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Low-Cost Vehicle Tracking System Based Web Application

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ABSTRACT: Tracking and monitoring systems are a necessity and are widely used in various industries and fields for security and supervision purposes. Particularly in vehicle monitoring perspectives, it is considered a sophisticated technology that is conducted and designed to monitor and manage the location and status of the vehicles in real-time settings. Different methods are employed to ensure monitoring and tracking, also to enhance robustness and security. These methods include onboard devices, GPS, and cellular networks. Therefore, this paper's hardware aspect consists of a very reliable, compacted, reasonable priced tracking device mounted on vehicles or any trackable bodies, this device is connected to the web application databases, the web application has databases for users and their information, irregularities, and maps where each user is marked on the map with the real-time position. The proposed system used an Arduino-based ESP8266 microcontroller and a NEO-6M-Ublox GPS receiver module we can receive the latitude and longitude from satellites then send the information via WIFI to a Database where this data will be processed to not only mark the exact real-time location but also saving these locations in case of any irregularities, do other helpful functions. The experimental results have shown that a low-cost tracking system managed by an easy-to-use Web application. Although the error range for the system is about (8-10) meters, depending on weather and terrain, many companies can make great use of such systems, fleet companies, taxi companies, delivery companies, and vehicle rental companies.

Keywords: Global Positioning System, GPS, Vehicle Tracking System, Google maps, Web applications. ESP8266OD)

1. INTRODUCTION

Navigation systems using Global Positioning System (GPS) are becoming a necessity for security and transportation fields and even personal daily usage. These systems allow us to monitor the positioning of a specifically equipped vehicle or any other mobile body momentarily. These systems use GPS satellites to acquire the real-time exact location with high accuracy [1]. Navigation systems have facilitated transportation operations [2]. During the last years, many startup fleets companies have appeared world-widely, these companies use a large fleet of vehicles to perform transportation tasks. Without supervision these Vehicles can be easily stolen or used for unwanted purposes or against the company rules and violate their policies, so the need for a reliable tracking system has arisen, to avoid these kinds of problems and control their movements [3]. Accordingly, researchers have worked on manufacturing systems to track cars in various ways, all of which are based on the 'trilateration' mathematical principle. Therefore, in this study we receive at least 4 GPS satellites signals and process the received data mathematically to mark the position precisely within only 10 meters error range,

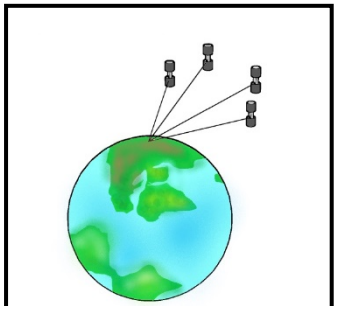

FIGURE 1. -An Example for Four GPS Satellite Signals for Tracking Systems

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then send this location via WIFI to a server where it can be shown to users and admins. We used WIFI technology due to its quick expansion with all industries, WIFI is now used everywhere with everything especially IoT systems, so expectedly WIFI will make a small area for other technologies and systems [4] (See Figure.1).

2. RELATED WORKS

Navigation systems are widely used these days all over the globe, in tracking systems, anti-theft applications, fleet management, traffic control systems, and personal purposes [5]. In the following section, intent to review diverse managing and tracking systems for vehicles with various methods and technologies.

