resonator operating at 16MHz, and a USB connector. The power jack is on the back, as is the reset button. The microcontroller was programmed in C. To process the PIR sensor pulses when there's movement in the room, send them to the microcontroller. If the LED detects any movement, a signal will be sent to activate it.

The microcontroller and other components on the board will be powered by a controlled 5V power source. A regulated 5V power supply, such as USB, or a VIN power supply with an on-board regulator, can be used to power the device.

3.1.2 GSM module

There are many forms of output taken from the PCB, such as TTL Output (for Arduino, 8051, and other microcontrollers) and RS232 output to interface directly with a PC, which are connected to a GSM module (personal computer). A microphone, a speaker, and a power supply will be connected to the board through pins or provisions, and the board will also have a ground connection. These rules change according on the module you're using. Sim900 GSM Module is utilized. This indicates that the module is able to interact in the 900MHz frequency range.

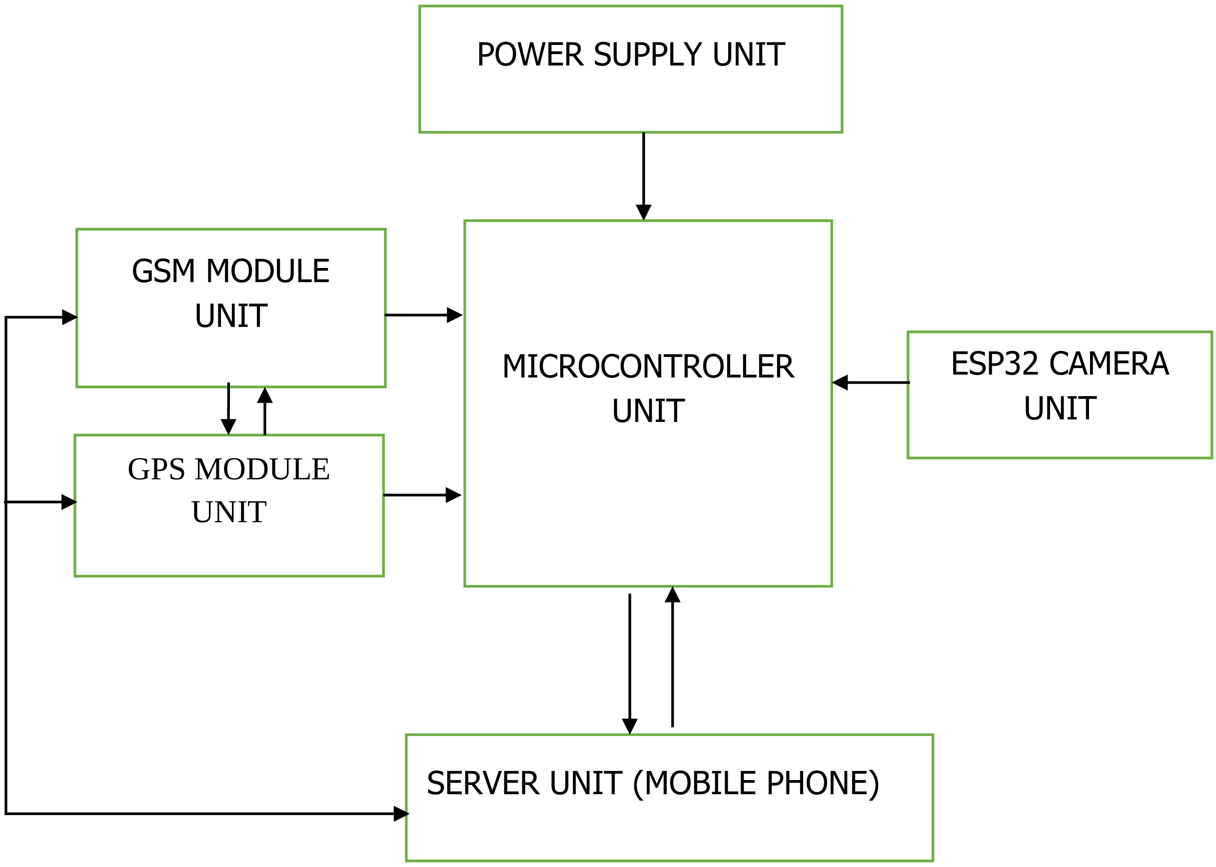

Fig. 1. The system block diagram

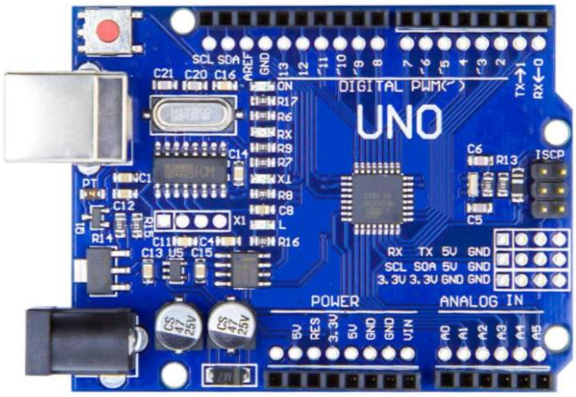

Fig. 2. Arduino UNO

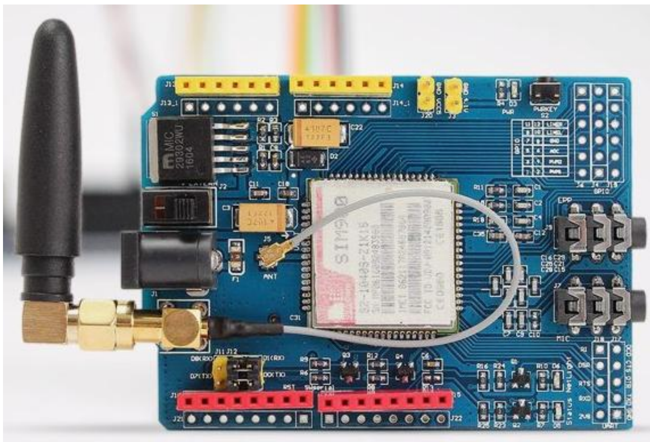

Fig. 3. GSM module

3.1.3 ESP32 camera

With the ESP32-CAM, you get an ESP32-S CPU, an OV2640 camera, a microSD card slot, and many GPIOs to connect to other devices. It's a development board for building embedded systems. This guide will cover the ESP32-CAM GPIOs and demonstrate how to use them. The ESP32-CAM is a camera module with a low power consumption that is built around the ESP32. Additionally, it has an on-board TF card slot in addition to the camera's OV2640 sensor. Multiple IoT smart device applications can make use of the ESP32-CAM such as wireless video monitoring, WiFi picture upload and QR recognition.

The features of the ESP32 camera are listed below:

1. Onboard ESP32-S module, supports WiFi + Bluetooth
2. OV2640 camera with flash
3. Onboard TF card slot, supports up to 4G TF card for data storage
4. Supports WiFi video monitoring and WiFi image upload
5. Supports multi sleep modes, deep sleep current as low as 6mA
6. Control interface is accessible via pinheader, easy to be integrated and embedded into user products.

3.1.4 GPS module

You can receive GPS signals using the NEO6MV2 module. A satellite's speed, direction of movement, and number of visible satellites can all be determined using this technique. A serial TX/RX connection is used for communication (just two I/O are required). The following are the capabilities of the GPS module:

1. Use XM37-1612 module, MTK Platform, with high-gain active antenna
2. TTL level, compatible with 3.3V/5V system

3. The default baud rate: 9600
4. With rechargeable backup battery, can save the ephemeris data when it power down,and make the warm start.
5. Suitable for RC quad copter, navigator

3.1.5 Jumper wire

With a connection or pin at each end (or sometimes without them simply "tinned"), a jumper wire connects the components of a breadboard or other prototype or test circuit inside or with other equipment or parts without soldering.

3.2 System Design

Computer software Proteus was used to design and simulate the circuit (PC). Fig. 7 depicts the circuit diagram.

