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A Project Report
On

"DESIGN AND IMPLEMENTATION OF ADVANCE ALGORITHM OF GNSS SIGNAL USING INTERFERENCE EFFECT"

Submitted in partial fulfillment of the requirements for the degree of

BACHELOR OF TECHNOLOGY
IN
AERONAUTICAL ENGINEERING

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CHAPTER:- 1

INTRODUCTION

1.1 GNSS

A global navigation satellite system (GNSS) is a network of satellites broadcasting timing and orbital information used for navigation and positioning measurements.

From communications systems to mobile navigation applications like Google Maps, GNSS affects what we do every day.

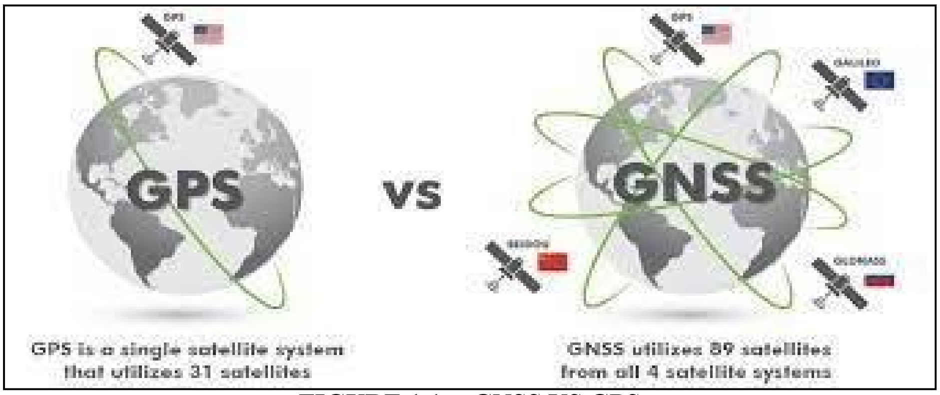


FIGURE 1.1 :- GNSS VS GPS

1.1.1 TYPES OF GNSS

- GLOBAL POSITIONING SYSTEM (UNITED STATES) -

GPS is operated by the U.S. Space Force, a branch of the U.S. Armed Forces. It was the first constellation to be established in space with its first satellite being launched in 1978, with its first series of satellites fully operational by 1993. Currently the system has 31 satellites in orbit supporting L1 (1575.42 MHz), L2 (1227.60 MHz) and L5 (1176.45 MHz) frequencies.

- GLONASS (RUSSIA) -

GLONASS was first developed in the Soviet Union to compete with GPS during the '70s and is currently operated by Roscomas State Co-operation for Space Activities, a department in the Russian government. The first GLONASS satellite was launched in 1982 and today has 24 satellites in orbit.
The constellation was fully launched and completed in 1995, with full satellite coverage achieved across Russia in 2010.
GLONASS satellites broadcast signals on GLONASS L1 (1598.0625-1605.375 MHz), L2 (1242.9375-1248.625 MHz) and L3 (1202.025 MHz) frequencies.

- GALILEO (EUROPEAN UNION) -

Galileo is a more recent constellation first launched in 2011. Operated out of the European

Union by the European Global Navigation Satellite Systems Agency, Galileo currently has 26 satellites in orbit, with a plan to reach 30 satellites by 2021.
These satellites transmit along the L-Band spectrum, labelling their frequencies E1 (1575.42 MHz), E5 (1191.795 MHz), E5a (1176.45 MHz), E5b (1207.14 MHz) and E6 (1278.75 MHz).

- BEIDOU (CHINA) -

First launched in 2000, BeiDou operates out of China by the China National Space Administration (CNSA). In the 20 years since, BeiDou has 48 satellites in orbit.
BeiDou satellites currently transmit many signals, including B1I (1561.098 MHz), B1C (1575.42 MHz), B2a (1175.42 MHz), B2I and B2b (1207.14 MHz) and B3I (1268.52 MHz).

- QZSS (JAPAN) -

Japan's Quasi-Zenith Satellite System (QZSS) is operated by the Japan Aerospace Exploration Agency (JAXA) and was first launched in 2010. While the other constellations have provided global coverage, QZSS maintains Asia-Oceana regional coverage between Japan and Australia.
As a regional constellation, QZSS only has four satellites currently in orbit, with a plan for an additional three satellites in the few years. QZSS signals transmit at the same frequency as GPS L1 (1575.42 MHz), L2 (1227.60 MHz), L5 (1176.45 MHz) as well as L6 (1278.75 MHz).

- IRNSS/NAVIC (INDIA) -

Another major regional constellation is the Indian Regional Navigation Satellite System (IRNSS) operated by the Indian Space Research Organization (ISRO) out of India. IRNSS is also known as NAVIC (Navigation with Indian Constellation) and includes eight satellites in orbit.
The constellation's coverage centers around India, reaching west to include Saudi Arabia, north and east to include all of China and as far south to include both Mozambique and Western Australia. NAVIC signals transmit on the GPS L5 frequency (1176.45 MHz) as well as along the S-Band (2492.028 MHz).

1.1.2 GNSS APPLICATIONS

- LOCATION - Determining your position in the world.
- NAVIGATION - Identifying the best route from one location to another.
- TRACKING - Monitoring and object's movement in the world.
- MAPPING - Creating maps of a specific area.
- TIMING - Computing precise timing within billionths of a second.