2.1 DESIGN AND IMPLEMENTATION OF VEHICLE TRACKING SYSTEM USING GPS/GSM/GPRS TECHNOLOGY AND SMARTPHONE APPLICATION

The paper proposed an efficient, low-cost tracking system using affordable, inexpensive components compared to other designs. This system is composed of many hardware parts, a small device embedded inside vehicles have a 20 Channel EM-206A SiRFIII GPS receiver module, an ATMEGA328 based Arduino Uno microcontroller, and an SM5100B GSM/GPRS module as a transmitter, then the location data is sent in real-time scale to a database server and then processed and figured on an IOS Smart Phone Application, which uses Google Maps API to view vehicles real-time positions.[6]. Likewise, in [7], A Cross-Platform Vehicle Tracking System is presented based on Android and Web Interfaces. The proposed system includes Google Maps API, Node.js, GPS, and GSM for tracking purposes in real-time. The results have shown enhancement of the vehicle management, transportation efficiency, and security by the conducted tracking system. Further, a mobile app-based Vehicle Tracking System (VTS) application is proposed by [8]. The presented system leveraged IoT, GPS, and GSM for sensing and tracking system purposes, respectively. The testing results show that conducting VTS has several advantages to the vehicle owner, particularly preventing fuel theft in the aforementioned case study. Moreover, especially in Somalia's transportation landscape, a GPS-GSM-IoT-based technology is proposed for a vehicle monitoring system. The proposed system offers an efficient and promising solution for tracking and monitoring vehicles by enabling real-time decision-making for vehicle owners through data acquisition and transmission. Additionally, it enhances the transportation ecosystem, road safety, fleet management, and vehicle security in Somalia, primarily by eliminating theft threats rather than solely focusing on transportation logistics optimization [9].

2.2 UBIQUITOUS GPS VEHICLE TRACKING AND MANAGEMENT SYSTEM:

This system provides useful and practical parental, fleet management Applications to monitor the driving behavior of employees, teens and also to track Vehicles in case of theft events. The main contribution of this system to the tracking field is providing Web-based and a Phone-based Applications that use Google maps to locate vehicles precisely and give dated reports about positions and notifications in case of exceeding the geographical, speed limits. This system acquires Vehicle speed, position in real-time also acquires history reports of movements, stops, and speed. This system uses GPS, GPRS, GSM ("Orion Easytrac" device as a GPS/GSM/GPRS module), and Internet combined (Sony EricsonW580i mobile phone as a receiver GSM / SMS modem connected to the server) [10].

2.3 UITM CAMPUS BUS TRACKING SYSTEM USING ARDUINO BASED AND SMARTPHONE APPLICATION

The authors in this paper designed a Vehicle Tracking System (VTS) to let university students recognize bus's location accurately and predict bus's arrival on a digital map on their smartphones using Google maps. In this system the author used a GPS receiver to obtain the signals that represent the location of that specific bus which has a certain ID, this location is then passed to a UNO Arduino, The Arduino will send the location to a local network by the Wi-Fi shield, this information could be displayed on google maps by the smart phone's app or the web app [11].

2.4 VEHICLE TRACKING SYSTEM FOR SCHOOL BUS BY ARDUINO

School buses tracking system in real-time was designed in this article with acceptable cost. The system includes two parts the first one is the tracking part which is embedded in the vehicle and the other part is the part responsible for viewing the results on google map. This system is based on a GPRS module and controlled by an UNO Arduino, where the GPS is receiving the location signals from satellites that contain the vehicle location "which could be calculated by determining the distance between that vehicle and the satellites ". These signals then will be passed to an Arduino by the (GPS and GPRS shield) the Arduino will calculate the latitude and longitude and send it to the server by the GPRS. The server will drop the location on the map by using Google Maps to show the vehicle's accurate location on it [12].

2.5 GPS-ARDUINO BASED TRACKING AND ALARM SYSTEM FOR PROTECTION OF WILDLIFE ANIMALS

Designed a very efficient system for tracking the movement of animals in forests with warning alarms if a wild animal strayed out of the predefined zone to protect the wildlife with affordable cost. The system used a combination of Wireless Sensor Network (WSN) and (GPS) along with a WIFI shield and the accelerometer for automatically tracking the location and the movement of these wildlife animals [13].

2.6 DESIGN AND IMPLEMENTATION OF A LOW-COST SECURE VEHICLE TRACKING SYSTEM

In this work, a secure, low-cost VTS was designed for tracking the vehicle's location and movement despite the existence of noise and obstacles using XBee wireless technology for gaining a high-security level with a low cost along with the GPS and display the results on Google Earth where the GPS delivers the location's data in real-time and delivers it to the XBee through the Arduino platform, the received location data displayed on Google earth by the monitoring station [14].

