VEHICLE
TRACKING SYSTEM

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Abstract

The main aim of this tracking system project is to communicate current location objects (can be a vehicle /person) to the concerned authority or to the concerned contacts of the person who has this device. ESP8266-12F is the central core part of the system. It receives current position and time from GPS receiver and communicates it to the concerned persons using GSM module periodically. ESP8266-12f also stores the current google maps location link to the SD card. It also has the option to bookmark a location so that respective location is saved to the SD card along with time stamp.

A vehicle tracking system is an electronic device, which is embedded as a part of the vehicle to enable the owner or the third party to know the vehicle's position. This device would be the cheapest source of vehicle tracking.

Sub Modules of the system

1. ESP8266-12F:

It is the central core part which communicates with other sub modules (GPS, GSM and SD Card device controller). It drives the green indication LED only when GPS receiver is keep tracking of valid data. ESP also scans the push button connected to GPIO-16 pin. If the button is pressed, the current location is saved to the SD card and location link is send to the trusted contacts. ESP communicates with GPS over serial communication using TX and RX pins, Similarly, it communicates with GSM over serial communication using TX pin which is used for sending messages only. It communicates with SD card device controller over SPI (Serial Peripheral Interface). It reads the configuration/application data from the SD card during the POWER-ON. It writes location (google maps link) to SD card periodically. Operating voltage of the ESP is from 3.0v to 3.6v (typical operating is 3.3v). It has 32-bit Tensilica L106 micro controller inside it.

2. GPS Receiver:

The GPS we are using in this project is XM37-1612. It receives latitude, longitude, time(GMT), speed from Antenna and transmits this information to the ESP periodically. The frequency at which the data has to be send to ESP, Baud rate and the protocol to be used is configured by ESP at POWER-ON by sending AT commands to GPS. The protocol we are using is NMEA GPRM protocol. The Baud rate is 9600(default) and the frequency is 1 sec(default). Operating voltage ranges from 3.0v to 4.3v (typical operating voltage is 3.3 v).

3. GSM Module:

The GSM module we are using in this project is SIM800L. It is used to send messages to the concerned phone numbers. ESP sends AT commands to the GSM module in order to send a message. The google maps location link is send to the configured contacts. Operating voltage ranges from 3.4v to 4.4v (typically 4v).

4. SD Card Device Controller:

It is the interface module between ESP and SD card. The communication between SD Card holder and ESP is SPI interface. SPI interface has 4 vital communication pins. They are
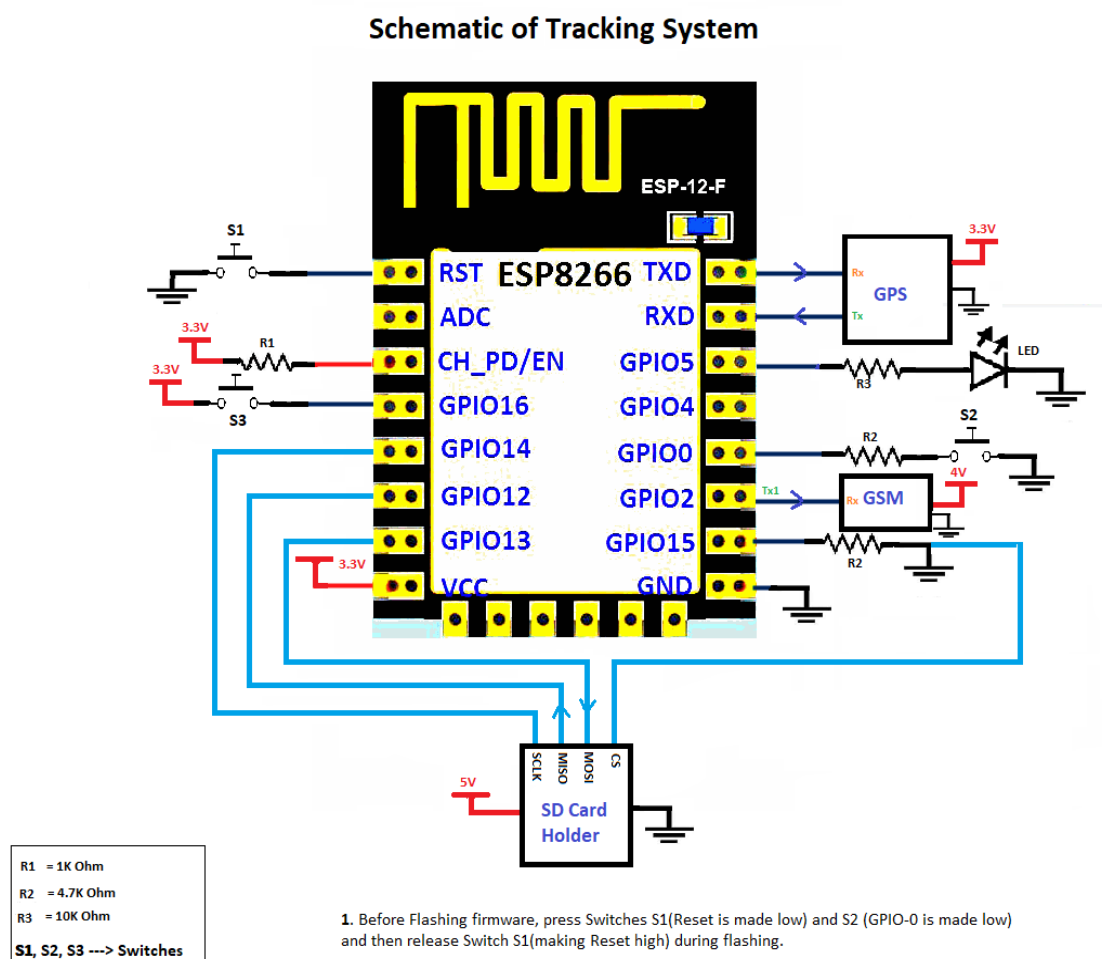
SCLK → Serial Clock

