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Collaborative Implementation of Geo-Tracking Device and Smartphoneapp

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ABSTRACT: This paper presents a vernacular approach towards geo-tracking through the amalgamated usage of the hardware and a Smartphone Application (software). The rudimentary usage of Global System for Mobile Communication(GSM), Global Positioning System (GPS) and a Micro-controller incorporated with a Smartphone App, provides a lucid solutions to diverse and convoluted issues. The system integrates multiple technologies forming a miniature and portable system for personalized tracking of a vehicular entity. The device can be embedded into any mobile entity for the real time tracking. The GPS and GSM module are managed by a micro-controller which keeps track of the data sent and received. The GPS obtains the geographic coordinates at periodic intervals via range of satellites and the GSM module transmits the received data to the server which in-turn transmits it to the Smartphone App that had initially generated a request for tracking. The Smartphone App monitors the location of the entity, projecting the traversed path on Google Maps API, making it easier for the end user to trace. Thus the user can consistently monitor the movement, analyze distance travelled and time taken in the rove. To bolster the viability and efficacy of this project, the paper includes experimental data and practical implications.

KEYWORDS: GPS/GSM Technology; Arduino; Smartphone App; Google Maps APIs.

I. INTRODUCTION

In the urban and supersonic life of today, the world faces plethora of mishaps like accidents, burglaries, rapes, etc, in order to over come such tedious circumstances we need to keep a track of the sensitive entity. These problems can easily be resolved with the usage of the proposed device in this paper, with optimal usage of GPS and GSM technologies collaborated with the widely used Smartphones.

Over the years it has been observed that there has been an extensive growth in the usability of Smartphones, becoming the necessity in mundane routine today. [1]This is due to their affordability and accessibility. The eMarketer[1] states that in 2014 itself there were more than 1.63 billion Smartphone users in the whole world and this number is increasing at a geometric rate as shown in the figure below. With the accelerated increase in familiarity with the Smartphones, people tend to have a keen inclination towards exploring it arrantly because its handiness.

This is a two phased mechanism of implementation. In the first phase a device is developed which determines the real time location of an entity to be tracked while in the second, the Smartphone App coordinates with the device and displays the location of the entity to the end user.

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Top 25 Countries, Ranked by Smartphone Users, 2013-2018
millions

	2013	2014	2015	2016	2017	2018
1. China*	436.1	519.7	574.2	624.7	672.1	704.1
2. US**	143.9	165.3	184.2	198.5	211.5	220.0
3. India	76.0	123.3	167.9	204.1	243.8	279.2
4. Japan	40.5	50.8	57.4	61.2	63.9	65.5
5. Russia	35.8	49.0	58.2	65.1	71.9	76.4
6. Brazil	27.1	38.8	48.6	58.5	66.6	71.9
7. Indonesia	27.4	38.3	52.2	69.4	86.6	103.0
8. Germany	29.6	36.4	44.5	50.8	56.1	59.2
9. UK**	33.2	36.4	39.4	42.4	44.9	46.4
10. South Korea	29.3	32.8	33.9	34.5	35.1	35.6
11. Mexico	22.9	28.7	34.2	39.4	44.7	49.9
12. France	21.0	26.7	32.9	37.8	41.5	43.7
13. Italy	19.5	24.1	28.6	32.2	33.7	37.0
14. Turkey	15.3	22.6	27.8	32.4	37.2	40.7
15. Spain	18.9	22.0	25.0	26.9	28.4	29.5
16. Philippines	14.8	20.0	24.8	29.7	34.8	39.4
17. Nigeria	15.9	19.5	23.1	26.8	30.5	34.0
18. Canada	15.2	17.8	20.0	21.7	23.0	23.9
19. Thailand	14.4	17.5	20.4	22.8	25.0	26.8
20. Vietnam	12.4	16.6	20.7	24.6	28.6	32.0
21. Egypt	12.6	15.5	18.2	21.0	23.6	25.8
22. Colombia	11.7	14.4	16.3	18.2	19.7	20.9
23. Australia	11.4	13.2	13.8	14.3	14.7	15.1
24. Poland	9.4	12.7	15.4	17.4	19.4	20.8
25. Argentina	8.8	10.8	12.6	14.1	15.6	17.0
Worldwide* **	**1,311.2**	**1,639.0**	**1,914.6**	**2,155.0**	**2,380.2**	**2,561.8**

*Note: individuals of any age who own at least one smartphone and use the smartphone(s) at least once per month; *excludes Hong Kong; **forecast from Aug 2014; ***includes countries not listed*
Source: eMarketer, Dec 2014

182905 www.eMarketer.com

A Geo-tracker is a pre-requisite these days. It can be used to track pet animals, vehicles (cars, ships or airplanes), etc. In this project the wireless transmission of data via GPS and GSM technology has made it a vernacular product. GPS is used to determine the real time location of the entity and GSM modem sends the information via SMS. The whole hardware system is monitored by a Micro-controller which is responsible for the intercommunication between the device and the Smartphone App. The SMS send by GSM modem is received by the Smartphone App, tracking and tracing by automatically updating the Google Map, making it easier to trace the entity by providing its accurate geo-location.

