

Navigation Aid for Travelers using NavIC Receiver

Shashank Keerthy Kumar, Yashaswini C Reddy, Varsha Hulamani, Shwetha BS

Jain Deemed-to-be University, Bengaluru, Karnataka, India

ABSTRACT

In India, many navigation devices and applications are based on American GPS system originally known as GPS (Global Positioning System) which is the most accurate among all the navigation systems and serves the entire globe. The navigation and positioning applications would be at halt, experiences void and the whole infrastructure and organization based on GPS which are currently in use would be collapsed, if America denies access for GPS service. To fill the void and to overcome dependency, India has developed its own regional navigation system originally named as IRNSS (Indian Regional Navigational Satellite System) and later renamed as NavIC (Navigation using Indian Constellation). In the near future all the applications based on GPS service are to be replaced with NavIC. Various attempts have been made to ease travelling across the globe. A number of applications and smart devices have been developed using GPS with different objectives. In this paper, an attempt has been made to develop a smart portable device using NavIC receiver to assist in travel across India. Using the IRNSS receiver we will get the current location of the person and the person then need to select the destination location from a list of places via GUI. Our application will then direct the person to the destination giving the route map and travel distance.

KEYWORD: IRNSS, GPS, NavIC

INTRODUCTION

Travel industry is one of the largest service industries in India. There has been increase in the number of travelers over the years. Also there has been problem that have occurred or faced by the people during travel. Various solutions have been developed to provide navigation aid for travelers such as Pocket Guide, GyPSy Guide and Google Maps which are based on GPS (Global positioning System) technology.

The Global Positioning System (GPS) is a constellation of satellites that orbit the earth twice a day, transmitting precise time and position (latitude, longitude and altitude) information [2]. With a GPS Receiver, users can determine their location anywhere on the Earth [2]. GPS has become a mainstay of transportation system worldwide providing accurate location information for an unlimited number of people anywhere in the world [1].

ISRO developed a satellite-based navigation system, called Indian Regional Navigation Satellite System (IRNSS), with a constellation of 7 satellites and complementary round infrastructure [4]. India developed its own navigation system even with the existence of GPS (global positioning system) mainly because there happened an incident in 1999, the Kargil war. During the war, India was dependent on USA for positioning information and because USA denied access to GPS the war had to prolong as it was difficult to locate the enemies. Development of our own navigation system would make our country independent of GPS. Several companies like Ola, Uber, Food delivery service apps etc. utilize the position information from the GPS satellites. These companies will have to face a huge loss and difficulty if they do not have access to GPS. Hence in this paper we aim at developing an application dedicated to travelers which is based on IRNSS.

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Navigational Systems							
Parameter	IRNSS/ NavIC	GPS	GLONASS	GALILEO	BEIDUO I	BEIDUO II	QZSS
Country	INDIA	U.S.A	RUSSIA	EUROPE	CHINA	CHINA	JAPAN
First Launch	1 st Jul 2013	22 nd Feb 1978	12 th Oct 1982	28 th Dec 2005	13 th Apr 2000	NA	11 th Sep 2010
No of satellites	7	31	24	27	21	10	3
FOC	2022*	1995	1996	2012	2007	2011	2018*
Incl. in degree °	30.5	55	64.8	56	55	NA	43
Accuracy in m							0.01 - 1
Semi-major axis(km)	42165	26560	25508	29601	27840	NA	42164
Period	1,436.1 min	11hr 58min	11hr 15min	14hr 5min	12hr50min	NA	12hrs
Coding	CDMA	CDMA	FDMA	CDMA	CDMA	CDMA	CDMA
Time system	IST	GPST	UTC(SU)	GST	CHINA UTC	CHINA UTC	JAPAN UTC
Frequency in MHz	*L5 1176.5 *S 2492.08	*L1 1575.42 *L2 1227.60 *L5 1176.45	*G1 1602 *G2 1246	*E1 1575.42 *E5a 1176.45 *E5b 1207.14 *E6 1278.45	B1:1589.74 B-1:1561.1(E2) B2:1207.14 (E5B) B3:1268.52 (E6)	E1,E2,E5b, E6 overlapped with GALILEO	*L1-1575.42 *L2C-1227.6 *L5-1176.45 *L1saif-1575 *LEX-1278.7
Note * Tentatively							
Comparison of few Navigation systems							

