Cloud-Based Vehicle Tracking System

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***Abstract*- The need for a vehicle tracking system in real-time is growing continuously due to the increase of the theft cases. This type of system needs to transmit large data with a huge number of HTTP request to the server to keep tracking and monitoring the vehicle in real- time, this will made the expenditure extremely high every month for transmitting the information of the tracked vehicles to the server, therefor this expensditure needs to be reduced by reducing the data size that transmits to the servers. This paper presented an integrated vehicle tracking system in real- time to track vehicle anywhere at any time. This system is mainly divided into two parts: vehicle tracking part and monitoring part. Tracking part is represented by installation the electronic devices in the vehicle using Arduino UNO R3 and SIM800L GSM/ GPRS modem. the coordinates is changed to add a type of protection to the information before sending it via a General Packet Radio Service (GPRS). The monitoring part is in the cloud and will receive the coordinates and the displays it on a map in a web page. The main contribution of this system is reducing the data size that sent from the embedded system by selecting only the necessary data for the tracked vehicle that sent to the remote server via constrain the transmission of information with the movement of the vehicles, since the coordinates will be sent each 10s, and will not sent when the vehicle is not moving and this will save the cost.**

keywords: **Vehicle tracking, Cloud computing, Microcontroller, GPS, GSM/GPRS.**

I. INTRODUCTION

In some vehicle emergency cases like theft, accident, stealing, and breakdown, an immediate response is needed, and the first action needed is to find the vehicle [1] , [2], [3]. To find a vehicle there are some methods that can be used to localized the vehicle like Global position system (GPS) or the cellular network [4], [5]. However, the GPS technique considered to use alot of energy and consume large aount of power [6], [7]. But as long as the vehicle has a battery that cannot consider being a problem anymore. The GPS and GSM/ GPRS tracking system used the GPS technology to determine precise position of the vehicle, that location of the vehicle can be found when the GPS is attached to the vehicle. Tracking system may find a stolen or lost vehicle by tracking and monitoring it, that could lead to arrest vehicle's thieves [8], [9], [10]. Thieves may sell the vehicle as one part or could sell it as spare parts. Therefore, we need an efficient tracking system with effective cost and fast transmitting [11], [12], [13]. The GPS has to be operated at all the time continuously and that could lead to think of a solution that if the driver may cut the power of the GPS. On the other side of such systems, there should be an admin who can check the driver's geographic location in real-time by displaying the coordinates on a map using a computer or mobile device or any other device as long as it has an internet connection to keep monitoring the vehicle [1], [14]. The server that receives the data sent from the vehicle can be a normal server with only one administrator that monitoring the map or could be in the cloud which means that can share the information in attached database with other admins or users, the cloud provides the maps anywhere and anytime with large storage [15]. Cloud based servers provide reliability, flexibility, scalability, accessibility [16], [17], [18]. The main contribution of this paper is reduceing the number of HTTP request sent from Arduino and reduces the size of the information that GPRS module sent to the remote server. Also, this work has added more protection for the information about vehicle by using faked data, and equipped the system with an auto- connecter circuit to ensure that the GPS is working all the time even after someone cut the main

power and also to auto-charge the battery. The rest of the paper is introduced as follows: the next sections will present a selected related work, after that the proposed work will be explained in section III, section IV will display and discuss the results and finally the conclusion will be in section V.