Fig. 4. ESP32 camera

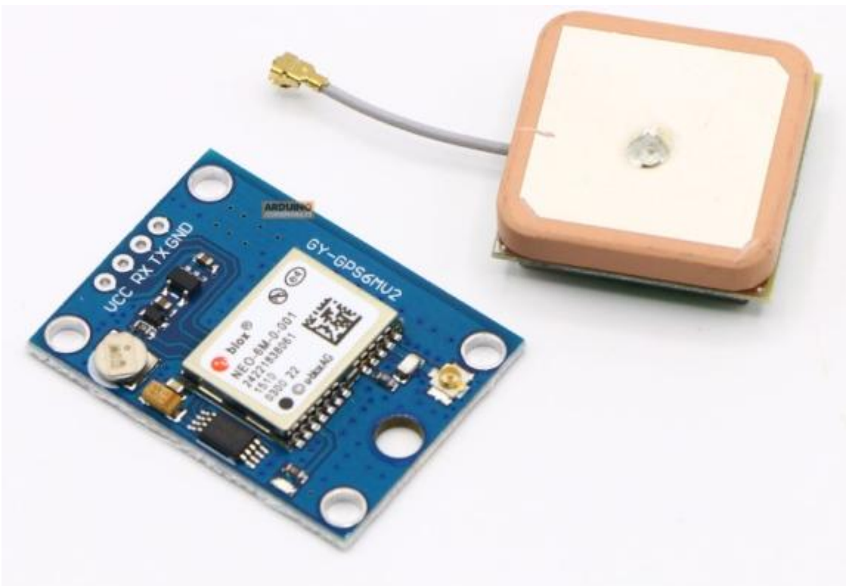

Fig. 5. GPS module

Fig. 6. Jumper wire

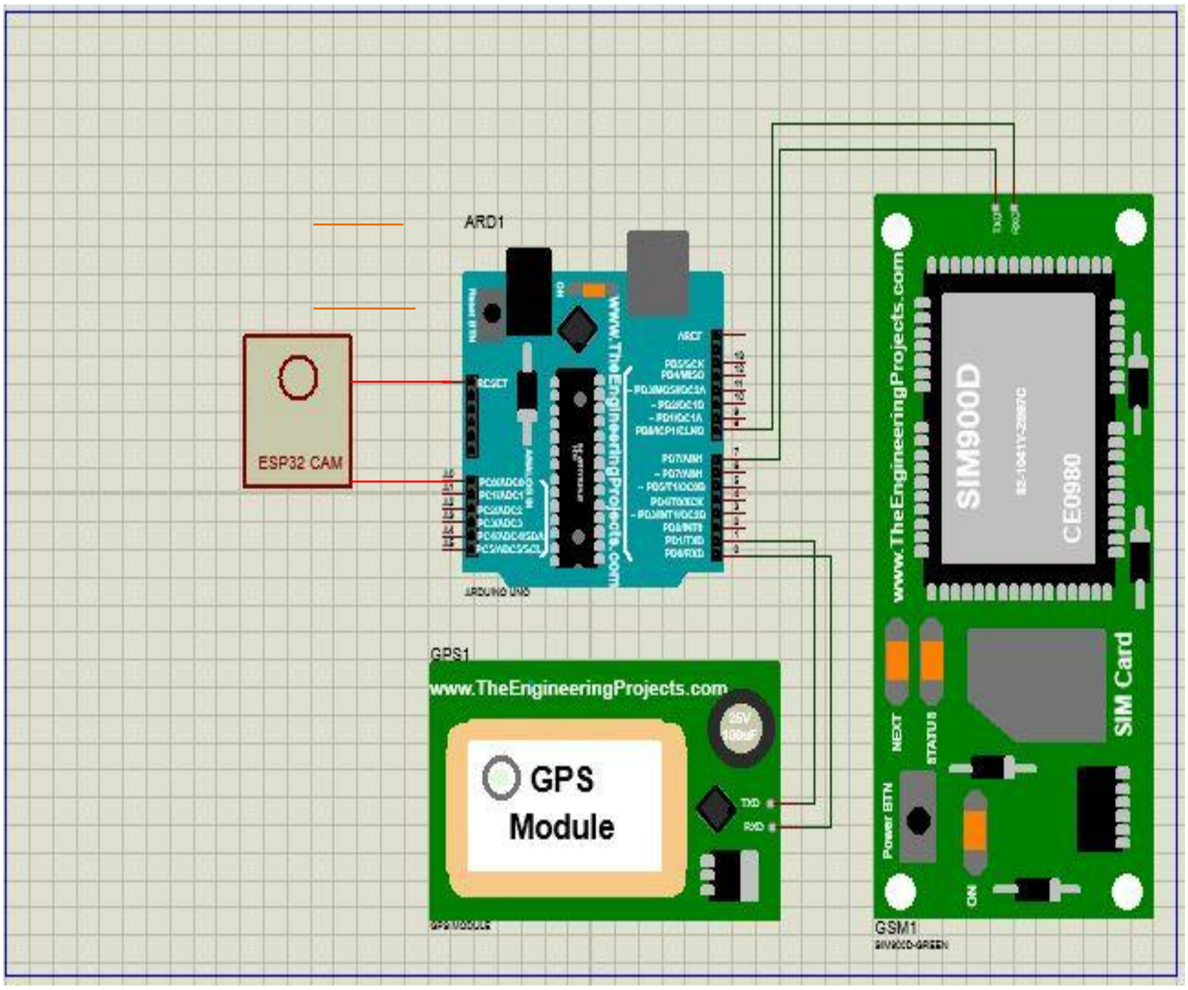

Fig. 7. Complete circuit diagram of system

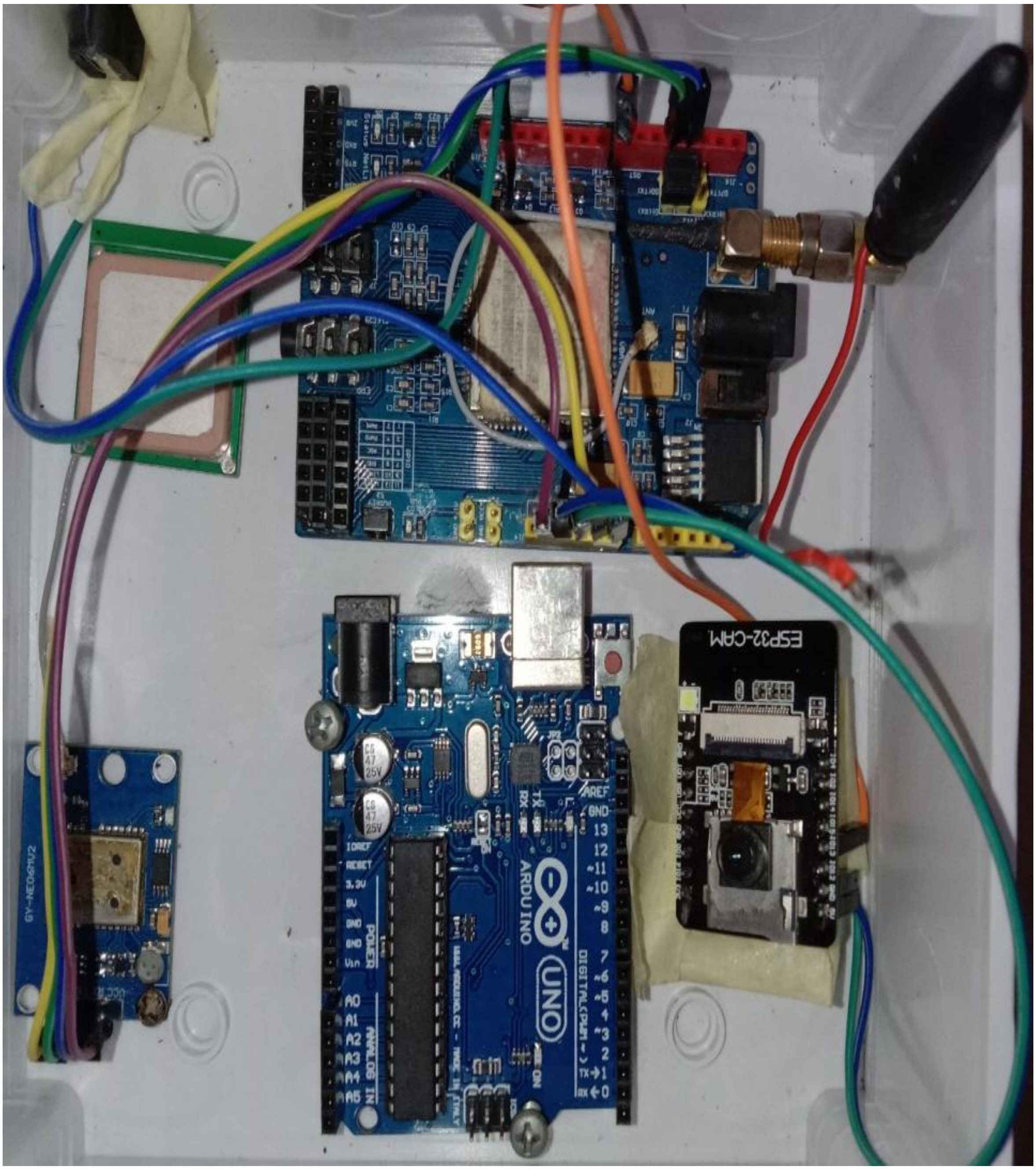

Fig. 8. Connection of components in the adaptive box

3.3 Construction Procedure