2.7 OFFLINE PUBLIC TRANSPORTATION MANAGEMENT SYSTEM BASED ON GPS/WIFI AND OPEN STREET MAPS

This paper is designed with three main phases, the first phase data collection, in this phase the GPS shield collects the data from the available satellites, this data will be stored in persistent memory (EPROM) in the smart on-board unit (SBU), the second phase is a transmission part, were the storage data should be transmitted from the memory to the back-end server by using a WIFI shield, the last phase is the data analysis where the geographical location at a specific time will be injected on a digitalized map and in the system that they used open street maps (OSM), each route has a speed limit and the information will be compared with the limited speed thus the system will decide whether the vehicle violated the traffic regulations or not at a given trip[15].

After reviewed the existing method that designated for cost effective VTSs in the literature, the proposed system tries to implement an easy-use, compacted, simplified, and low-cost tracking system with high accuracy, using Arduino-based ESP8266 microcontroller and a NEO-6M-Ublox GPS receiver module we can receive the latitude and longitude from satellites then send the information via WIFI to a Database where this data will be processed to not only mark the exact real-time location but also saving these locations in case of any irregularities, do other helpful functions. These results can be easily shown on an easy-use web application where the supervisors can observe the route of their fleets easily and accurately. The proposed system is meant to work in almost all-weather conditions and all terrains and with a relatively low-cost price tag. This design aims to help companies and individuals monitor their properties, fleets, or any mobile bodies on maps easily with high efficiency and low cost.

3. METHODOLOGY AND MATERIALS

Navigation and tracking systems technologies mainly depend on satellite signals, where there's a mounted GPS receiver that calculates the distance between the device and a set of available satellites so longitudes and latitudes could be determined

This study demonstrates the implementation of a practical GPS Tracking System, we used a GYGPS6MU2 GPS receiver module by UBLOX, this module is unique and special for its (compacted size (25x25mm), high sensitivity (-160 dBm), high frequency (5 Hz), Anti-jamming feature (device receives the signal in different terrains "crowded cities" and different weather conditions), also its efficient working temperature range (-40 to 80 Celsius)), this module is attached to a microcontroller so the information would be processed and organized. We used an ESP8266OD Arduino-based Microcontroller to receive the information (location) from the module and send it via WIFI to the server. (See Figure.2).

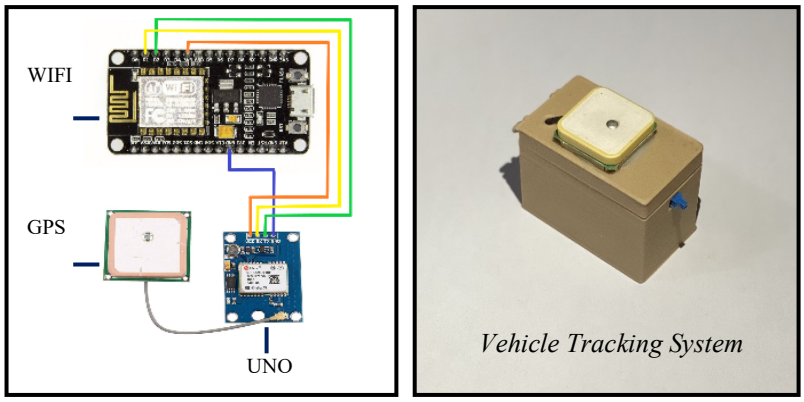


FIGURE 2. -The Proposed Vehicle Tracking System

The data was transferred from the microcontroller to the server using JSON files which are preferred when dealing with data-transferring, in JSONs data get stacked as a dictionary with keys and values, the JSON file in this project included the following keys;(longitude, latitude, date, time) (See Figure.3).

{"lat":31.994005,"lng":44.340031,"time":11 : 33 PM ,"date":11 / 07 / 2021}

FIGURE 3. - Data Transferring Representation in JSON File

The server itself was designed using the DJANGO platform which allows users to create databases and web programs using PYTHON programming language (We used DJANGO to create databases in SQLITE3(Locations, Profiles, Reports) for this study). The databases we created were connected so the backend of applied server would be accomplished.