II. Related Work

In this section a selected related work has been introduced as follows: [1] Proposed control and tracking system via utilizing GPS and GPRS technologies, this proposed system is divided into three parts: tracking part, monitoring part and a control part. This system used GPS/ GPRS SIM808, Arduino UNO R3, and fuel sensor as embedded system attach to the vehicle. It used a remote server and Google maps to display the location of vehicles and used HTML, CSS and SQL for database PHP, JAVA SCRIPT for interface and process. [20] Proposed an integrated, cost effective system that depends on GPS/ GPRS to track the vehicle. The admin can retrieve the record of vehicle anytime and anywhere. In this system, GPS/ GPRS SIM908 module is used along with Arduino UNO. This embedded system is attached to the vehicle and sends coordinates every 10 seconds to the remote server and then display the location on a Google map. They used various languages for the implementation such as HTML, CSS, Ajax, XML and PHP for design, web and interface between the web and that database has been done using MySQL. [21] Design and implementation an Anti-theft vehicle tracking system that based embedded system and design and development the theft control for an automobile to prevent and control the theft vehicle. This system based on GSM and LTE Release 8. The embedded system placed in the target vehicle. The proposed system comprises of raspberry pi Microcontroller as the heart of the system, GSM/ GPRS SIM900A module, GPS NEO 6M module, 5MP raspberry pi 3 Model B Camera Module Rev 1.3, Google map application and relay circuitry. Once the owner of the vehicle detects the vehicle being stolen, the information begins uses for further processing. The owner can call the particular number that represents the interface mobile that pleased with hardware kit on the vehicle. By reading the signal receives from mobile owner, it gives the owner's ability to control the operation of the engine either say to lock it or to stop engine directly. The owner can control after entering a security key that predefined in both the owner and embedded system. Pi- Camera was utilized to capture a photo to the driver and then transmit this photo to the vehicle's owner as MMS. The owner can stop the vehicle by sending SMS and get vehicle location via using GPS module.

III. Proposed Work

The proposed system has two main parts. The first one is the component that attached to the vehicle that consists of arduino uno, NEO 6M GPS Module and GPRS SIM800L Module which will send the coordinate and information to the second part which is the remote server.

A. Attached Device

The electronic component of vehicle tracking system have been done as shown in Fig. 1, since GPS antenna begin sending the information of vehicle's position, that has gotten from multiple satellites (at least four satellites), to the microcontroller to analyse the information, the Arduino will take the coordinates and fake the information to add security to the coordinates to prevent unauthorized persons getting the vehicle coordinates. Also the vehicle ID will be faked to get more security

to vehicle and to prevent the unauthorized person to track a specific driver or vehicle. After that the coordinates and the ID will be transmitted via cellular networks (GSM or UMTS) through GPRS service to the remote server. Mocha host web services have been used to store the information on the cloud to get a good flexibility, scalability and accessibility. The web application and a web site have been exploited the information that stored on the database. The website will retrieve the information form the database and converted it to extensible mark-up language (XML) before the information is displayed on the Google map (on the server side) to provide a real- time tracking. The Google API has been utilized to activate Google maps in web page.The admin can reach, monitor, track and manage multiple vehicles at the same time. The proposed system attached the electrical component of the tracking system in the vehicle to determine the location of the vehicle and transmit the data to the remote server via GSM/GPRS, the output of the server will be displayed on web application. Fig. 2 shows paritcal connection of the electronic components.

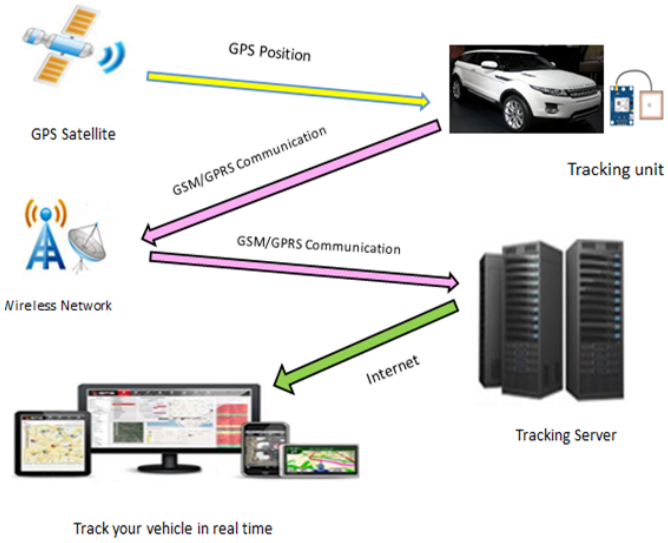

Figure 1: Flow of data

The proposed system has hardware requirement and components as follows :