The paper also presents a clear depiction of the pace and the distance travelled by the entity.[2] The device is handy and can be easily installed, all it requires is to be embedded into the respective entity and it can easily be tracked down, anytime and anywhere, in all kinds of weather conditions.

II. LITERATURE SURVEY

Due to the reduced size of GPS and its ease of embedding, has made the GPS one of the most popular technologies, attracting research scholars for a decade now. Leading to a recent amelioration in the usage of Tracking Systems, worldwide.

In a research conducted by Yoichi on “GPS Moving Performance on Open Sky and Forested Paths” [3], the systematic analysis of the movement of GPS in open sky and near the environment shaded by trees was reported in it [3]. The basic objective of this project is the determination of a delimited system providing facile and undulated steps towards GPS sensing. By the usage of sensors and testing its performance through the environment of tree foliage.

In [4], there is a determination of a vehicle tracking system, implanted into a vehicle to ensure its tracking by the owner or any third party observer. A design for the collaborative working of GPS and GSM is proposed through the usage mobile communication via SMS, providing a continuous watch on the vehicle.

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In [6], GPSylon shows maps that have been downloaded from expedia map servers. Connected to a GPS locator, it tracks the entity's position on various maps. It reads data in National Marine Electronics Association (NMEA) format sent by the GPS network. The major operation is exhibition of maps, allowing the user to navigate like a digital atlas. The maps can be viewed in different scales using an open map library for cartography.
In [7], OpenGTS(GPS Tracking System) is an open sourced system developed to provide a web based tracking via GPS for a fleet of vehicles. It has been used in over 110 countries for tracking thousands of vehicles which include trucks, ships, containers, people, taxis, delivery vans, farm animals, etc.
Vehicle tracking systems based on social network services such as Twitter and Facebook has attracted in a number of users[5]. In this every registered vehicle has its own account on twitter and its location can be identified by the social networking site. A web interface displays it location and the status of the car such as whether a door is open or is the ignition on/off, allowing the user to operate the car from a distant source through a Smartphone App.

III. SCOPE OF STUDY

This project has been widely divided into two divisions: Device (hardware) and the Smartphone App(Software). The device basically consists of Micro-controller, GPS Module and GSM Module. The GPS Module obtains the locations from the range of satellites. The satellites are equipped with atomic clocks that are synchronized with the network of satellites. The GPS transmits a pseudo random code, time transmission and satellite location by the computation of which in three equations, we obtain the coordinates of the entity.

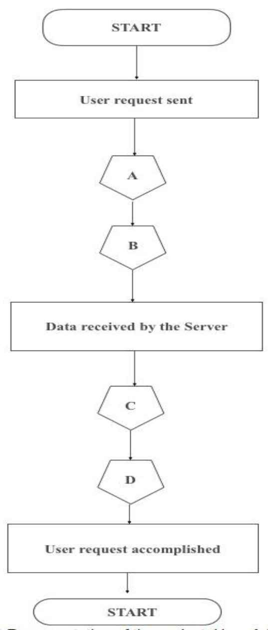

Figure 2: Flowchart Representation of the project. Here A & B are a part of the Hardware Flowchart while C & D are part of Software Flowchart