1.2 GPS

The Global Positioning System (GPS) is a U.S.-owned utility that provides users with positioning, navigation, and timing (PNT) services.

This system consists of three segments: the space segment, the control segment, and the user segment. The U.S. Space Force develops, maintains, and operates the space and control segments.

1.2.1 TYPES OF SEGMENTS IN GPS

- SPACE SEGMENT

The GPS space segment consists of a constellation of satellites transmitting radio signals to users. The United States is committed to maintaining the availability of at least 24 operational GPS satellites, 95% of the time. To ensure this commitment, the U.S. Space Force has been flying 31 operational GPS satellites for well over a decade.

- CONTROL SEGMENT

The GPS control segment consists of a global network of ground facilities that track the GPS satellites, monitor their transmissions, perform analyses, and send commands and data to the constellation.
The current Operational Control Segment (OCS) includes a master control station, an alternate master control station, 11 command and control antennas, and 16 monitoring sites. The locations of these facilities are shown in the map above.

- USER SEGMENT

The user segment consists of equipment that processes the received signals from the GNSS satellites and uses them to derive and apply location and time information.
The equipment ranges from smartphones and handheld receivers used by hikers, to Sophisticated, specialized receivers used for high end survey and mapping applications.

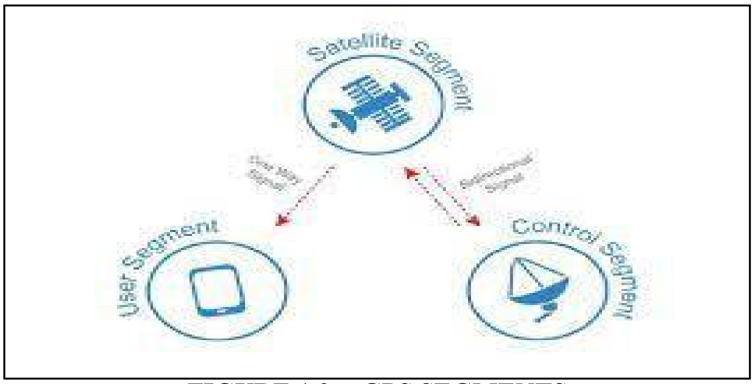


FIGURE 1.2 :- GPS SEGMENTS

1.2.2 GPS SERVICES

GPS satellites provide service to civilian and military users. The civilian service is freely available to all users on a continuous, worldwide basis.
The military service is available to U.S. and allied armed forces as well as approved Government agencies.

- AUGUMENTATONS -

A GPS augmentation is any system that aids GPS by providing accuracy, integrity, availability, or any other improvement to positioning, navigation, and timing that is not inherently part of GPS itself.
A wide range of different augmentation systems have been developed by both the public and

private sectors. To meet specific requirements, the U.S. government has fielded a number of publicly available GPS augmentation systems, including (but not limited to) the following systems.

- PERFORMANCE -

The performance standards define the services delivered through the L1 C/A-code signal. The metrics are limited to the signal-in-space (SIS) and do not address atmospheric errors, receiver errors, or errors due to the user environment (e.g. multi path errors, terrain masking, and foliage).

1.3 IMU

Inertial measurement units (IMU) have exploded in popularity over the last decade so that you can now find them in almost any sporting environment.

An IMU is a collection of sensors, including an accelerometer, gyroscope and magnetometer. It collects data about the movement of the unit itself. Inertial measurement units collect raw, unfiltered data that many sports technology companies refine using algorithms and in-depth calculations to produce digestible metrics. The hardware itself is relatively cheap to manufacture. However, the algorithms and software applied to the raw data from the IMU's provide the real value to the end-user.

One of the most used components within the inertial sensor is the accelerometer. Accelerometer detect changes in acceleration to give detailed data on how something is moving in space. Accelerometer are everywhere and are simple to manufacture. Simple ones are in our smartphones, our laptops, in cars, and in our wearable devices. Some high-end accelerometer can detect changes in acceleration to 1600 Hz, producing more than 1600 data points every second.

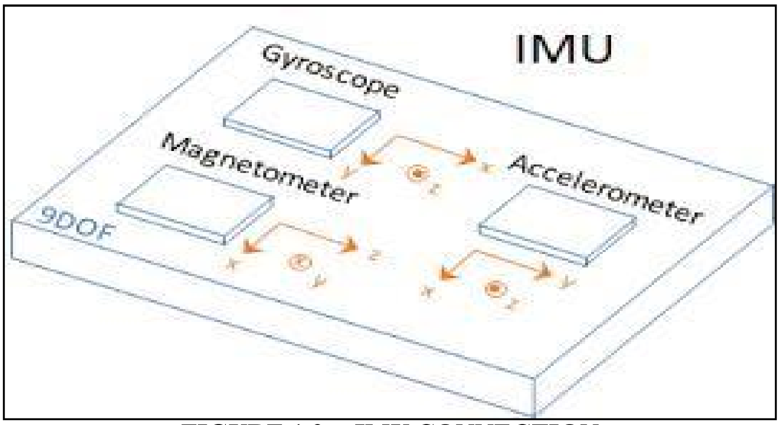


FIGURE 1.3 :- IMU CONNECTION

1.3.1 APPLICATIONS OF IMUs

- This sensor is used to determine the direction within a GPS system.
- This sensor is used to track the motion within user electronics like cell phones, remotes

of the video game.