BACKGROUND STUDY

[5]After the USA developed GPS, several other countries also developed their own regional and global satellite navigation system detailed as follows

1. GLONASS satellite system developed by Russia for global operation
2. Chinese regional satellite navigation system (Beidou system) with Beidou-1 regional and Beidou-2 global.
3. European global satellite navigation system (Galileo system)
4. Quasi-Zenith Satellite System(Japan)
5. NAVIC or Navigation with Indian Constellation(India)

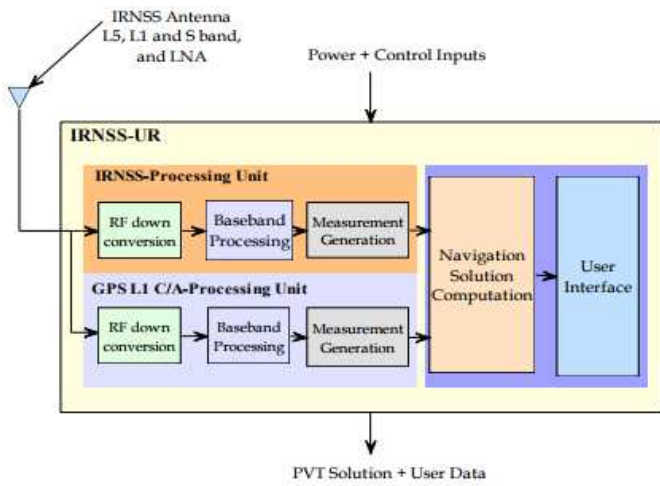
Rapid growth in the field of wireless communication and positioning technology, in the recent past, led to the deployment of wireless devices equipped with GPS sensor on numerous public as well as private vehicles [4].The recently developed solutions for the problems faced by a traveler include Smartphone Applications, and Mobile devices. Google Map is among the widely used app which will guide the user to the destination giving them the information about the distance of travel, time of travel and cost of travel. It has an advanced option of voice search where the user just need to give a voice command about the destination. It can also be used to locate the ships, planes etc. Another such solution is GyPSy Guide which provides a professional tour guide commentary along scenic drives, and they also highlight the very best of the region with entertaining stories about history, geology etc. [4]. Pocket Guide is the application which will guide the tourist by voice easing the searching process.

[3]In the paper they have proposed a system that will provide latitude and longitude positions of a particular location. They have used Indian navigation system IRNSS user receiver to collect the latitude and longitude information from the Indian satellites.

They have carried out a field survey where they have mounted the IRNSS user receiver antenna to the rover and have placed the IRNSS user receiver in the car. They have travelled to several places along with the rover and have obtained the latitude and longitude positions of the locations mentioned in the paper. Later a comparative study has been made between the GPS data and the IRNSS data from which we can come to a conclusion that they are almost the same. Using the same IRNSS user receiver and the concept of getting the latitude and longitude position from them we have developed a navigation system that will help the travelers by providing the total distance from the current location obtained from IRNSS user receiver to the destination location which is taken from the data base along with the map.

IRNSS User Receiver

[4]A typical block diagram of the IRNSS-UR is shown in figure below. IRNSS-UR is expected to receive, down converted and demodulate the transmitted satellite signals both at L5 (1176.45 MHz) and S1 (2492.028 MHz) band frequencies. Most importantly, IRNSS-UR generates measurements precisely with respect to the external/internal trigger such as 1 Pulse per Second (PPS). In addition, IRNSS-UR shall also include capability to process Global Positioning System (GPS) L1 Coarse/Acquisition (C/A) signals centered at 1575.42 MHz and generate measurements with respect to the external/internal trigger. The receiver shall output the user position computed using L5 only, S1 only, L1 only, combined L5 and GPS and combined S1 and GPS and combined IRNSS and GPS. Control inputs to the system include 10 MHz external reference clock, 1-PPS signal and commands/data through Ethernet and/or RS232 interface. The IRNSS-UR shall also have a USB port for IF sampled data collection into the PC and an external storage device into the PC and an 'external storage device.