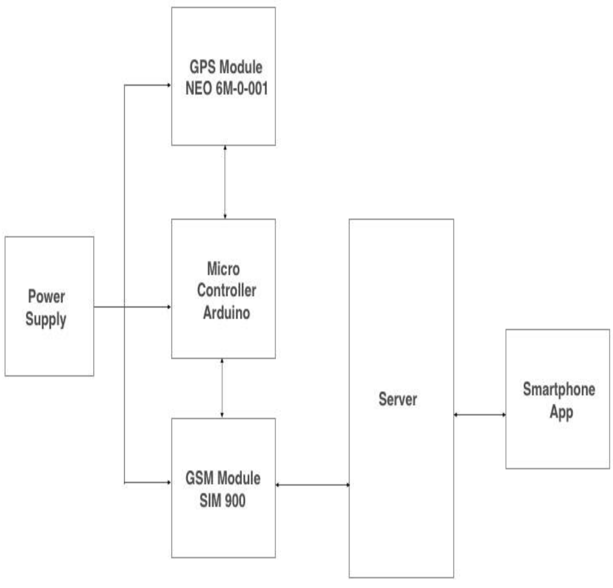

Figure 3: Block Diagram of the Project

After receiving the coordinates they are transmitted to the micro-controller. Having being connected to both the units, the micro-controller (Arduino) acts as an inter-mediator between the GPS and GSM module, synchronizing the working of both the units. The micro-controller transmits the location coordinates in NMEA format to the GSM module.
The GSM module receives the data and then transmits it to the server through a specific protocol (TCP/IP). The raw data received by the server is in the hex code which needs to be turned into ASCII for its transmission to the

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Smartphone App. The converted data is then sent to the Smartphone via an SMS. After receiving coordinates through the server, the App puts them to use thus performing the requested function by the user. It helps in determining the functions such as distance travelled by the entity, the current location of the entity, analysis of previous records of walking and clearing history.

The data has been stored in database using SQLite in the App. This device can be used as a soldier tracking system, as a personalized system for being in touch or as a vehicle tracking system, for tracking cars, trucks, vans, scooters, etc.

IV. METHODOLOGY

In the process of development of this project a micro controller, hardware components and software app have been brought to use. Generally a 9V power supply is connected to all three components: the GPS Module, the GSM Module and the Micro-Controller.

A.Adruino Uno

It is a broad consisting of micro controller ATmega 328. It is powered via a USB Connection through an external or internal source. Arduino is basically used for the connectivity between the GPS and GSM/GPRS. It consists of a flash memory which stores the programming done into the system. Arduino has its own IDE where the board can be controlled with a simple C/C# program.

B. GPS Module

GPS stands for Global Positioning System. GPS was built in the year 1973, with the help the studies of done in 1960's, to overcome the constraints of the then existing navigation system. It was built by the U.S.Department of Defense (USDOD), using 24 satellites initially. The practical and fully functional model of the project was by 1994.
GPS is used to discern the Latitude and Longitude of any entity it is attached to on Earth, providing the exact Universal Time Coordinated time. GPS module is the most eminent component of the Geo-tracking system. It receives the coordinates of the entity every second from the satellite, along with time and date. The GPS percepts data in NMEA format (National Marine Electronics Association). Here the GPS module acts as a receiver and transmitter; it receives the signals through an antenna and transmits data to Arduino.The GPS module used in this project is identical to the on shown in the Figure 4. Ref.[8]. In Figure 4, (1) is a GPS receiver. It is used to receive the real time location details of the subject. The position can also be computed by a 3D view with the help of just 4 satellites .The Space Segment of the GPS basically consists of 24 operational orbits along with 3 extraneous ones, moving around the Earth every 12 hours, sending the signals to the receiver on Earth.[9] The receiver module requires at-least 20 channel EM-406A-SiRF-III receiver. In Figure4, (2) is the UART & DLINE section switch. In case of the selection switch there are two basic scenarios:

a. if DLINE is chosen then the Tx and Rx of the GPS module is connected to the 2 and 3 pin respectively of the Arduino board.
b. if UART is selected then the Tx and Rx of the GPS will be connected to 0 and 1 pin respectively.

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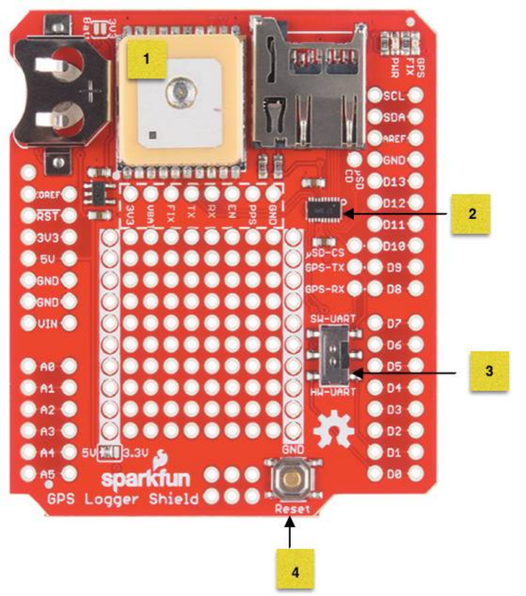