- GSM/ GPRS SIM 800L

  This module is used in this paper to send the information from the Arduino to the server using the GSM/GPRS. The module is shown in Fig. 3. The features of this module can be seen in Table I [19].
- NEO- 6M GPS Module

  This module is used to get the location of the car using GPS technology, the features of this module can be seen in Table II [6].
- Arduino Programing

  IDE Arduino software has used Arduino C language which is close to C++ language. The transmitter of the proposed

system steps can be summarized as follows:

- The GPS will find the location of the vehicle and send it to the attached Arduino.
- The Arduino will check whether the location of the car is changed, if not it will not send it to the cloud
- The Arduino will fake the user ID (the driver ID) and also fake the location of the vehicle The GSM/GPRS will send the information to the remote server.The flowchart of the system can be seen in Fig. 3.

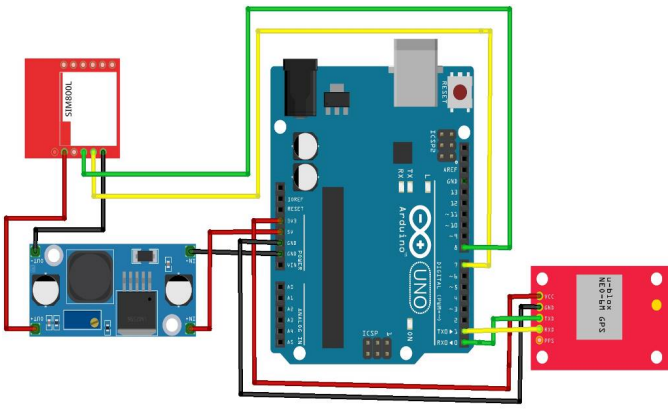

Figure 2: Practical join of electronic component

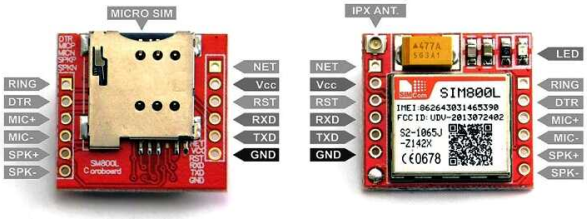

Figure 3: SIM 800L GSM/GPRS module

TABLE I
GSM/ GPRS SIM 800L FEATURES

Features	Implementation
Power supply	3.4v∼ 4.4v
Power saving	0.7 mA
Frequency band	850GSM, EGSM900, DCS1800 and PCS1900
Transmitting power	Class4(2w)at GSM850 and EGSM1900 Class 1(1w) at DCS 1800 and PCS 1900
GPRS connectivity	Multi- slot class 1 ∼12 defaults (12)
Temperature range	$-40^{\circ}C \sim 85^{\circ}C$
Real Time clock	Support RTC
Data GPRS	Downlink Transfer max 85.6kbps Uplink Transfer max85.6kbps A PAP protocol for PPP connect Integrate the TCP/ IP protocol

TABLE II
NEO-6M GPS MODULE

Features	Implementation
Position Accuracy	2.5m
Navigation Sensitivity	-161 dbm
Protocol	NMEA (National Marine Electronic Association)
Voltage	2.7 v $\sim$ 3.6v
Current	45mA
Serial Baud Rate	4800,230400 and default 9600