Phase 1: In this phase we will be reading the data from the antenna and parsing the data.

- To parse the data we need to antenna first collect the NMEA data. We know that the NMEA data will have different sentences as shown below. Among the sentences we are mainly concentrating on the GPGGA and IRGGA which provide the fixed data information.
- The NMEA data is stored in a text file. It is programmed in such a way that the program will be terminated once the GPGGA or IRGGA sentence is read.

Algorithm to read the NMEA data

1. Start
2. Enable serial port and select the baud rate
3. Open a new file "NMEASTRING.TXT" to copy the NMEA data.
4. Define a variable x to store the NMEA data
5. While the NMEA data starts with 'GPGGA' or 'IRGGA'
6. Store the data in variable x
7. Print variable x
8. Stop

```
$IRZDA,060225.56,24,07,2017,5,30*59
$IRGSV,3,1,11,01,,,50,02,67,271,52,03,42,129,49,04,54,083,5
$IRGSV,3,2,11,05,71,159,53,06,36,259,49,07,27,104,47,,,,,1*
$IRGSV,3,3,11,,,,,,1*68
$IRGSA,A,3,,02,03,04,05,06,07,,,,,3.6,2.5,2.5,4*22
$IRGSV,3,1,11,01,,,45,02,67,271,45,03,42,129,45,04,54,083,4
$IRGSV,3,2,11,05,71,159,47,06,36,259,43,07,27,104,43,,,,,3*
$IRGSV,3,3,11,,,,,,3*6A
$IRGSA,A,3,,02,03,04,05,06,07,,,,,3.6,2.5,2.5,4*22
$IRGGA,060225.56,1238.4985,N,07726.4053,E,1,6,2.5,622.19,M,
$IIRMC,060225.56,A,1238.4985,N,07726.4053,E,0.11,149,240720
```

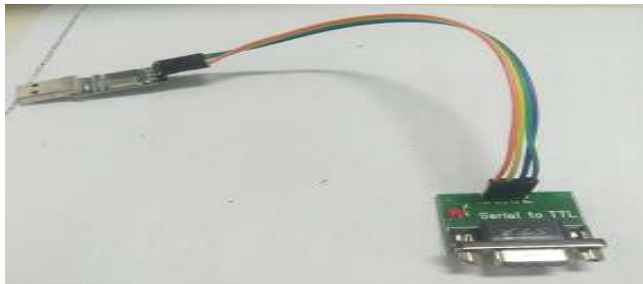
NMEA DATA

- Once the data is read and stored in the NMEASTRING.TXT file, the next main import step is parsing.
- Parsing is required because the NMEA sentence has many fields which are unwanted, we need only those fields which are important to us so parsing of the NMEA sentence is done.
- The GPGGA or IRGGA sentence contains field that provide information on latitude and longitude.
- We need to parse this information from the GPGGA or IRGGA sentence.

Algorithm for parsing

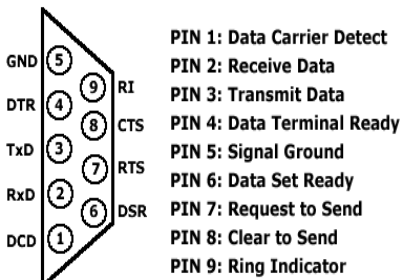
1. Start
2. Read data from the NMEASTRING.TXT file
3. If the line starts with GPGGA or IRGGA select those and store the latitude value in 'lat' and longitude value in 'lng'.
4. Parsing latitude
 $x = \text{float}(\text{lat})$
 $y = \text{int}(x/100)$
 $z = (x - y/100)/60$
 $z = z+y$
5. Parsing longitude
 $a = \text{float}(\text{lng})$
 $b = \text{int}(a/100)$
 $c = (a-b*100)/60$
 $c = c+b$
6. Print variable c and z.
7. Store the data in 'parseddata1.txt' file
8. Stop

NMEA reader



NMEA reader

RS-232 DB-9 Male Pinout



RS-232 DB-9 pin configuration

NMEA reader is designed to convert from RS232 (5v) level to USB (3.3V, 1A). The signal received by IRNSS receiver is 5V which must be processed by the Raspberry Pi. Since the Pi understands only 3.3V level, the received signal must be down converted into 3.3V. There is no converter in market which directly converts TTL to USB, hence we use a RS232 to TTL converter fed with the received IRNSS signal. The output of this converter is given as an input to TTL to USB to produce a signal level compatible with Raspberry Pi.