It was connected to the Arduino UNO through a female port (pin 0 of the GSM module to Arduino UNO pin Rx, etc.) and the GPS module had four pins: VCC, RX, TX, and GND. The GPS module's VCC was connected to the Arduino UNO's pin 3.3v, and the RX pin to its pin 3.

On the GPS module, we used the TX pin to connect to the Arduino and the GND pin to the GPS module's GND. A positive and a negative terminal on the power supply were connected to Vin on the Arduino and GND on the Arduino, respectively. Of the 16 pins on the ESP32 camera, only three were used: 5V, GND, and IO13.

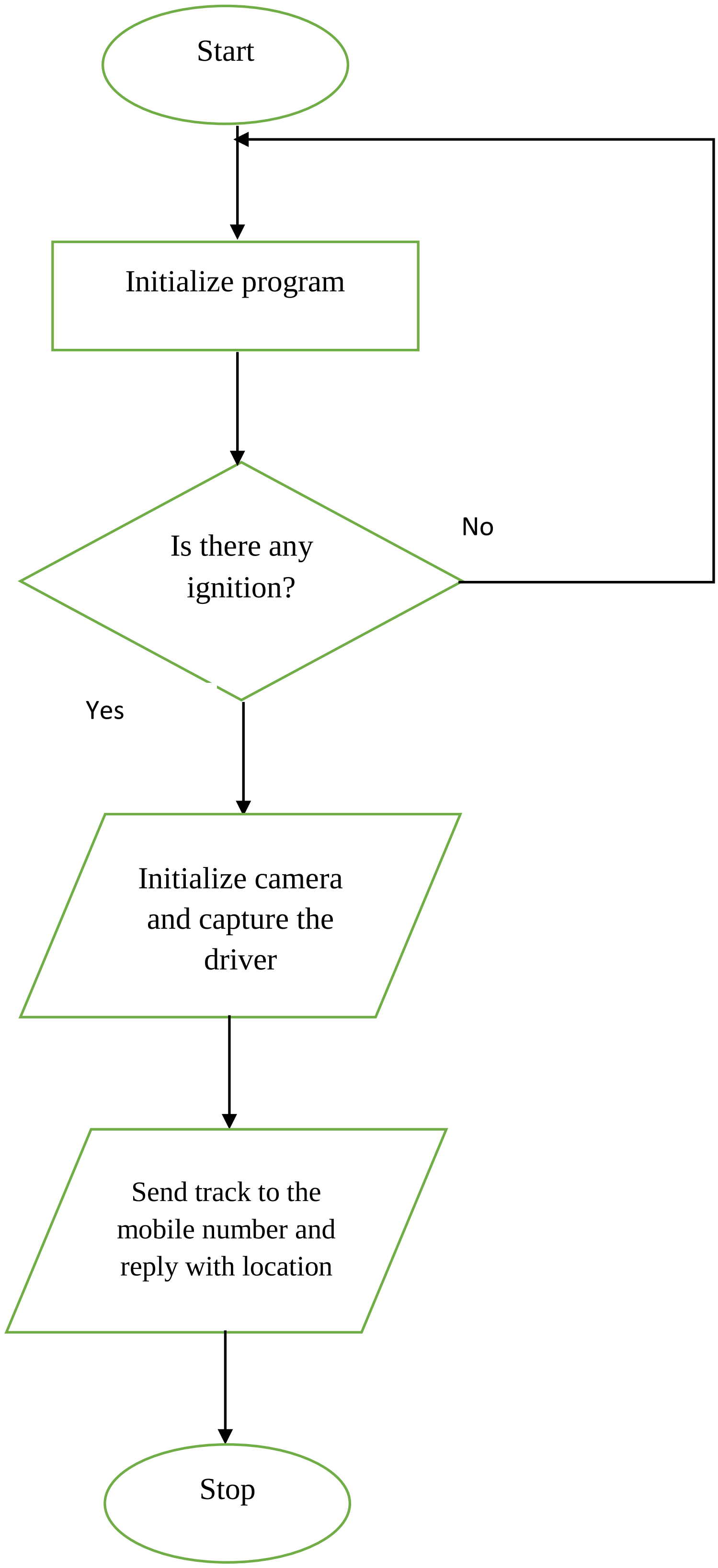

Fig. 9. The system flowchart

4. RESULTS AND DISCUSSION

Several testing was carried out on the system by visiting different locations as shown below.