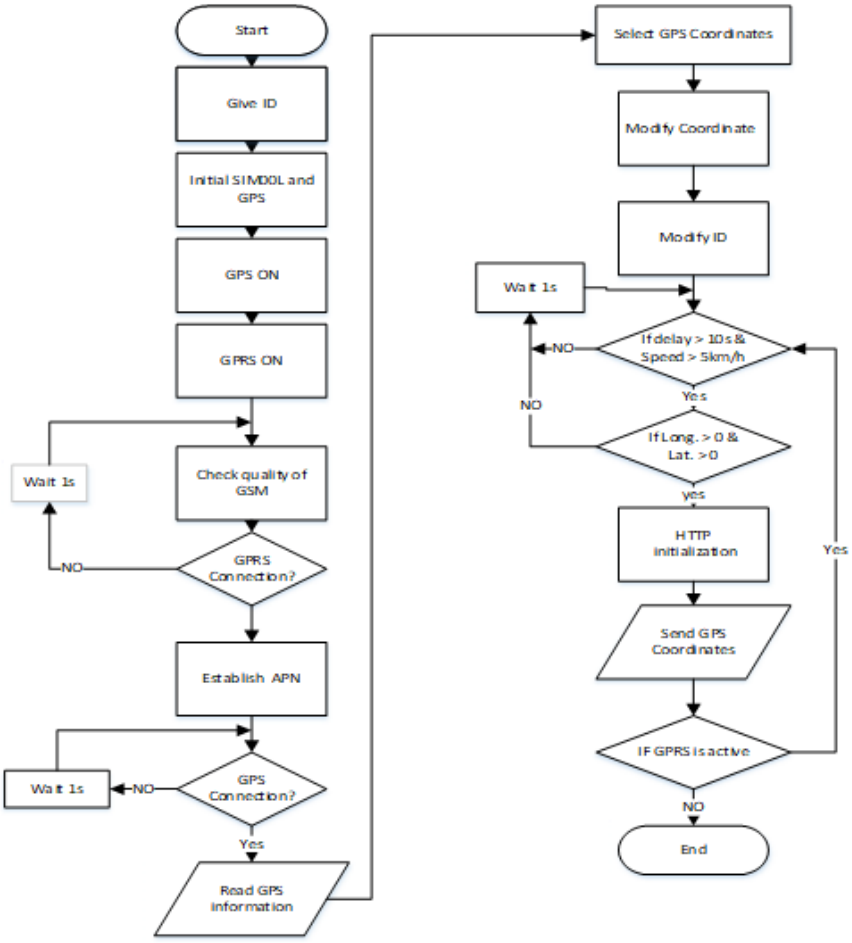

Figure 4: Flow chart of procedure of embedded system

Fig. 4 shows the procedure of the propopsed system that can be done by using AT command and Arduino C language. There some command that used in this language which can be explained as:

- Setup band rate is 9600 bps.
- ("AT+CSQ") that used to check quality of a signal of GSM.
- ("AT+SAPBR=3, 1, "CONTYPE ", "GPRS"") that used to setup an access point Name APN
- ("AT + SAPBR = 3, 1, "APN", "3gprs"") that used as gatway to access to internet.

- ("AT + SAPBR = 1, 1") that used to enable GPS to be utilized.
- ("AT+HTTPINIT") that used to send HTTP request to cloud server.
- speed= gps.speed.kmph(); Serial.print("speed = "); Serial.print(sp, DEC); if (speed > =3){ ("AT+HTTPPARA="URL", "http://iraqgpstrack.com/ name of database depends on your work?"); this code that used to constrain the transmission coordinates to server with speed of vehicle.
- Modify or fake ID is done by using private equation as in Eq. 1

$$C = (M + K_1 * K_2) \tag{1}$$

C = represents fake ID.

M = represents the original ID.

= represent the first float number key.

= represent second float number key.

This euation reflected at the server side

- Modify coorsinates is done via added float number to coordinates and then subtract this number at server side. Added float number with change the position of vehicle from area to another area and insure the integer number of coordinates don't change because the integer number of each city may kown when using Google Map.This modify does not effect on characteristic of real- time trackingand does not causes and delay. This modify prevent any atteacker that listen to GSM network from knowing the exact location of vehicles

B. Server side

The server side works on a cloud and will receive the faked information that sent from the transmitter. After receiving the information the server will modify these information to the orginal information as in Eq. 2 and Eq. 3. Retrieving the original coordinates and ID by using the same keys that the sender uses to fake the information.

$$D = \frac{c}{k_2} - K_1 \tag{2}$$

Where : C =Fake unique ID.