METHODOLOGY

SYSTEM ARCHITECTURE

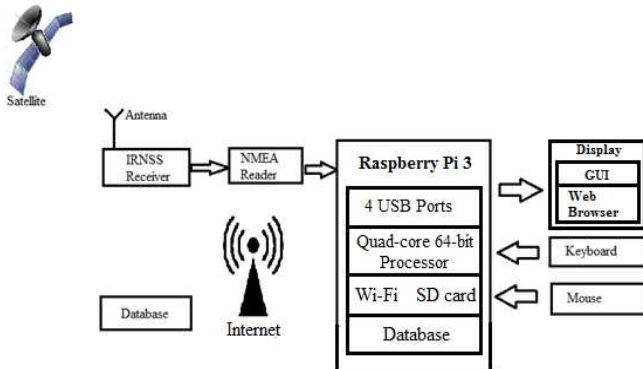


Figure 1 Block diagram of the proposed system We have divided our project into three phases

```
File Edit Shell Debug Options Window Help
Mysore
$GPGGA,011159.000,1257.6720,N,07729.1192,E,1,12,0.75,833.7,M,-88.3,M,0.0,0000.0,0.0,0000.0,0000.0,0000.0,0000.0,0000.0,0000.0
1
lines=$GPGGA,011159.000,1257.6720,N,07729.1192,E,1,12,0.75,833.7,M,-88.3,M,0.0,0000.0,0.0,0000.0,0000.0,0000.0,0000.0,0000.0,0000.0
12.9612
77.48532
```

- CODE 2 is the main code. When we run the code we get the GUI interface



PARSED DATA IMAGE

- The data that is parsed and stored in parseddata1.txt is the current location. It will provide the latitude and longitude of the location of the IRNSS receiver or GPS receiver. The variable z gives the latitude information and the variable c gives the longitude information.

Phase 2: We have got the source location information from the Phase 1. Now we must get the destination location information. We have created a data base to store the destination locations with its latitude and longitude positions, once we enter or search for the destination place name its latitude and longitude position will be extracted. In this phase we will be creating a database to store the destination locations with its latitude and longitude positions and developing a GUI that will provide information of the current location, destination location and the distance between current and destination location

- We have created a database called 'NMEA'. In the database we have created a table called 'Project'.
- The table 'Project' has three constraints Name, Latitude and Longitude.
- We have inserted the information into database.

Ex: Insert into Project (Name, Latitude, Longitude)

Values (Mysore, 12.2958, 76.6394)

```
File Edit Tabs Help
MariaDB [NMEA]> select * from Project
+-----+-----+
| Name      | Latitude | Longitude |
+-----+-----+
| Bagalkot  | 16.12    | 75.45     |
| Bangalore | 12.97242 | 77.589643 |
| Belgaum   | 15.52    | 74.34     |
| Bellary   | 15.09    | 76.55     |
| Bijapur   | 16.5     | 75.47     |
| Chennai   | 13.0827  | 80.2707   |
| Chikkamagaluru | 13.18    | 75.49     |
| Maronali  | 12.6893  | 77.4742   |
| kanakapura | 12.54824 | 77.419884 |
| Mysore    | 12.2958  | 76.6394   |
+-----+-----+
10 rows in set (0.01 sec)
MariaDB [NMEA]>
```

GUI IMAGE

- We have to click on the button in front of the Destination Location to select our destination location i.e. to the place where we are making our journey.
- Once the destination is selected we have to click on the button 'show map'.
- Once show map is clicked the NMEA data will be read to get the current of the device.
- Once the latitude and longitude of the current location is fetched we will get the name of the place from the distance API.
- This name will be displayed in the 'current location' in the GUI



IMAGE TO SHOW DESTINATION AND CURRENT LOCATION

- Then the distance between the latitude and longitude is calculated using the distance api and is stored in 'distance' in the GUI.