- This sensor is used in industries to support and calculate the location of equipment such as antennas.
- These sensors assist in maneuver aircraft without or with a pilot. IMUs are used in entertainment systems of flights and consumer airspace to add convenience within addition to contact in their remotes.
- In the future, these can be used in GPS, RF, LiDAR which will allow precise localization of citizens, equipment, and vehicles in indoors & outdoors.

1.4 IRNSS - NAVIC

The Indian Space Research Organization (ISRO) and its commercial wing ANTRIX developed the Indian Regional Navigation Satellite System or IRNSS with its operational name of NAVIC (Navigation with Indian Constellation).

It is a Navigation Satellite System that will provide accurate real-time positioning and timing services over India and the region around the country.

1.4.1 NAVIC

- It is an Indian Regional Navigation Satellite System or IRNSS.
- It was developed in India by Indian Space Research Organization (ISRO) and its commercial wing ANTRIX.
- It consists of 8 satellites located at a distance of approximately 36,000 Km. Currently, 7 satellites are active:
  - 3 satellites are in Geostationary Orbit (GEO)
  - 5 satellites are in inclined Geosynchronous Orbit (GSO)
- The objective of the NavIC is to provide navigation, timing, and reliable positioning services in and around India.
- Working of the NavIC is very similar to the Global Positioning System(GPS)implemented by the United States.
- The NavIC is certified by 3GPP (3rd Generation Partnership Project) which is responsible for coordinating mobile telephony standards globally.

1.4.2 IRNSS

- It is an independent regional navigational satellite system developed by India.
- Objective: It is being designed to give precise position data service to users located in India and also to users in the area out-spreading up to 1500 Km from India's boundary.

- The two kinds of services provided by IRNSS will be:
  - Standard Positioning Service (SPS) and
  - Restricted Service (RS).
- The system can offer a position accuracy of more than 20 m within India which is the primary area of service.

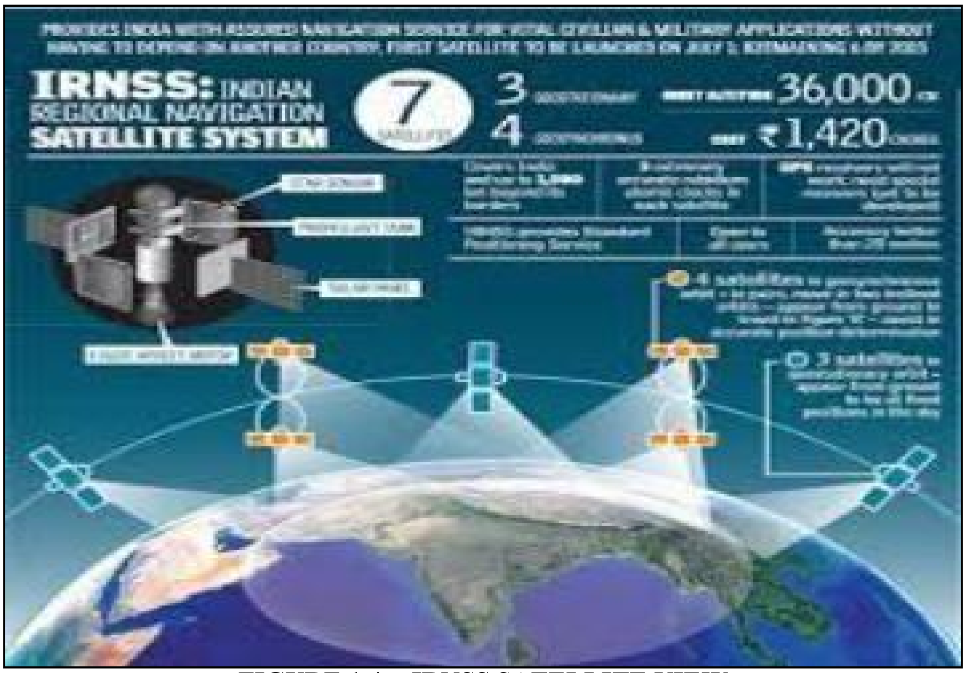


FIGURE 1.4 :- IRNSS SATELLITE VIEW

1.4.3 GIS BASICS

- A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
- It is the partnership of these two data types that enables GIS to be such an effective problem solving tool through spatial analysis.
- GIS can be used as tool in both problem solving and decision making processes, as well as for visualization of data in a spatial environment.
- Geospatial data can be analyzed to determine:
  - Mapping where the things are
  - Mapping Quantities
  - Mapping Densities
  - Finding what is inside
  - Finding what is nearby
  - Mapping Changing

1.5 INTERFERENCE STUDIES

GPS Interference can come from a variety of sources, including radio emissions in nearby bands, intentional or unintentional jamming, and naturally occurring space weather.

The U.S. government works to minimize human sources of GPS interference through spectrum regulations (domestic and international), interference detection and mitigation efforts, and law enforcement.

1.5.1 TYPES OF INTERFERENCE

- IONOSPHERIC INTERFERENCE -

Ionospheric interference occurs when GPS signals slow down and scatter as they pass through the ionosphere. Electromagnetic fields can distort radio waves, and affect the travel time of GPS signals just before they can be processed by the receiver.