D= original ID.

= float number key.

= float number key.

$$D = C - K_1 \tag{3}$$

Where: D = original coordinate.

C = Fake coordinate is transmitted from the transmitter.

= float number key.

The server side has several subparts as follow:

1) Database

   This paper has used PHPMYADMIN which dependents on SQL. PHP has been also used to establish the connection to receive data from Arduino and analyses the data. The database has received the orginal Latitude and Longitude and orginal ID. The original coordinates and ID will be stored in a table in the database to be used after that.

2) Monitoring The admin can reach all information about the vehicle and track it at anytime and anywhere, and it can retrieve tracking coordinate about any ID wanted just by specifying the ID, enter the start time, and the end time and then search, the coordinates of this ID will appear drawn on the embedded Google map as a line as will be shown later in the results section. The Admin can assign an account to each employer that has a vehicle. Only the Admin can manage each account with a specific agent and it can edit, add and delete the accounts, while the employer can only track and monitor it's vehicle.

3) Google Maps In this system an embedded Google map on the site has been used using JavaScript and then activated it by API key that provided by Google. The Latitude and Longitude will retrieve from the database and then converting it to XML format to be display on Google maps. The coordinates will be displayed subsequently and continuously on Google maps each 10s, it will get the XML information from the database and check if new coordinates are available at this time to display its location on the map, if there is no new coordinates available in database the map will display the last coordinates of the last location of the vehicle that sent via HTTP request. On the Maps, an icon marker will pin the location of the vehicle and this icon displays the ID of the agent, when click on the icon of any vehicle, it will display the information about this vehicle along with the information of the driver who drives the vehicle. The information displayed includes: coordinates, date, time, name of the vehicle, vehicle number, driver's phone number and an image of the vehicle. Fig. 5 demonstrate the flowchart of how the receiver can display the locations on the map.

The proposed project designed and implemented a vehicle tracking system with more scalability, accessibility, cost effective of component, reduce cost of transmitting, add more security to data via fake it and then display the positions on Google maps. This project has reduced the data size and the HTTP request sent from the transmitter. This is done by not sending the coordinates of the GPS when the vehicle has stopped at a place for more than 10s, it has been done depending on the speed of the vehicle; also if the speed is less than 3km/ hour the GPRS module doesn't send the coordinates and consider the vehicle stops in the same place. The embedded system is tested with moving vehicles and found that if the vehicle moves slowly in a traffic the speed fucnction of GPS will read it as more than 3 kmph, therefore 3 kmph is selected to constrain the transmission of the coordinates. The last coordinate will display on Google Maps as its current location vehicle when rhe vehicle stops while the other systems usually send the coordinates, even if the vehicle is stopped in the same place. Our system will be very useful if there is traffic and the car has not moved. Another approach used in this work to reduce the size of data sent from the vehicle by reducing the information and the parameters sent which are provided by the GPS as we only sent longitude, latitude and the ID of the GPS. A security is add to the data sent by fake the ID of agent (vehicle) by multiply the ID by float number and then add another float number this fake changed the ID without add delay to process of GPS since this work constrain with time limit 10s before sending it to the remote server,

in addition to this project is fake the Latitude and Longitude by sending another location to the database by add variable to coordinates to change their location from original location to another location (fake location) to prevent attacker from know the location of any vehicle at worst case when attacker get the coordinates through listen to network this also add type of security to the location of the vehicle since when attacker get the id and coordinates may not reach the correct vehicle information.