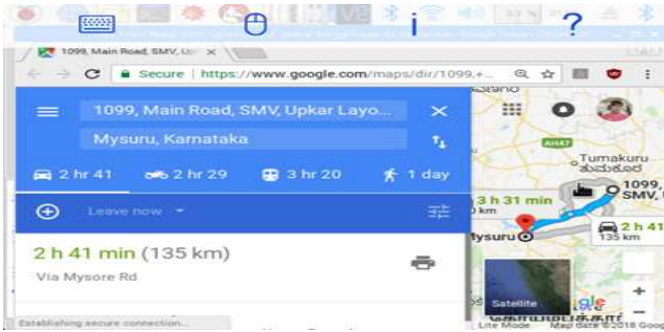
IMAGE TO SHOW THE DISTANCE

Phase 3: Now we have the source location and destination location, only thing we have to do is get the map. We did a brief survey on how can we plot and the best result we got was using the Google direction API. It is impossible to develop our own maps if we would have done it on a plain map it will be difficult to understand. So we decided to use the Google Direction API.

- After the distance information between the two locations is displayed in the GUI, we will be directed to the web browser which will give the route map between the source and destination location.

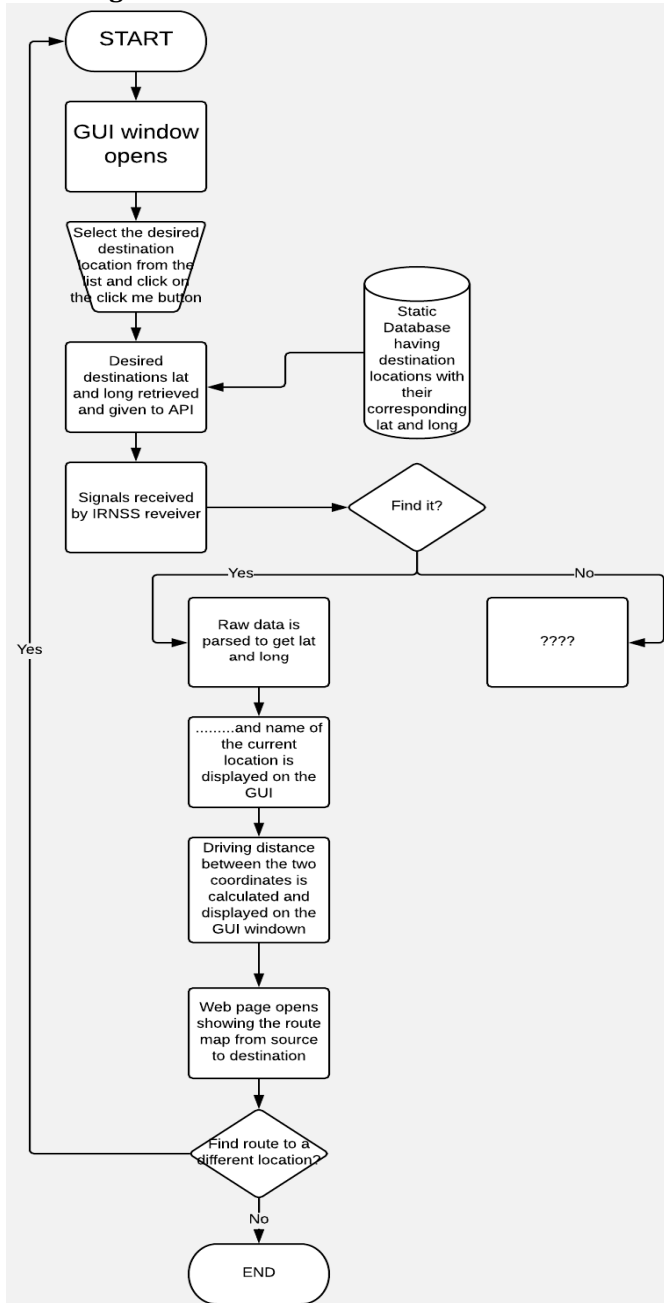
THE DATABASE IMAGE

- Similarly we have stored the Latitude and longitude information of Chennai, Bijapur, Bellary, Bagalkot, Chikkamagaluru and Mangalore in the database 'NMEA'.
- When we select any location in the GUI, its corresponding latitude and longitude position is retrieved.
- Graphical User Interface is a platform that enables user to interact with the processor.
- In Graphical User interface we have 4 constraints, Current location, Destination Location, Distance and Show map button.
- We in have written two codes for our project. In CODE 1 we are reading the data, parsing, calculating the distance and displaying the web browser.
- In CODE 2 we have only developed the GUI and we are linking the CODE 1 to this code.