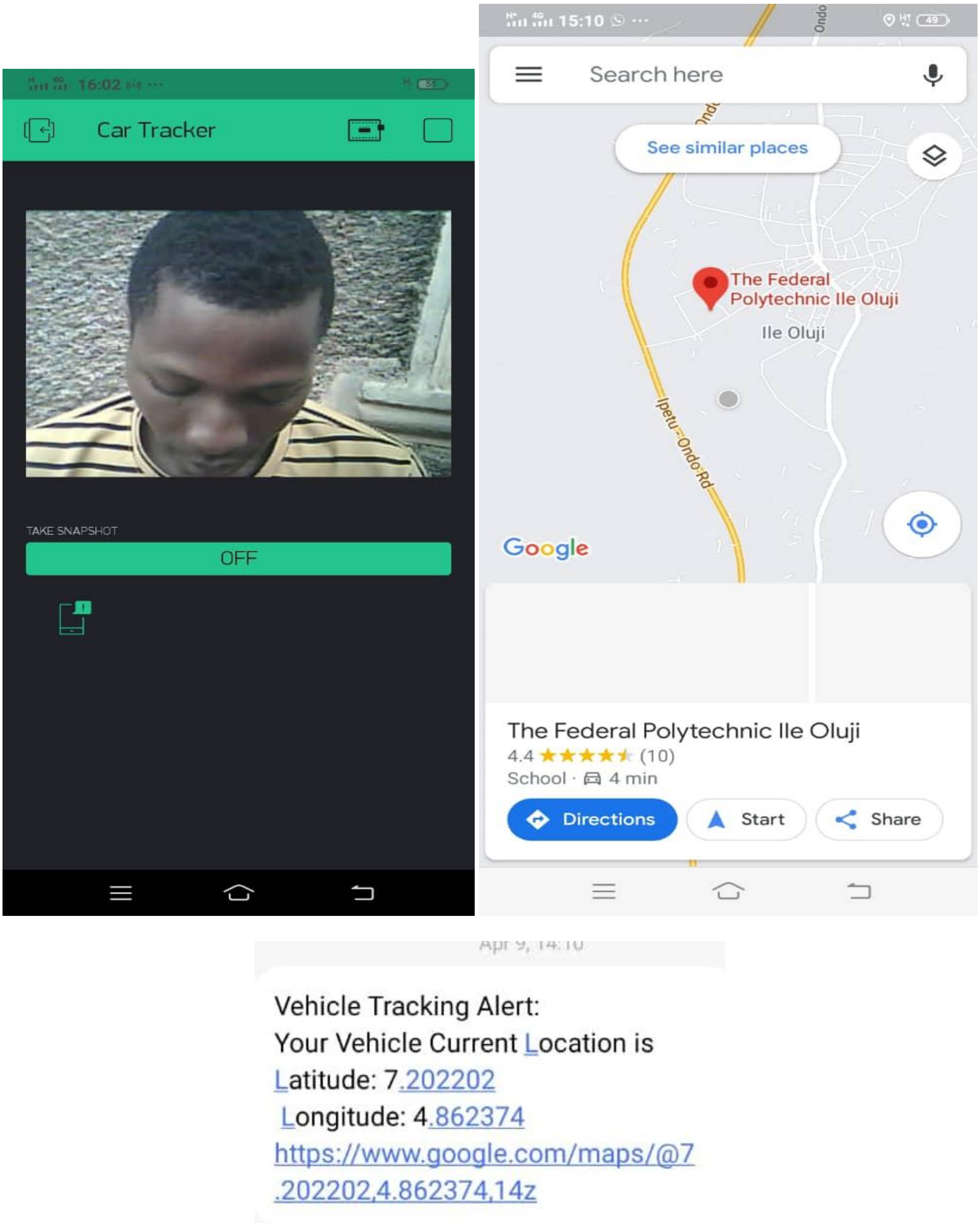

Fig. 10. Testing at the federal polytechnic, Ile-Oluji campus

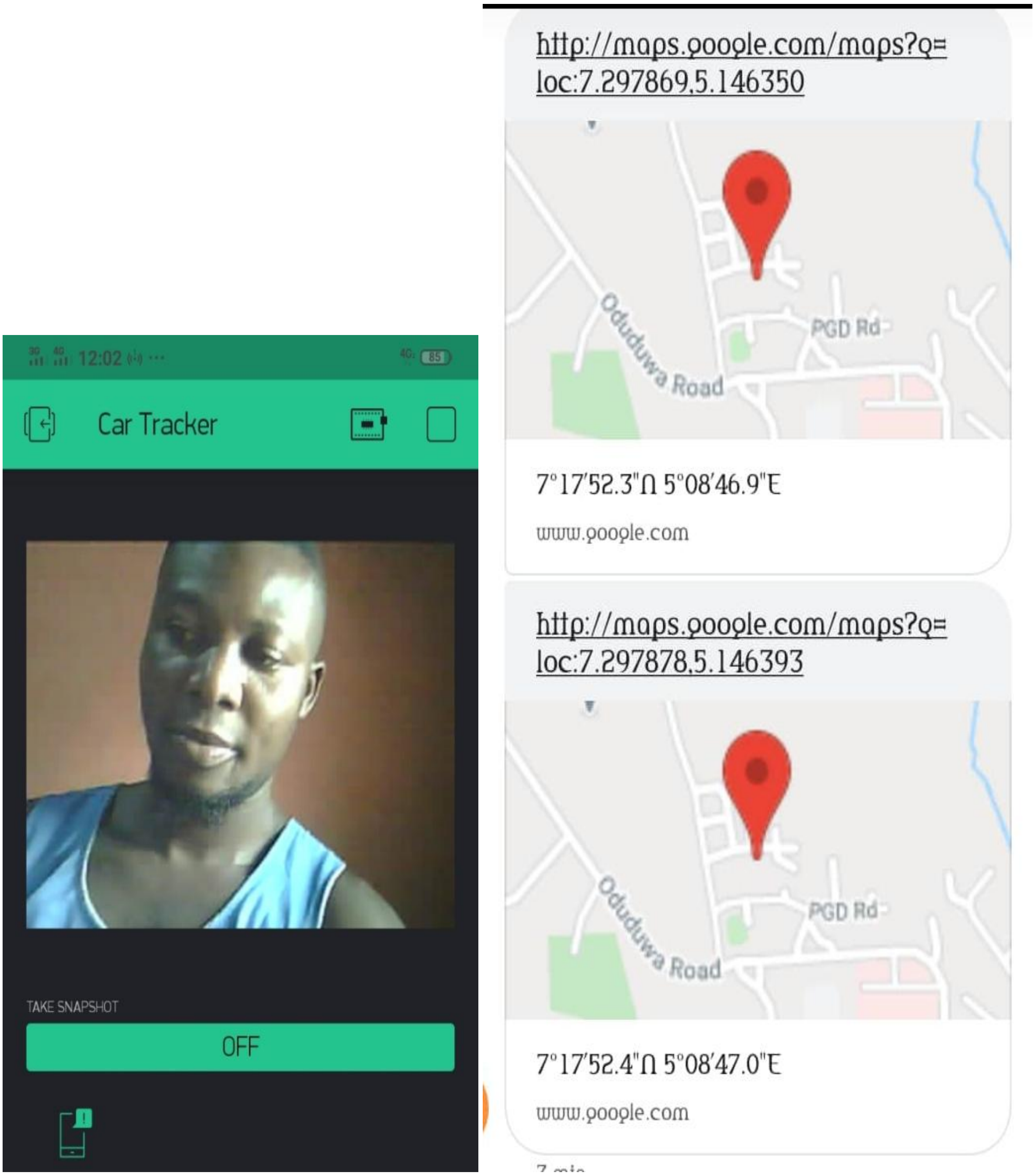

Fig. 11. Testing at the Federal University of Technology, Akure (FUTA) campus, Nigeria

As a result of these findings it was discovered that each vehicle could continuously capture the driver's face while in motion, and then send that image to a phone app called BLYNK, which acts as the system's database. The system administrator may then access these images to see who is driving. Messages are sent to a predetermined number via the GSM module's SIM card and are returned with the vehicle's current location as a response. Google Maps will then show you where you are.