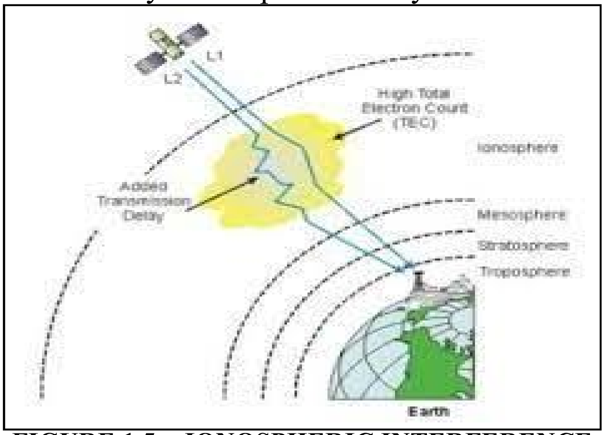


FIGURE 1.5 :- IONOSPHERIC INTERFERENCE

- ELECTROMAGNETIC INTERFERENCE -

A phenomenon that may occur when an electronic device is exposed to an electromagnetic (EM) field.
The electromagnetic energy from the source propagates through the path and interferes with the operation of the receptor.

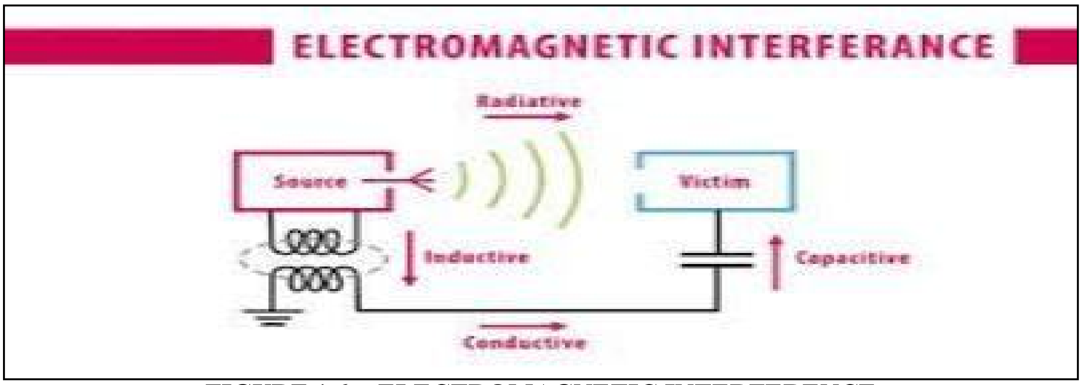


FIGURE 1.6 :- ELECTROMAGNETIC INTERFERENCE

Electromagnetic interference (EMI), also called radio-frequency interference (RFI) when in the radio frequency spectrum, is a disturbance generated by an external source that affects an electrical circuit by electromagnetic induction, electrostatic coupling, or conduction. The disturbance may degrade the performance of the circuit or even stop it from functioning. In the case of a data path, these effects can range from an increase in error rate to a total loss of the data.

- ATMOSPHERIC INTERFERENCE -

The atmosphere is the transmission medium . Like all transmission mediums, the atmosphere is subject to attenuation loss. This loss can have a major effect on the availability of signal in

that region.
Attenuation in the atmosphere is dependent upon several conditions, primarily the weather. The region in which a link is being established has specific weather conditions, allowing for easily predictable attenuation sources.
For example, fog and snow are the two primary weather conditions in temperate regions. In tropical regions, heavy rain and haze are two main weather conditions.

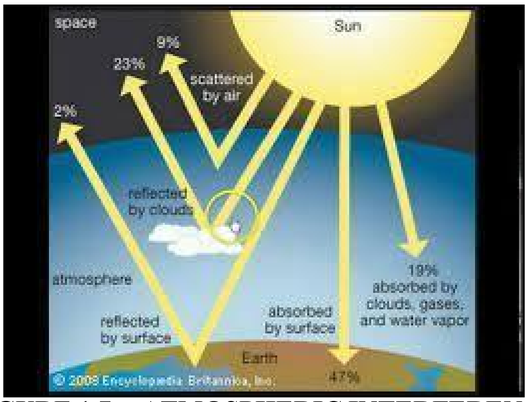


FIGURE 1.7 :- ATMOSPHERIC INTERFERENCE

1.5.2 GPS JAMMING

- Signal jamming devices can prevent you and others from making 9-1-1 and other emergency calls and pose serious risks to public safety communications, as well as interfere with other forms of day-to-day communications.
- The use of a phone Jammer, GPS blocker, or other signal jamming device designed to intentionally block, jam, or interfere with authorized radio communications is a violation of federal law. There are no exemptions for use within a business, classroom, residence, or vehicle. Local law enforcement agencies do not have independent authority to use jamming equipment; in certain limited exceptions use by Federal law enforcement agencies is authorized in accordance with applicable statutes.

1.6 DATA COLLECTION AND SATELLITES RECEIVERS

The Data which we are collecting through the receivers will be available in two modes:

- Static Mode
- Dynamic Mode

1.6.1 STATIC MODE DATA COLLECTION

The static data is obtained by keeping the receiver in at a place and the values are displayed and the static data which is obtained is recorded for further interference study and we will collect the data using GPS, IMU and NAVIC receiver.