The WEB interface (frontend) was designed using CSS, HTML, JAVA Scripts together to get a decent easy-use web program GUI where all the information will be shown (maps, devices current locations, and other pages about administration, client's information, registration, reports about clients and irregularities with details). (See Figure.4).

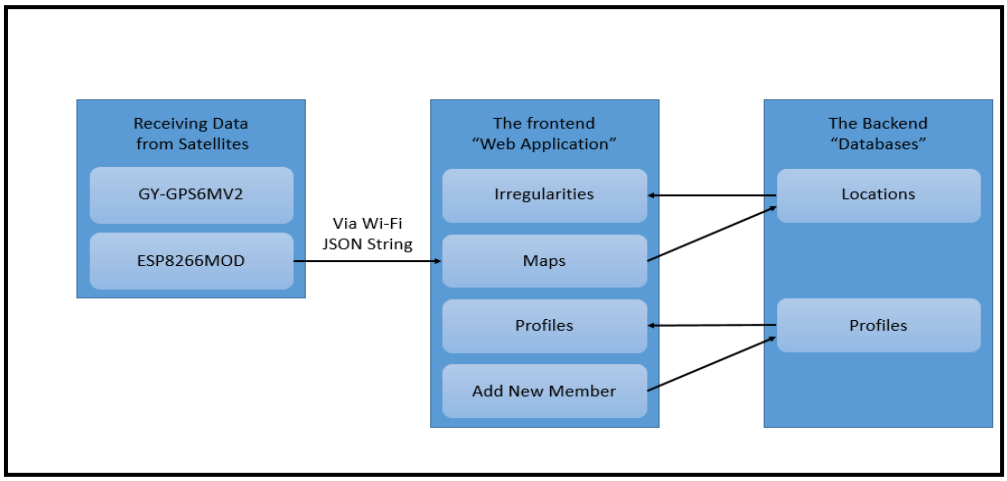


FIGURE 4. - Flowchart of The Proposed VTS Process

The authorization and authentication of the WEB application were dealt with carefully so that other than the HOME page no one can reach any URL inside of the WEB application without logging in, even after logging in, you must have admin's authority to add members, watch all members on the map and view their profiles. (See Figures 5,6,7,8).