Figure 4: GPS Module. (1)GPS Receiver, (2) UART and DLINE section switch, (3)Power Switch, (4)Reset Button

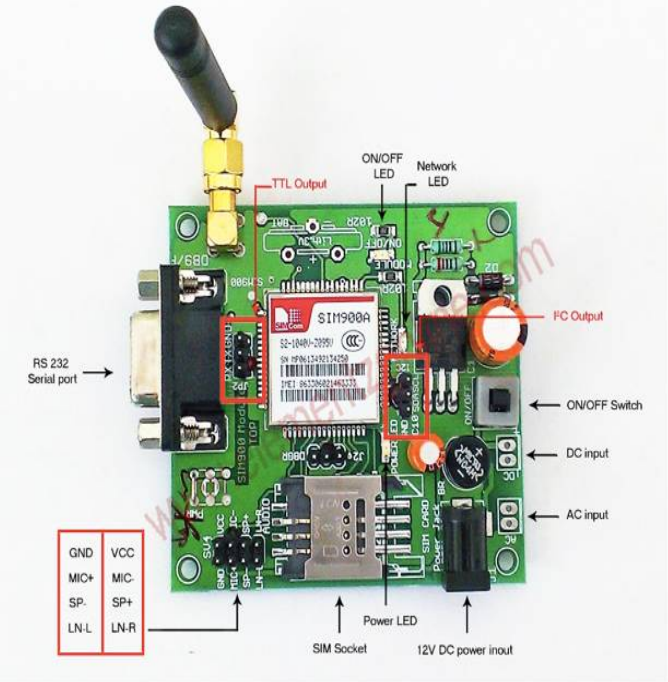

Figure 5: GSM Module SIM 900A[11]

C. GSM Module

The GSM Module used here is SIM900A which is a quad-band solution in SMT module, embedded into the device. IT can be used to send voice, text or fax messages to any device with low power consumption.[10] Two of the most important parts of a GSM Module are antenna and SIM card.

The data is transmitted by the TCP/IP protocol to the remote server using AT commands. In AT commands each and every line begins with AT, followed by other commands and is terminated by Carriage Return (CR)

Here are a few steps involved in the connection:

- AT+CGATT=1: it is sent for the connection with the GPRS.
- Now the Packet Data Protocol with Access Point Name (APN) is edited/set.
- AT+CGDCONT=1, \"IP \", \"APN \" : Internet is required by APN when it is establishing a communication between the GPRS and mobile via a gateway.
- AT+CGPCO=0, \" user name \", \" password \ ", 1: The network provider generally provides with a username along with a password that authorizes the connection establishment.
- AT+CGACT =1, 1: Next, the PDP context is activated.

D. Server & Database

The Server receives the raw data from the GSM module in hex format. Each time the data is sent it is stored into log files keeping a record of the data sent. The Parser sends the data further using the device dependent protocol, which in this project is TCP/IP protocol. The data in hex format is converted into the ASCII Code so that it can be interpreted easily by the Application. The data is transmitted using HTTP Protocols which is then stored in the database. The database uses Sqlite.

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A connection is established by the command:

$ con=mysqli_connect($hostname, &username, $password)

Field	Type	Attribute	Default
Entity_ID	int(8)		
Time	timestamp	ONUPDATE CURRENT_TIMESTAMP	CURRENT_TIMESTAMP
Latitude	double(8,6)		0.000000
Longitude	double(8,6)		0.000000

Table I: The structure of GPSDATABASE

Through the following command, Entity ID is the primary key of GPSDATABASE. Hence, it is automatically incremented and no repetition is allowed in this. The structure of GPSDATABASE is depicted in Table I.
The data can be inserted into the database by the command:

$sql="INSERT INTO GPSDATABASE(Entity_ID, Time, Latitude, Longitude) VALUES ('$_GET[id]','$_GET[lt]','$_GET[ln]')";