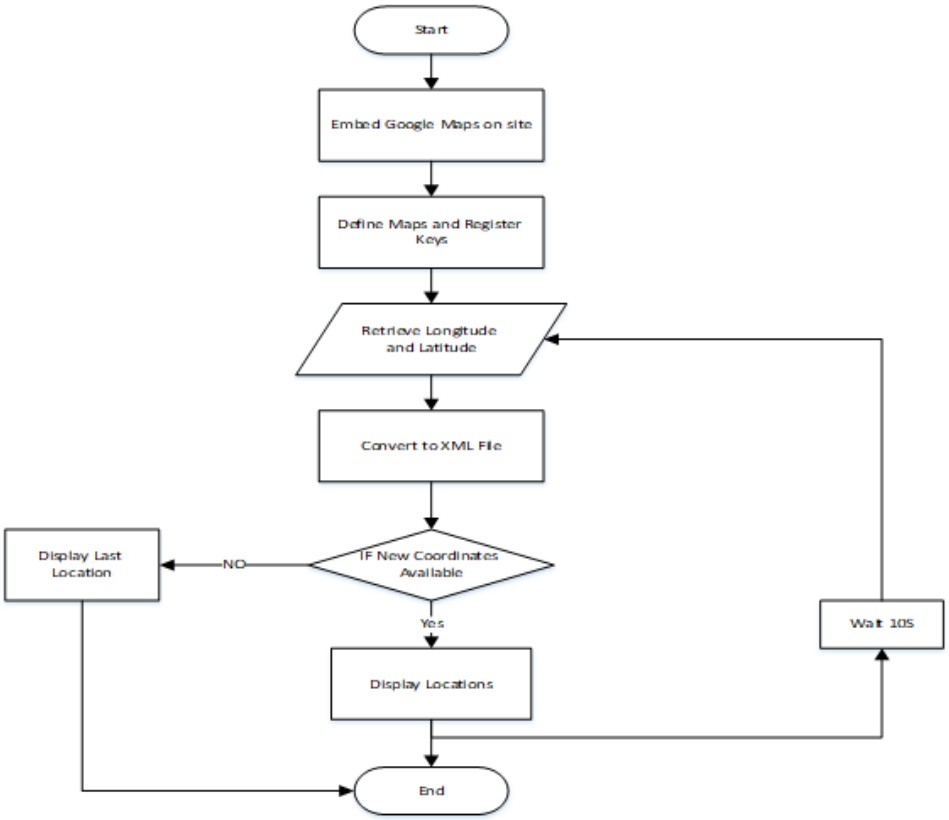

Figure 5: Flow chart for display location

IV. Results and System Evaluation

The result of this work calculated the average of the transmitted HTTP request per minute and it was 3.88 coordinate/ minute when the embedded system sent coordinates each 10s for the normal system, but when applying our rule for the program the average of transmitting HTTP request/minute will change to 1.65 HTTP request/ minutes without effect on the accuracy of tracking as shown in Fig. 6. The rate 1,685 HTTP request /minutes is gotten when the vehicle is moving and stops several times. A car tracked from location to another, the process sent coordinates about 177 coordinates from ID =50 on date 2019 /6/29 at time 3:23 PM to date 2019/6/29 at time 3:51 PM as this happened during the 28 minutes and the result will be mean 3.88 coordinate/minute. After that, the new rule the improvement the result will be reduced and improved as the number of HTTP request sent from GPRS will be 219 coordinates for 2 hours and 10 minutes, the

process started from date 2019/6/30 at 09:51 PM to date 2019/07/1 at time 12:01 AM as show in Fig. 6 and the result of the number of HTTP request will be 1.685 requests /minutes. The data size of vehicle tracking system reduced via transmitted only 20 byte, longitude (8byte), latitude (8byte) and the ID (4byte) of vehicle for remote server and utilized the date and time of server via adjust the time of server on the time of Iraq UTC+3. Fig. 7 shows comparison among the proposed system data size in green colour with other real-time system data size that presented by Ayad in 2016 [1] in blue colour and data size that presented by Ibrahem in 2013 [20] in pink colour through time based on the movement and time of stopped of vehicles since each houre the time stop is increase about 5s and the results is calculating and comparing according to this time. The data size of proposed system decreases with increases the duration of vehicle stops without movement for more than 10s.