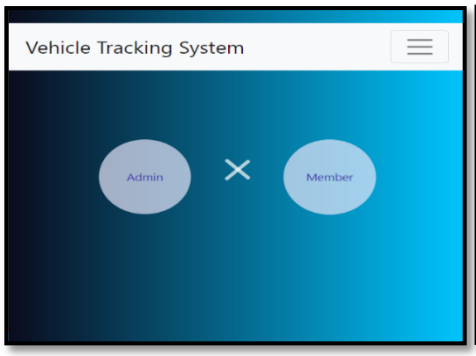


FIGURE 5. - Home Page for The Proposed VTS

FIGURE 6. - The Proposed VTS's Login Page

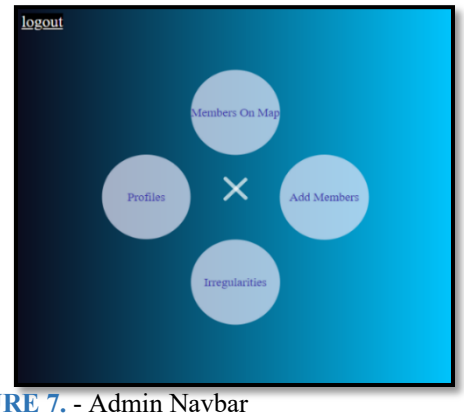


FIGURE 7. - Admin Navbar

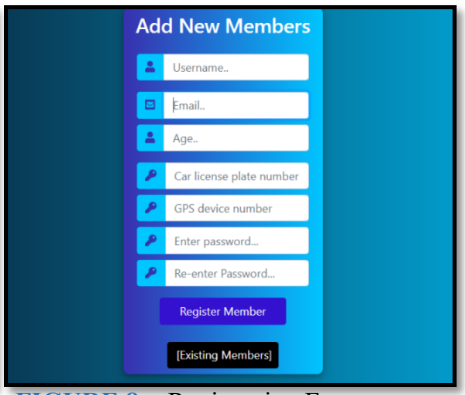
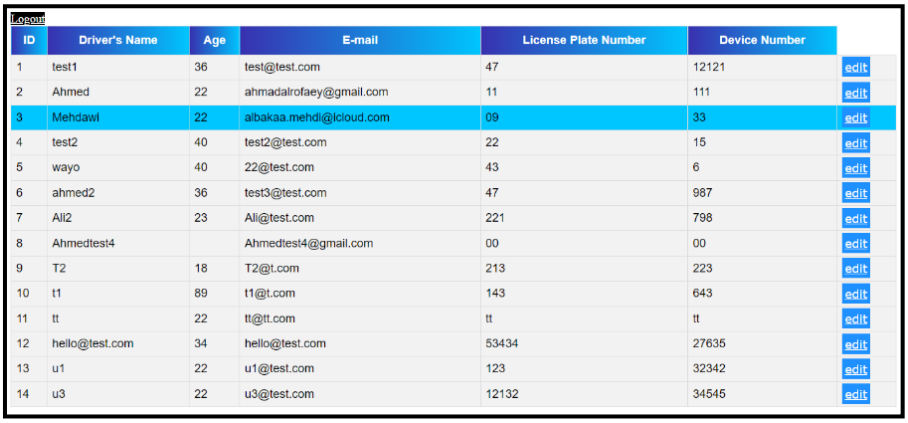


FIGURE 8. - Registration Form

4. RESULTS AND DISCUSSION

After implying all the previous methods, the system was designed and assembled, thus it satisfied the goals of this article, we received data from the GPS sensor then all results were shown on their pages in the WEB application in real-time, latitude and longitude received from the microcontroller unit were used on Maps Page to show the exact location in real-time with 5 seconds update rate so that administrators can supervise their crew locations on the map accurately, momentarily, and just 5 meters error range in average this range can vary from 5-10 meters depending on the crowdedness and terrains and weather conditions also the temperature of the unit. In the case of any irregularity, like exceeding the speed limits or driving out of the defined borders or any other term, rule assigned by the administrators, the time, date, longitude, and latitude at where this irregularity occurred, will be saved in a database and an alert will be issued to the driver's profile page. Administrators can add drivers to their crew on the registration page where admins insert the new user's information (Username, E-mail, Password, Age, Plate's number, Device number). Certain pages are exclusive for admins so they are unreachable to users ;(maps, registration, profiles). Admins can observe the movement of each driver and know how many irregularities a user has, admins also can add new members to their crew, where users can only see their mark on the map and the irregularities they had committed. (See Figures 9,10,11).