CS → Chip Select

MISO → Master Input Slave Output

MOSI → Master Out Slave Input

Here ESP is the master and SD Card Holder is slave. Operating voltage of SD Card Holder is from 4.5v to 5.5v (typically 5v). Its has both 3.3v and 5v electrical interface for data communication.

Circuit Diagram

Schematic of Tracking System

R1 = 1K Ohm

R2 = 4.7K Ohm

R3 = 10K Ohm

S1, S2, S3 ---> Switches

1. Before Flashing firmware, press Switches S1(Reset is made low) and S2 (GPIO-0 is made low) and then release Switch S1(making Reset high) during flashing.

2. In order to run the firmware release both Switches S1(Reset is made high or floating) and S2 (GPIO-0 is made high or floating).

3. Switch S3 is pressed to bookmark(save) the current location in to SD card

4. LED glows => Indicates valid data(lat, long) is coming from GPS.

Configuration and tracking files in SD card

SD card should contain two files in it. The user has to create these files before using the device. One is configuration text file which contains the configurable details like phone numbers of concerned persons, frequency at which the messages have to be send are stored. These details are entered by the end user. These configurable parameters are read only during POWER-ON by the ESP. The user has to enter at maximum 3 phone numbers, each phone number in each line. The format for phone numbers is "+91xxxxxxxxx". After entering the phone numbers, the user has to enter a number which indicates the frequency in minutes at which messages are send to configured phone numbers.

It has one more file called tracking text file in to which the google maps location link is stored along with time stamp periodically (based on configured period). Bookmarks are stored in to SD card by appending a string called "Bookmark →" in the beginning indicating it as bookmark location.

Implementation Flow

1. Initialisation:

ESP first checks whether SD card is inserted in SD Card holder or not. Then it reads phone numbers and the time period (in minutes) at which the messages have to be send. It sends AT commands to GPS module in order to configure it to use GPRMC protocol.