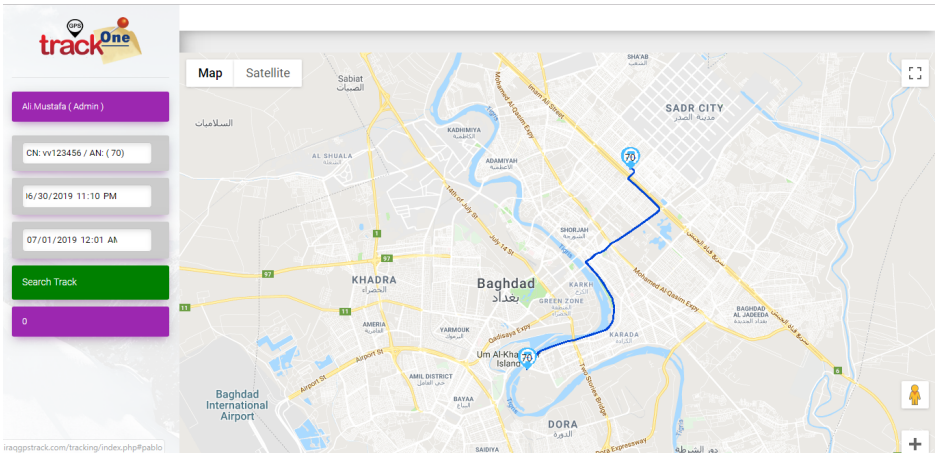

Figure 6: Flow System after improvement

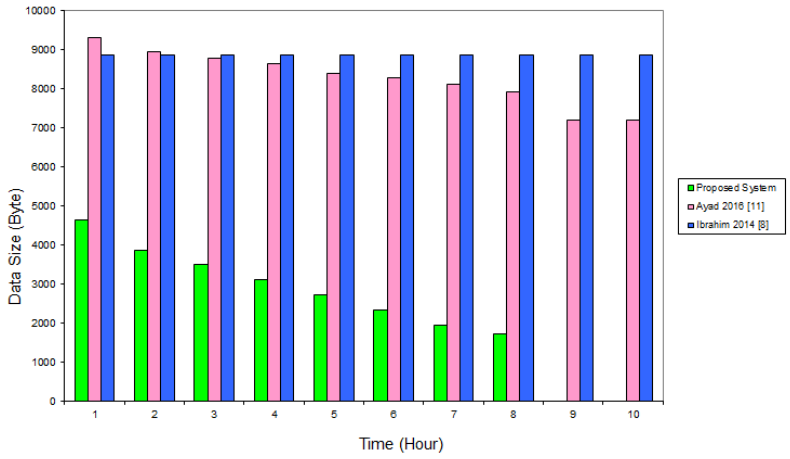

Figure 7: Comparison among data size

V. CONCLUSIONS

In this paper a tracking system has been designed and implemented that has two parts the first part is an Embedded Arduino attached with a GPS/ GPRS that located in a vehicle, this part is responsible to provide real time tracking and monitoring and send it to the server. The data size that sent from this part is too short as the system sends only the important data which are the location of the car and the ID of the driver. Moreover, the system has a new novel method to send the location of the car only if it is moving, that means if the car is in a middle of a traffic and the traffic is not moving, then the system will not send the information, in this case the data sent will be less than any other systems. The second part consists of a cloud server that let the admin to check and track the location of the cars. Another approach that this paper has done is that the data sent from the vehicle to the server is faked, in this case only authorized person can track the vehicles. After comparing the results gotten from proposed system, we found that the proposed system has a better performance compared with that in other systems in term of data size and consuming power especially in heavy traffic roads.

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