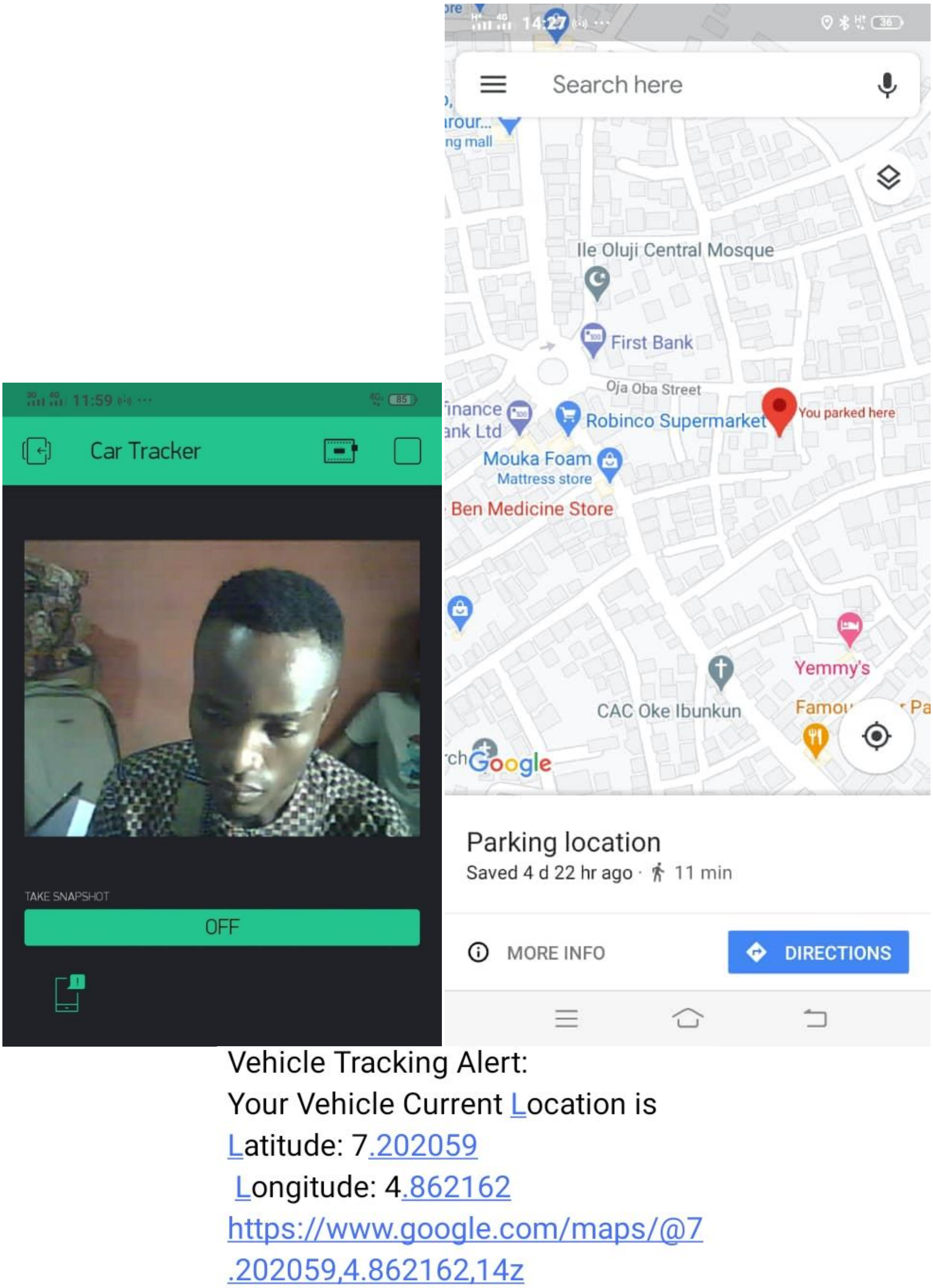

Fig. 12. Testing at Ogbontuntun Street, Ile-Oluji, Ondo State, Nigeria

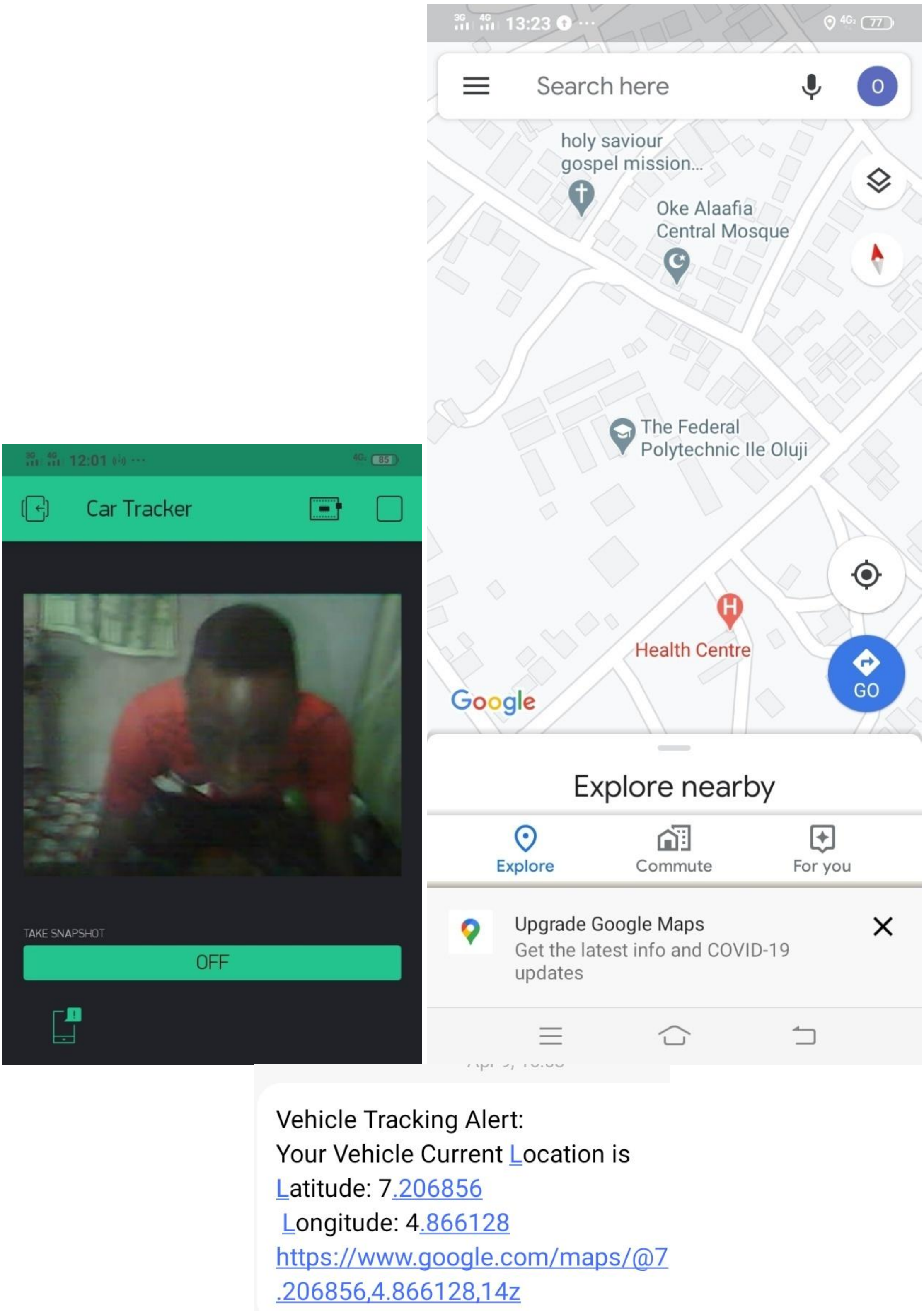

Fig. 13. Testing at primary health center, Ile-Oluji, Ondo State, Nigeria

5. CONCLUSION

This system can be utilized in both personal and business contexts to improve safety and security, communication, and performance tracking. The use of vehicle tracking devices has increased in big cities, and for good reason. Theft of motor vehicles is on the rise right now, unfortunately. On the other hand, this technology can help reduce vehicle theft. Transportation systems, as well as security and tracking in a wide range of companies, can all benefit from this technology. It lowers the risk of a collision, protecting the driver and other road users. In the event of an accident, the system will send out alerts to pre-programmed phone numbers, allowing emergency personnel to get as quickly as possible on scene. This will come in handy if an accident happens at nighttime or in a deserted area. The importance of this vehicle tracking and accident alert feature will only grow in the coming years.

Using a vehicle monitoring system is a cost-effective solution to keep your car safe from theft, and it makes it simple to find out who or where took your car. As a result of the system's focus on security and finding hot spots for criminal activity, cars can't simply be taken from their owners by thieves.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

SOURCE CODE FOR ARDUINO UNO

```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#include<LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
static const int RXPin = 4, TXPin = 3;
static const uint32_t GPSBaud = 9600;
// The TinyGPS++ object
TinyGPSPlusgps;
int temp=0;
// The serial connection to the GPS device
SoftwareSerialss(RXPin, TXPin);
String stringVal = "";
void setup(){
Serial.begin(9600);
ss.begin(GPSBaud);
lcd.begin();
pinMode(13,OUTPUT);
pinMode(9,OUTPUT);
pinMode(7,OUTPUT);
digitalWrite(13,LOW);
digitalWrite(7,HIGH);
lcd.print("Vehicle Tracking");
lcd.setCursor(0,1);
lcd.print("    System      ");
delay(2000);
gsm_init();
lcd.clear();
Serial.println("AT+CNMI=2,2,0,0,0");
lcd.print("GPS Initializing");
lcd.setCursor(0,1);
lcd.print("  No GPS Range  ");
delay(2000);
lcd.clear();
lcd.print("GPS Range Found");
lcd.setCursor(0,1);
lcd.print("GPS is Ready");
delay(2000);
lcd.clear();
lcd.print("System Ready");
  temp=0;