2. Forever Loop:

ESP receives time(Greenwich), latitude, longitude from GPS for every 1 second. If it receives valid data from GPS receiver, it drives the indication LED and then, it Coverts received GMT time to Indian time by adding 5hrs and 30 minutes. It also coverts the latitude and latitude in order to make it compatible with google maps. ESP sends AT commands periodically to GSM in order to send message (google maps location link) to contacts. It also stores current google map location link to SD card along with time stamp. It scans the input pin GPIO-16. If GPIO-16 is made high by pressing the Push button, then message is send to the contacts and also the current location is saved to SD card tracking.txt file as a bookmark.
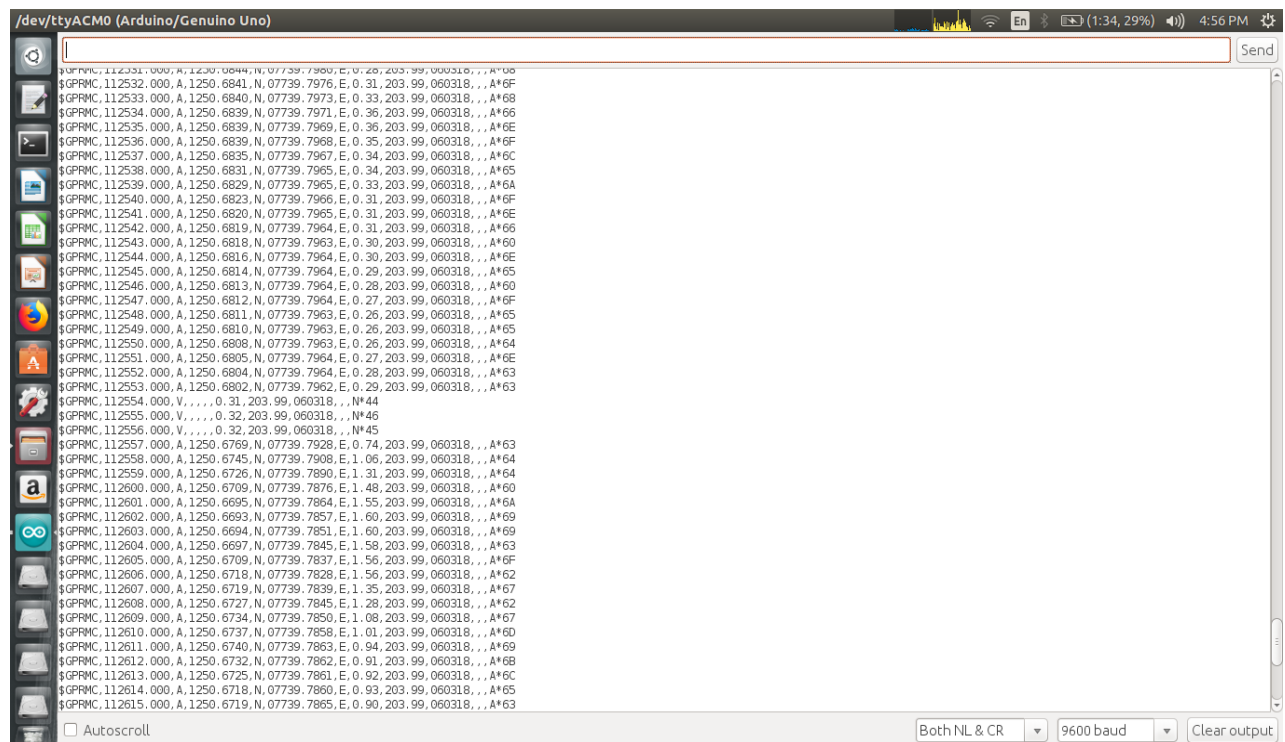

GPS AT Commands

During POWER-ON, the following AT command "**$PMTK314,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>**" is to send GPS receiver in order to use only GPRMC protocol. ESP receives the similar kind of following format from GPS receiver.
"**$GPRMC,060406.000,A,2503.7148,N,12138.7451,E,0.01,0.00,180313,,,D*78**"

If ESP receives 'A', it indicates a valid data, if it receives 'V', its invalid data.

Below is the screenshot indicating valid and invalid data received from GPS receiver.

GSM AT Commands

Depending on the configured period, ESP sends AT commands periodically to GSM in order to send message to configured phone numbers. Following are the AT commands send to GSM module

AT → for auto bauding

AT+CMGF=1 → Text message format

AT+CMGS=\"number\"→ In order to send message to the number specified

Send GPS location now and an end of character (char(26)).

Problems/challenges faced

1. **Frequent resets**: In the beginning, ESP restarted frequently. There are 2 reasons for this watchdog reset. They are

a. Power supply fluctuations

b. Unable to service the watchdog with in its time out.

Power supply fluctuations are due to loose connections and using a common power supply to all the modules without using regulators.

We overcame these challenges by making connections properly (without any loose connections) and used a separate power supply for each module.

We removed unwanted delays and reduced the processing time so that every time watchdog timer is serviced with in its time out.

2. GSM Antenna position

First we connected the antenna in such a way that its solenoidal part is pointed away from the GSM module. Then after several trails we came to the know that the solenoidal part of antenna should be above the GSM module.

3. Compatibility of Latitude and Longitude with Google Maps

By studying tintgps.cc we understand how to encode latitude and longitudes coming from GPS receiver, so that it can be made compatible with google map location link.