- Co-ordinated and name of the current location is displayed on the GUI window. And also given to the distance API.
- Input to the distance API being co-ordinates of source and destination location calculates the driving distance. This distance is displayed on the GUI window.
- Web browser opens calling the Map API and route map between source and the destination is displayed
- Repeat the above steps if the desired destination location changes.

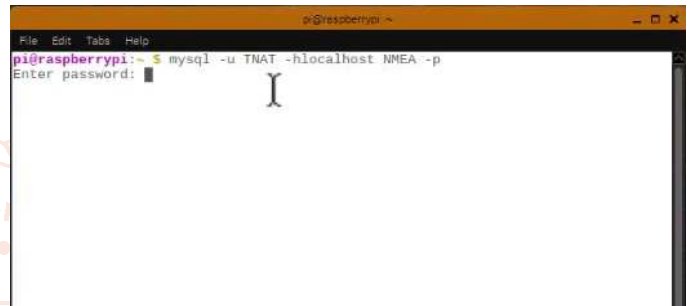
Flow Diagram



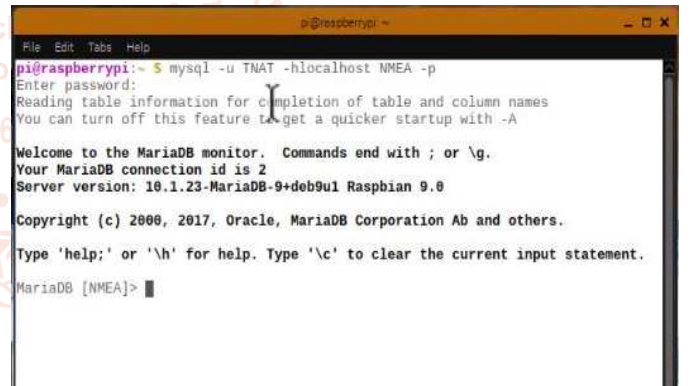
- Run the program, the GUI window opens.
- Select the desired destination location from the list and click on the show map button.
- Co-ordinates corresponding to the selected destination is retrieved from static database and is given to the Distance API.
- Signal received by GPS receiver has many NMEA sentences namely GPGGA, GPGSV etc.
- The sentences starting with GPGGA is selected and is parsed to extract information of lat and long.

RESULTS

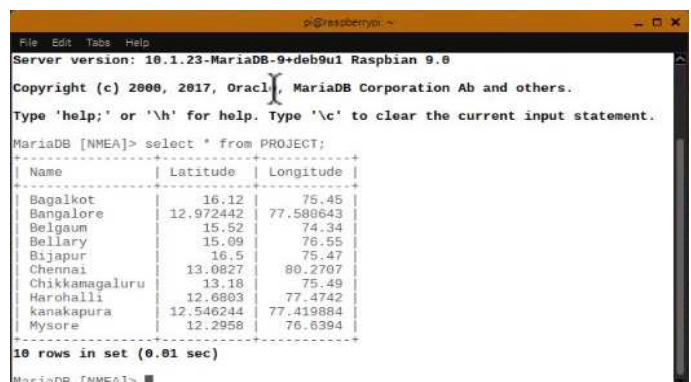
- We have created a database by name 'Project'.
- We are using Maria Data base in our project
- Enter the User name of the database is `mysql -u TNAT -hlocalhost NMEA -p` in the terminal and enter the password to open the database as you can see in the below image.