1.6.2 DYNAMIC MODE DATA COLLECTION

The data is obtained from it by moving from one place to the other place by constant moment. The obtained data are recorded for further interference study. Same as above we will collect the data using GPS, IMU and NAVIC receiver.

1.6.3 SKY VIEW OF SATELLITES FOUND

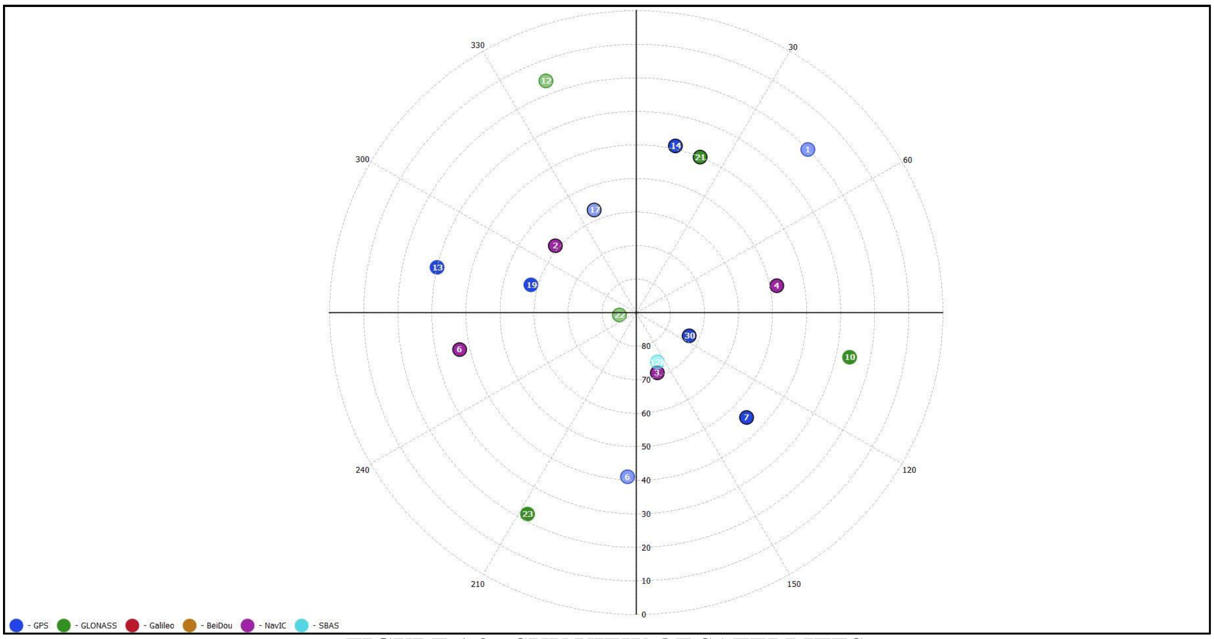


FIGURE 1.8:- SKY VIEW OF SATELLITES

1.6.4 SIGNAL STRENGTH OF VARIOUS SATELLITE

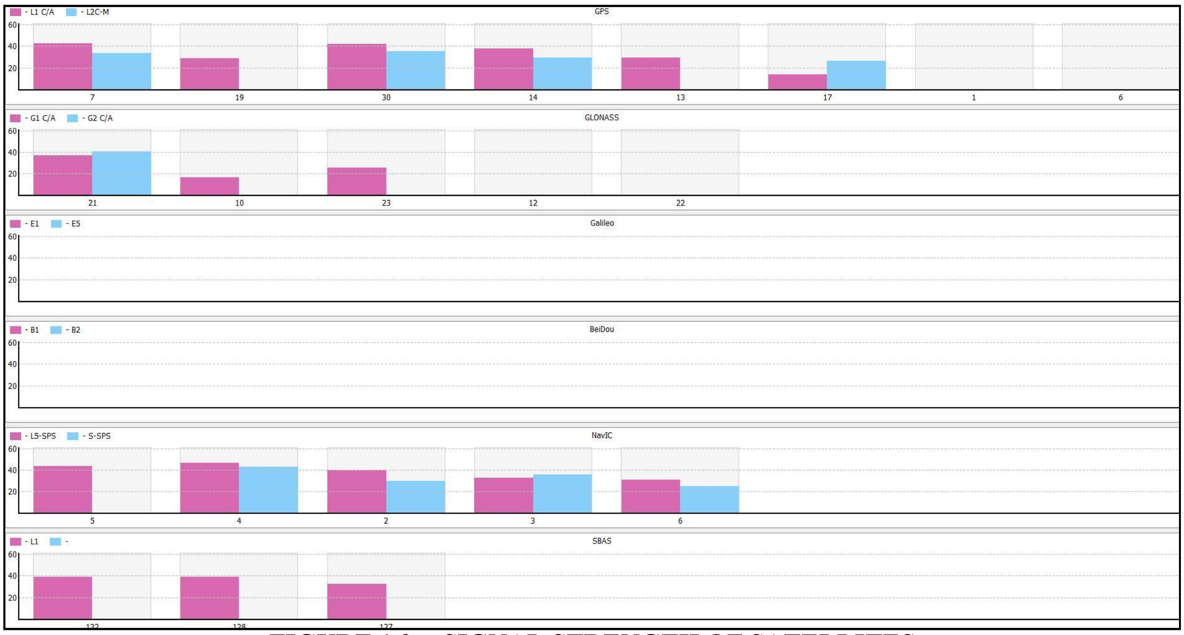


FIGURE 1.9 :- SIGNAL STRENGTH OF SATELLITES

1.7 NMEA FORMAT

NMEA stands for National Marine Electronics Association. NMEA existed long before GPS was invented. According to the NMEA website, the association was founded in 1957 by the Electronics Sales Group to improve communication with manufacturers. In today's GPS world, NMEA is the standard data format supported by all GPS manufacturers. Like ASCII in many ways, is the digital computer character standard in the computer world.