}

void loop()
{
serialEvent();


      while(temp)
      {
        while (ss.available() > 0)
        {
gps.encode(ss.read());
```

```
                if (gps.location.isUpdated())
                {
                 temp=0;
digitalWrite(13,HIGH);
tracking();
                }
          if(!temp)
          break;
        }
      }
digitalWrite(13,LOW);
}
void serialEvent()
{
while(Serial.available()>0)
  {
if(Serial.find("Track"))
    {
      temp=1;
      break;
    }
    else
    {
    temp=0;
    }
  }
}
void gsm_init()
{
lcd.clear();
lcd.print("Finding Module..");
digitalWrite(9,HIGH);
delay(2000);
digitalWrite(9,LOW);
booleanat_flag=1;
  while(at_flag)
  {
Serial.println("AT");
delay(1);
while(Serial.available()>0)
    {
if(Serial.find("OK"))
at_flag=0;
    }

delay(1000);
  }
lcd.clear();
lcd.print("Module Connected..");
delay(1000);
lcd.clear();
lcd.print("Disabling ECHO");
booleanecho_flag=1;
  while(echo_flag)
  {
Serial.println("ATE0");
```

```
while(Serial.available()>0)
   {
if(Serial.find("OK"))
echo_flag=0;
   }
delay(1000);
  }
lcd.clear();
lcd.print("Echo OFF");
delay(1000);
lcd.clear();
lcd.print("Finding Network..");
booleannet_flag=1;
  while(net_flag)
  {
Serial.println("AT+CPIN?");
while(Serial.available()>0)
   {
if(Serial.find("+CPIN: READY"))
net_flag=0;
   }
delay(1000);
  }
lcd.clear();
lcd.print("Network Found..");

delay(1000);
lcd.clear();
}
void init_sms()
{
Serial.println("AT+CMGF=1");
delay(400);
Serial.println("AT+CMGS=\"08067206561\"");   // use your 10 digit cell no. here
delay(400);
}
void send_data(String message)
{
Serial.print(message);
delay(200);
}
void send_sms()
{
Serial.write(26);
}
void lcd_status()
{
lcd.clear();
lcd.print("Message Sent");
delay(2000);
lcd.clear();
lcd.print("System Ready");
  return;
}
void tracking()
{
```

```
init_sms();
send_data("Vehicle Tracking Alert:");
Serial.println(" ");
send_data("Your Vehicle Current Location is:");
Serial.println(" ");
Serial.print("Latitude: ");
Serial.print(gps.location.lat(), 6);
Serial.print("\n Longitude: ");
Serial.println(gps.location.lng(), 6);

  // https://www.google.com/maps/@8.2630696,77.3022699,14z
Serial.print("https://www.google.com/maps/@");
Serial.print(gps.location.lat(), 6);
Serial.print(',');
Serial.print(gps.location.lng(), 6);
Serial.print(",14z");
send_sms();
digitalWrite(7,LOW);
delay(500);
digitalWrite(7,HIGH);
delay(2000);
lcd_status();
}
```


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