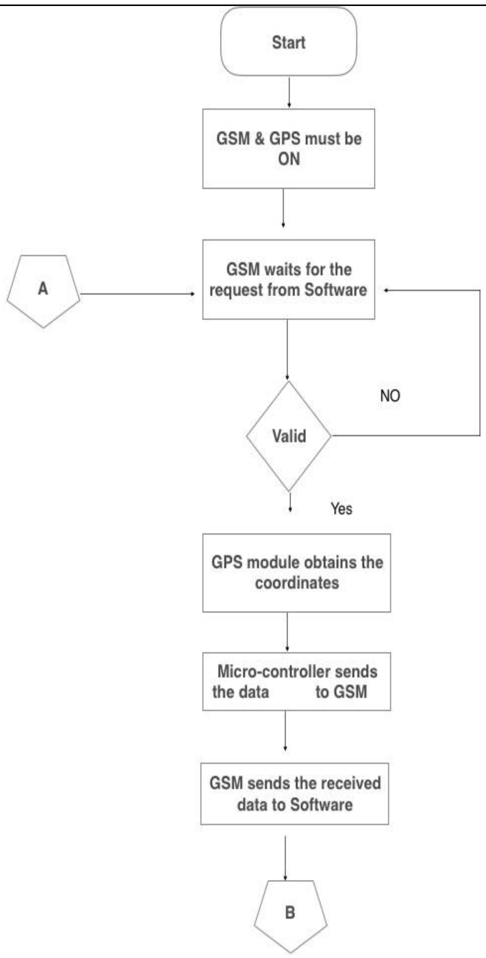

Figure 6: Hardware Implementation through a Flowchart

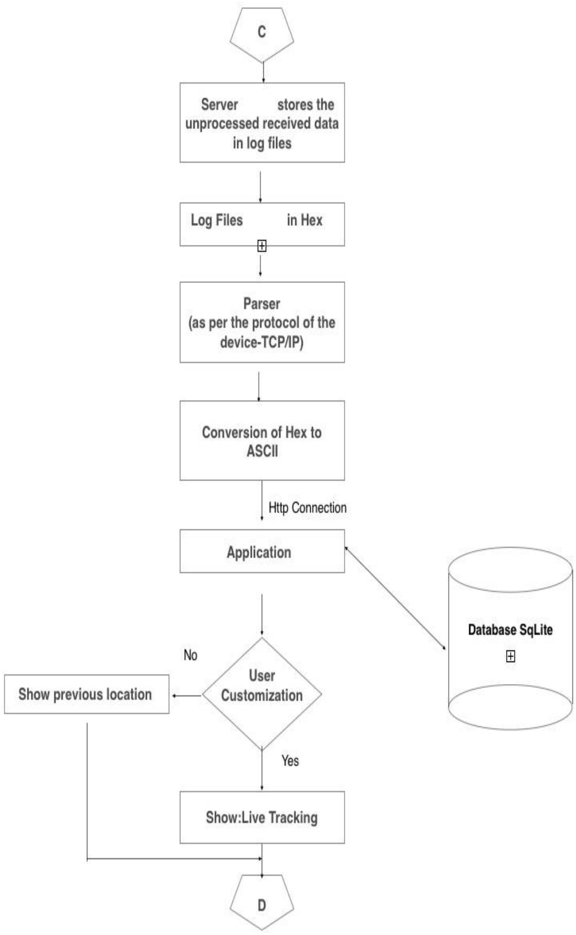

Figure 7: Software Implementation through a Flowchart

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E. Google API

The Google API is used to depict the location of a targeted entity using the HTTP Protocol in the Smartphone App. The Google maps efficiently handles the responses and functionalities of the map like drag and drop, clicks, zooming the type and scale of map, etc. With the help of legs array, distance and duration parameters the total distance can be calculate from the initial to final point of traversal.

V. RESULT

The device was tested for its proper functioning by embedding it into a volunteer's car. From the other end, through the Smartphone App a request for tracking the device was sent. The device was immediately tracked by the App along with which it displayed the precise location of the device every single second till the entity came to a halt or till the App was closed.

ID	Entity_ID	Time	Latitude	Longitude
12	1	2016-04-27 09:10:34	28.5417	77.1944
13	1	2016-04-27 09:10:43	28.5434	77.1932
14	1	2016-04-27 09:10:52	28.5458	77.1923
15	1	2016-04-27 09:11:01	28.5473	77.1911
16	1	2016-04-27 09:11:10	28.5494	77.2001

Table II: GPSDATABASE with real time date

Figure 8: Testing of Geo-Tracker

VI. CONCLUSION

The paper proposes a novel method for geo-tracking with the most easily available equipment and popular technologies. This system can be a savior in horrendous situations such as car crash in remote areas, Soldier tracking, tracking kids and loved ones, automobile safety, etc. It can even be used for managing and increasing the efficiency of transportation. Through the usage of unique ID for every entity there can never be in incertitude amongst the entities and the Smartphone App displays the map and other functionalities in streamlined manner. The proposed project is efficient, low-costed and is truly a reliable system for security.

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