The purpose of NMEA is to provide equipment users with the ability to combine hardware and software. NMEA GPS data also makes it easier for software developers to write software for a wide range of GPS receivers without having to write a user interface for each GPS receiver.

For example, Visual GPS software (freeware) receives NMEA data from any GPS receiver and displays it graphically. Without standards like NMEA, writing and maintaining such software is time consuming and expensive. What makes NMEA a bit confusing is that there are quite a few "NMEA" messages, not just one. So just as there are different types of GPS receivers with different capabilities, there are different types of NMEA messages with different capabilities. In addition, NMEA data can be transmitted over various types of communication interfaces such as RS232, USB, Bluetooth, 0 WiFi, UHF, etc.

1.7.1 NMEA FORMATS AND THIER INTERPRETATION

- The data is sent in variable-length phrases with a predetermined sentence pattern and Sentence structure:
  - Address field
  - Data fields
  - Checksum field
  - Terminating field
  - All sentences contain only ASCII characters
  - The maximum length of a sentence is 82 characters
  - All fields are separated by delimiters
- NMEA MESSAGE FORMAT

To understand the NMEA message structure, let's examine the popular $GPGGA message. This particular message was output from an RTK GPS receiver:

$GPGGA, 170834, 4124.8963 N, 08151.6839 W,
1, 05, 1.5, 280.2 M, -34.0 M, Blank, Blank, 0*75

GLOBAL POSITIONING SYSETM FIX DATA

NAME	EXAMPLE DATA	DESCRIPTION
Sentence Identifier	$GPGGA	Global Positioning System Fix Data
Time	170834	17:08:34 Z
Latitude	4124.8963 N	41d 24.8963' N or 41d 24' 54" N
Longitude	08151.6838 W	81d 51.6838' W or 81d 51' 41" W
Fix Quality: - 0 = Invalid - 1 = GPS fix - 2 = DGPS fix	1	Data is from a GPS fix
Number of Satellites	05	5 Satellites are in view
Horizontal Dilution of Precision (HDOP)	1.5	Relative accuracy of horizontal position
Altitude	280.2 M	280.2 meters above mean sea level
Height of geoid above WGS84 Ellipsoid	-34.0 M	-34.0 meters
Time since last DGPS update	Blank	No last update
DGPS reference Station ID	Blank	No station id
Checksum	*75	Used by program to check for transmission errors

1.7.2 COMMON NMEA SENTENCE MESSAGES

- $GPGGA - Global positioning system fixed data
- $GPGLL - Geographic position - latitude / longitude
- $GPGSA - GNSS DOP and active satellites
- $GPGSV - GNSS satellites in view
- $GPRMC - Recommended minimum specific GNSS data
- $GPVTG - Course over ground and ground speed

1.7.3 COMMON NMEA EXAMPLES

- $GPGSA -
  GPS DOP and active satellites

  Eg . $GPGSA,A,3,,,,,,16,18,,22,24,,,3.6,2.1,2.2*3C
  $GPGSA,A,3,19,28,14,18,27,22,31,39,,,,,1.7,1.0,1.3*35
  1 = Mode:
  M=Manual, forced to operate in 2D or 3D
  A=Automatic, 3D/2D
  2 = Mode:
  1=Fix not available
  2=2D
  3=3D
  3-14 = IDs of SVs used in position fix (null for unused fields)
  15 = PDOP
  16 = HDOP
  17 = VDOP

- $GPGSV -
  GPS Satellites in view

  Eg . $GPGSV,3,1,11,03,03,111,00,04,15,270,00,06,01,010,00,13,06,292,00*74
  $GPGSV,3,2,11,14,25,170,00,16,57,208,39,18,67,296,40,19,40,246,00*74
  $GPGSV,3,3,11,22,42,067,42,24,14,311,43,27,05,244,00,,,,*4D
  $GPGSV,1,1,13,02,02,213,,03,-3,000,,11,00,121,,14,13,172,05*67
  1 = Total number of messages of this type in this cycle
  2 = Message number
  3 = Total number of SVs in view
  4 = SV PRN number
  5 = Elevation in degrees, 90 maximum
  6 = Azimuth, degrees from true north, 000 to 359
  7 = SNR, 00-99 dB (null when not tracking)
  8-11 = Information about second SV, same as field 4-7
  12-15= Information about third SV, same as field 4-7
  16-19= Information about fourth SV, same as field 4-7

- $GPRMA -
  Recommended minimum specific Loran-C data

  Eg. $GPRMA,A,llll.ll,N,lllll.ll,W,,,ss.s,ccc,vv.v,W*hh
  1 = Data status
  2 = Latitude
  3 = N/S
  4 = longitude
  5 = W/E
  6 = not used
  7 = not used
  8 = Speed over ground in knots
  9 = Course over ground
  10 = Variation
  11 = Direction of variation E/W
  12 = Checksum

1.8 SOFTWARE

1.8.1 PYTHON

Python is an interpreted high-level general-purpose programming language. Python’s design philosophy emphasizes code readability with its notable use of significant indentation. Its language constructs as well as its object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.
Python is dynamically-typed and garbage-collected. It supports multiple programming paradigms,including structured (particularly, procedural), object-oriented and functional

programming. Python is often described as a "batteries included" language due to its comprehensive standard library. Python consistently ranks as one of the most popular programming languages.