4. String Concatenation function (strcat)

Initially we used "stract" function to concatenate google maps website link, latitude and longitude. But this predefined strcat function takes long time (nearly 8 seconds) to process. So, this causes a watchdog reset. In order to avoid this huge delay, we directly send this google maps website link, latitude and longitude without using concatenation.

Limitations:

1. We can't send the messages to as many contacts as possible because of watchdog timer issues.

2. GPS antenna should have clear visibility, so that it can give valid position(latitude and longitude) details.

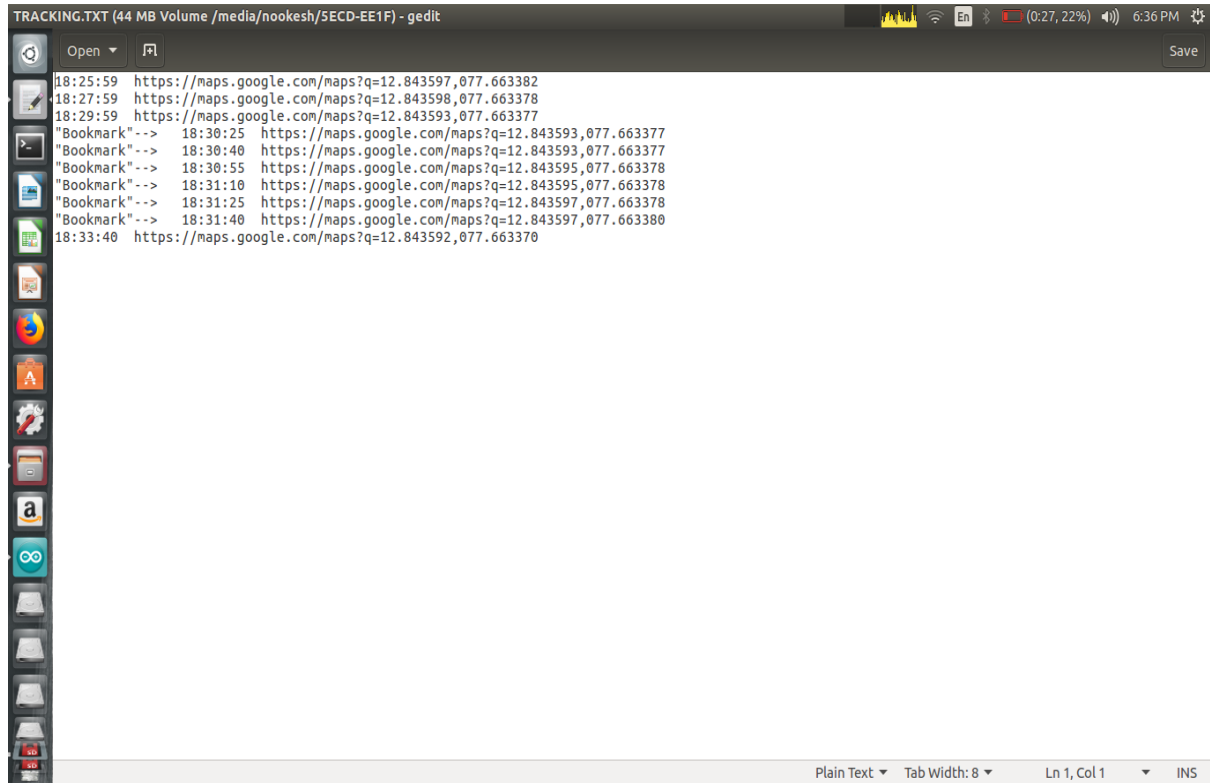## Enhancements that can be added:

1.WIFI:

By enabling the WIFI present in ESP, we can push object data (like latitude, longitude, speed) to the web page along with time stamp, thereby achieving real time live tracking.

2. Speed of the vehicle is also known to us, thereby if we destination we can approximate the travel time to reach the destination.

3. Suitable configuration data to meet the requirements of different applications. We can use the same tracking device for women security in case of eve teasing. It can also be used to find the location of the stolen vehicle. So this can be extended to use for Anti-Theft, security and tracking purpose.

Results:

1. Below is the screenshot of AT commands tapped on serial monitor sent to GSM Module in order to send google map location link to configured phone numbers.

2. Below is the screenshot google map location links written to Tracking.txt file of SD card along with time stamp and bookmarks.