- Once we enter the username and password, we will be directed to the screen shown in below image



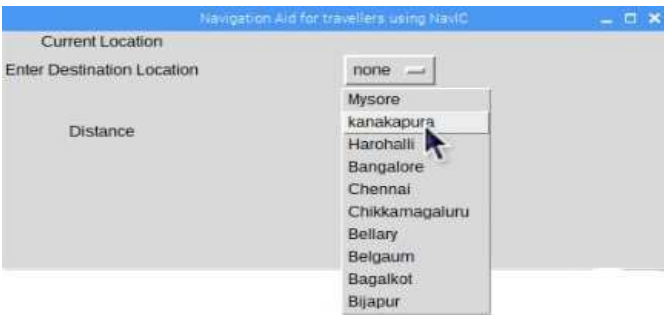
- We have to type the command 'select * from project' to view the contents of the table
- We have created a data base where we have stored few locations with their latitude and longitude positions.
- These locations act as destination locations in our project.



- The below picture is a graphical user interface.
- It has three sections as we can see. Current Location, Destination Location and Distance



- When we click on the button given in front of 'Destination Location' we can see all the destination locations given in the database as shown in below image.



- The location we select will be the destination location i.e. the location to where we will be making our journey to.



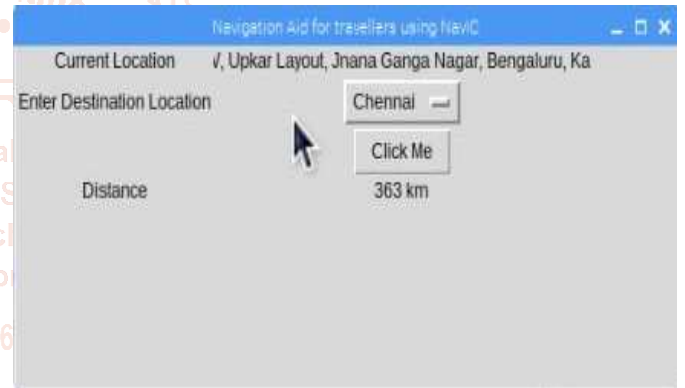
- After selecting the destination we must click the 'show map' button.

- Once we click the show map button we will start receiving the NMEA data from the IRNSS receiver as shown below.