1.8.2 MATLAB

MATLAB is a proprietary multi-paradigm programming language and numeric computing environment developed by Math Works.

MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.

The MATLAB application is built around the MATLAB programming language. Common usage of the MATLAB application involves using the Command Window as an interactive mathematical shell or executing text files containing MATLAB code.

CHAPTER:- 2

LITERATURE SURVEY

2.1 "DESIGN AND IMPLEMENTATION OF A GNSS SIGNAL COLLECTION SYSTEM USING DIRECT RF SAMPLING"

by Yanhong Kou and Hongquan Liu, February 2019

Advanced commercial broadband ADC (analog-to-digital converter) are already eligible for radio frequency direct RF sampling, especially band pass sampling for GNSS (Global Navigation Satellite System) receivers in L-band Compared to IF (intermediate frequency) sampling, this approach exhibits exceptional features of a simple structure, high flexibility, and low distortion. This article presents the design and implementation of a GNSS signal collection system using direct RF sampling, using only amplifiers and filters between the antenna, and the collected data is sent to a computer via Gigabit Ethernet. For storage and processing with regard to the most crucial problems of direct RF sampling, the effects of alias noise and clock time are discussed, and an expression is given to calculate the noise requirements of aliasing. Next, the design of the Field Programmable Gate Array (FPGA) code and the computer software is described. Using a GNSS software receiver, acquisition results and position solutions based on signals collected from live satellites and a GNSS RF signal simulator show that the system operates efficiently and that offers flexibility for multi-signal multi-constellation structure.

2.2 "DESIGN AND IMPLEMENTATION OF KALMAN FILTERS FOR GPS RECEIVERS"

by Jakkaraju Pavan Kumar, Namit Rarotra and Uma Maheswari, May 2015

This article discusses the design and development of a Kalman filter for efficient code and carrier tracking in a GPS receiver. The goal is to integrate a Kalman filter into the tracking channel of a GPS receiver. The tracking channel continuously synchronizes the received satellite signal and the locally generated code and carrier frequencies using tracking loops. The first step is to develop a tracking channel and the next step is to develop a Kalman filter model suitable for the design. The reliable and standard tracking loops for tracking code and carrier are Delay Locked Loop (DLL) and Costas Loop respectively. When these loops lose the lock, that is, when the signals are weak, the receivers can no longer retrieve the navigation data unless the code and carrier are relocked. This causes is Turbances in tracking, i.e. the receiver can no longer determine its position until the signal becomes strong. The proposed design can solve this problem by using a Kalman filter in a phase-locked loop. The Kalman filter, with its linear recursive filtering, provides greater precision in estimating the phase/frequency of the received incoming signal with the initial system status, system noise statistics and associated measurement errors. Replacing the low pass filter (LPF) with the Kalman filter in the tracking channel gives a better estimate of the tracking. The analysis shows that the Kalman filter is the best replacement tool that can strongly influence the navigation area in a way that minimizes the tracking error. Thus, the design provides continuous tracking of GPS signals, avoiding frequent requests even.

2.3 "EMEDDED SYSTEM INTERFACING WITH GNSS RECEIVER FOR TRANSPORT APPLICATIONS"

by Mohammad Umair Bagali and Thangadurai N, January 2019

Real-time vehicle movement tracks using the display of way points on the base map with IRNSS / NAVIC records and GPS in the GUI at the same time. In this publication, a portable electronic device with application software was designed and developed, which is used to acquire real-time position information from a rover using IRNSSUR. Stores position information in database and displays vehicle position information in real time such as date, time, latitude, longitude and altitude using GPS and IRNSS / NAVIC receiver at the same time. The hardware device designed with a application software that has been developed helps to map the movement of the vehicle / rover simultaneously in real time, which also identify the region with data loss, vary the position information, compare the with the distance traveled by the Rover, it helps, and also helps to retrieve past surveys and map traces from IRNSS and GPS at the same time. Vehicle movement using the with IRNSS / NAVIC and GPS is tracked on the base map to find the similarities and differences between the two. During this investigation, it can be concluded that the position of the rover using GPS and IRNSS was accurate and continuous in our survey period with some exceptions. It is in these few places that data loss is observed due to variations in satellite visibility. For India region, the IRNSS/ NAVIC can be a better replacement for GPS.

2.4 "GPS RECEIVER AUTONOMOUS INTERFERNCE DETECTION"

by P. Enge and A. Ndili, April 1996

Interference is a challenge when using GPS for high-precision aircraft approaches because it threatens the accuracy and integrity of the GPS navigation solution. Such interference can result from "unwanted" sources (such as TV / FM harmonics, radar, MSS) or it can result from hostile efforts (interference). This research focuses on algorithms for the detection and monitoring of onboard interference. The types of interference considered include coherent CW and broadband, pulsed and continuous. We examined the effects of 4,444 different types of interference on GPS receiver measurements. Based on the simulation and validation of the test bench, we present interference detection algorithms that are based on the observable effects of different types of interference on the measurements derived from the GPS receiver. Interference detection is based on a combination of the following statistical test correlator output, correlator output variance, carrier time, and AGC loop gain. The role and utility of pseudo liths in reducing the adverse effects of interference are also discussed.