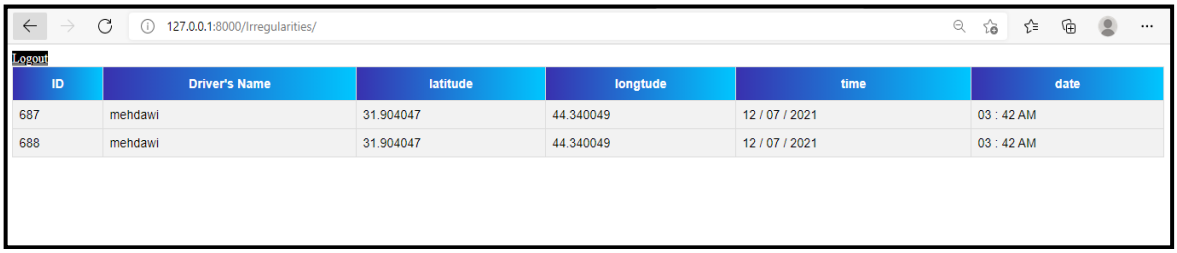


logout

ID	Driver's Name	Age	E-mail	License Plate Number	Device Number	
1	test1	36	test@test.com	47	12121	edit
2	Ahmed	22	ahmadalrofaey@gmail.com	11	111	edit
3	Mehdawi	22	albakaa.mehdi@icloud.com	09	33	edit
4	test2	40	test2@test.com	22	15	edit
5	wayo	40	22@test.com	43	6	edit
6	ahmed2	36	test3@test.com	47	987	edit
7	Ali2	23	Ali@test.com	221	798	edit
8	Ahmedtest4		Ahmedtest4@gmail.com	00	00	edit
9	T2	18	T2@t.com	213	223	edit
10	t1	89	t1@t.com	143	643	edit
11	tt	22	tt@tt.com	tt	tt	edit
12	hello@test.com	34	hello@test.com	53434	27635	edit
13	u1	22	u1@test.com	123	32342	edit
14	u3	22	u3@test.com	12132	34545	edit

FIGURE 9. - VTS's Profile Page

FIGURE 10. - The Proposed VTS's Maps Page



ID	Driver's Name	latitude	longtude	time	date
687	mehdawi	31.904047	44.340049	12 / 07 / 2021	03 : 42 AM
688	mehdawi	31.904047	44.340049	12 / 07 / 2021	03 : 42 AM

FIGURE 11. - Irregularities Cases in the VTS

Despite the efficient accuracy of the GPS module (8-10) meters, it takes about 5 seconds for the module to connect to the internet and about (2-3) minutes to deliver the first values. (See Figure.12,13).

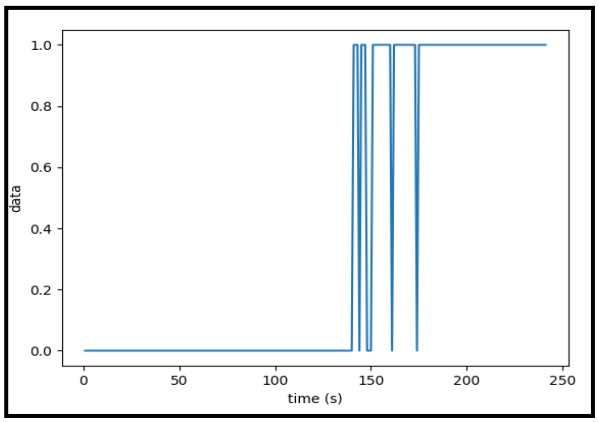


FIGURE 12. - The Time Required for Date Send

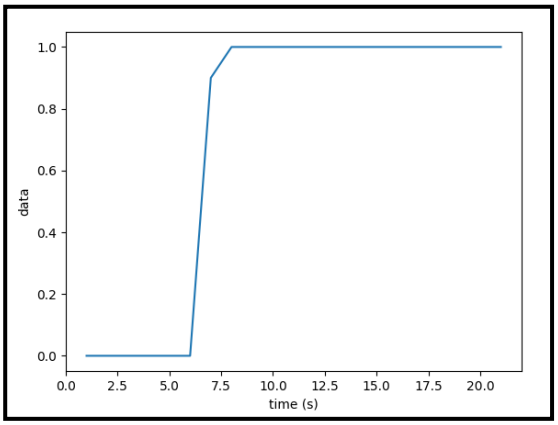


FIGURE 13. – The Time Required for Network Connection

As a comparison between this system and the systems we mentioned before in the related works, this system has satisfied the main purpose so well [10].

5. CONCLUSIONS

To ensure accurate tracking and enhance security in the VTS, designing a cost-effective system for tracking and monitoring in a real-time environment is a crucial role in the transportation and tracking sectors. Therefore, an Affordable, low-cost, and accurate vehicle tracking system is proposed in real-time settings. The introduced VTS include three modules that include receiver, transmitter, and microcontroller modules to implement an easy-to-use, compact, simplified, and cost-effective tracking system with high accuracy. This system was developed to match the requirements of a simple tracking system with low-end cost using WIFI technology and Django Web app, this system can effectively decrease the theft cases and prevent drivers from using the vehicle out of the company rules or out of working times. Thus, the presented tracking system will cost much less than similar existing systems with empowering security and satisfy services for small businesses, although it can be developed and upgraded in time to do much more advanced services such as controlling the vehicle and others.

CONFLICTS OF INTEREST

The Author Declares No Conflict of Interest.

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