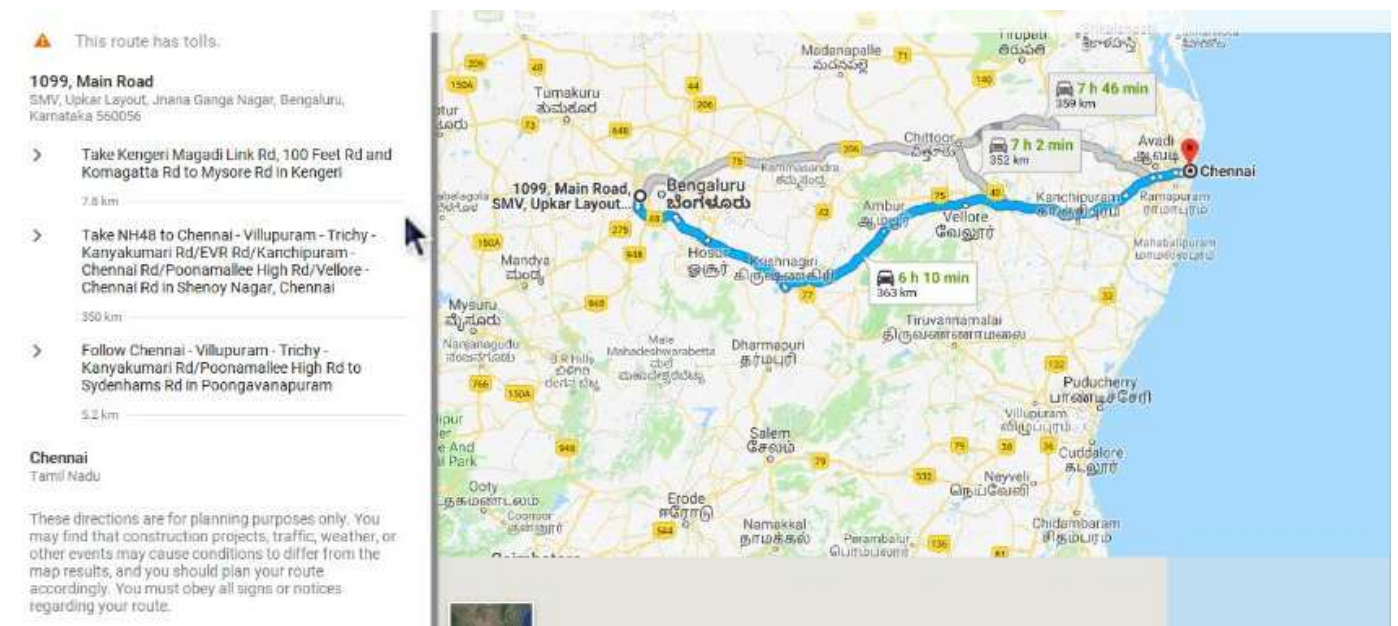
```

$IRZDA,060225.56,24,07,2017,5,30*59
$IRGSV,3,1,11,01,,,50,02,67,271,52,03,42,129,49,04,54,083,52,1*55
$IRGSV,3,2,11,05,71,159,53,06,36,259,49,07,27,104,47,,,,,1*55
$IRGSV,3,3,11,,,,,,1*68
$IRGSA,A,3,02,03,04,05,06,07,,,,,3,6,2,5,2,5,4*22
$IRGSV,3,1,11,01,,,45,02,67,271,45,03,42,129,45,04,54,083,46,3*5C
$IRGSV,3,2,11,05,71,159,47,06,36,259,43,07,27,104,43,,,,,3*5C
$IRGSV,3,3,11,,,,,,3*6A
$IRGSA,A,3,02,03,04,05,06,07,,,,,3,6,2,5,2,5,4*22
$IRGGA,060225.56,1238.4985,N,07726.4053,E,1,6,2,5,622.19,M,-89.33,M,*7D
$IIRMC,060225.56,A,1238.4985,N,07726.4053,E,0.11,149,24072017,1.62,W,A,S*7
$IRVTG,148,T,146,M,0.11,N,0.20,K,A*23
$IRALM,4,1,2,935,001,12c0,1518,14a358,0014,caea96,804568,fb58bb,ac2b3a,7e
$GPZDA,060225.04,24,07,2017,5,30*53
$GPGSV,3,1,12,13,18,231,40,06,84,008,51,28,38,079,47,19,39,356,46,1*60
$GPGSV,3,2,12,05,04,199,36,02,46,223,45,17,29,021,47,27,,,,1*59
$GPGSV,3,3,12,30,29,158,45,24,16,315,41,15,02,262,41,26,,,,1*50
$GPGSA,A,3,13,06,28,19,,02,17,,30,24,,,2,0,1,1,1,7,1*2C
$GPGGA,060253.04,1238.4985,N,07726.4057,E,1,8,1,1,624.15,M,-89.33,M,*70
$GPRMC,060253.04,A,1238.4985,N,07726.4057,E,0.14,327,24072017,1.62,W,A,S*70
$GPVTG,326,T,324,M,0.14,N,0.26,K,A*20
$IRZDA,060226.178,24,07,2017,5,30*67
$IRGSV,3,1,11,01,,,48,02,67,271,51,03,42,129,50,04,54,083,52,1*57
$IRGSV,3,2,11,05,71,159,53,06,36,259,49,07,27,104,48,,,,,1*5A
$IRGSV,3,3,11,,,,,,1*68
$IRGSA,A,3,02,03,04,05,06,07,,,,,3,6,2,5,2,5,4*22
    
```

- In the NMEA data we get the current location.
- The current location will be displayed in the GUI current location section as shown in below image.
- Once the current location is obtained now distance between the current location and the selected destination location is calculated.
- The distance between the two locations is displayed in the GUI distance section as shown in the below image.



- Once the distance and the current location is displayed in the GUI a map will be opened in the browser which will show the route from the current location to the selected destination location.



CONCLUSION

In this paper, we presented the design and implementation of a mobile application called Terrestrial Navigation Aid for Travelers, with which users can get travel guidance information they need anytime and anywhere across India. By using Terrestrial Navigation Aid for Travelers, users can get detailed information, including the estimated driving distance, route map to destination and estimated time of travel. This application can further be updated by adding advanced features like nearest tourist destinations with the image etc.

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