2.5 "DETERMINATION OF NAVIC DIFFERENTIONAL CODE BIASIS USING GPS AND NAVIC OBSERVATIONS"

by K Siva Krishna and D Venkata Ratnam, March 2020

The hysteresis between pseudo-distance codes is called differential code bias (DCB), which is one of the main causes of errors in estimating the correct total electron content (TEC) in the ionosphere. The differential delay difference between the dual band signal in the satellite and the receiver is called the Satellite Differential Code Deviation (SDCB) and the Receiver Differential Code Deviation (RDCB). The combined receiver and satellite DCB lead to TEC measurement errors. SDCB and RDCB must be precisely excluded from Global Navigation Satellite System (GNSS) measurements. DCB estimates of GNSS signals are important for improving the positioning accuracy of GNSS users in ionosphere and space weather applications. Indian Constellation Navigation System (NAVIC) was developed by India to meet ionosphere and troposphere positioning, navigation, synchronization and remote sensing applications. The proposed DCB estimation algorithm is required to calibrate NAVIC TEC measurements for NAVIC satellites and receivers. In this work, a Global Positioning System Assisted DCB NAVIC estimation algorithm & GPS; It's implemented using TEC GPS measurements from one station. TEC data was co-located by the NAVIC and the GPS receiver (Koneru Lakshamaiah Education Foundation, Guntur, India, 16.47N, 80.61E) for the month of September 2016. The SDCB and RDCB estimates for the NAVIC satellites and receivers in Guntur, India. The maximum SDCB value of 9.2 TECU was observed for the pseudo-range number (PRN) of the NAVIC satellite. The standard deviations of the NAVIC satellites were on the order of 0.53e1.11 TECU. The NAVIC RDCB was estimated to be 16 TECU. The DCB results have been validated using the Fitted Receiver Bias (FRB) method. The implemented DCB estimation algorithm would be useful to improve the position accuracy of NAVIC Users.

2.6 "IMPLEMENTATION OF GPS BASED OBJECT LOCATION AND ROUTE TRACKING ON ANDROID DEVICE"

by Joshua Samual, November 2015

Location based services have enabled people to locate and track the location of other people, objects, machines, vehicles and resources from the comfort of their own home as long as they have the required gadget such as a Smartphone, a PDA and others (Adusei, et al, 2004). The request for sensitive information at location is typically initiated by a user known as a customer or network provider. Most applications today use the 'GPS' global positioning system. provide location information; for example of a social networking site like Facebook that allows users to share their location with their friends and family , another common example is an app that allows users to retrieve weather forecast data based on their current location. However, with the many benefits that come from using the location-based service, there are issues that disrupt users' privacy; therefore, there is a need for appropriate government regulations. The aim of this project to develop a tracker / monitor Android application (mobile) using object GPS devices to determine current and previous location at specified intervals, this system, unlike the previous tracker system, giving the user the ability to bookmark the current location and the ability to return anywhere to that location using Google Maps API in case they can't remember the location.

2.7 "OBJECT DETECTION AND TRACKING USING KALMAN FILTER AND FAST MEAN SHIFT ALGORITHM"

by A Ali and K Terada, January 2017

Object detection in films entails verifying the presence of an item in photo sequences and probable finding it exactly for recognition. Object monitoring is to display an item`s spatial and temporal modifications throughout a video collection, consisting of its presence, position, size, shape, etc. These approaches are intently associated due to the fact monitoring normally begins off evolved with detecting objects, even as detecting an item time and again in next photo collection is frequently important to assist and confirm monitoring. In this paper, a unique technique is being provided for detecting and monitoring item. It consists of mixture of Kalman clear out and rapid suggest shift set of rules. Kalman prediction is size follower. It can be misled with the aid of using incorrect size. In order to cater it, rapid suggest shift set of rules is used. It is used to find densities extreme, which offers clue that whether or not Kalman prediction is proper or it's far misled with the aid of using incorrect size. In case of incorrect prediction, it's far corrected with the assist of densities extreme within side the scene. The proposed technique has the strong potential to transferring item within side the consecutive frames beneath a few forms of problems consisting of fast look modifications because of photo noise, illumination modifications, and cluttered background.

2.8 "CODE ACQUISITION AND TRACKING OF IRNSS SIGNALS"

by Anirudh Lanka, Aishwarya Shivani R., Amoolya R. Bayari, Suresh Dakkumalla and Shylashree N, April 2019

Navigation using the Indian Regional Navigation Satellite System (IRNSS) requires processing of the lowest raw data received from the corresponding satellites. The acquired Radio Frequency signal is subjected to a software based IRNSS receiver consisting of a Numerically Controlled Oscillator to convert from Radio Frequency Range to Intermediate Frequency Range for further processing. The converted signal is then subjected to various algorithms for achieving Code Acquisition, Locking and Tracking to complete the navigation. This paper discusses about building a software based IRNSS receiver to simulate the navigation behavior in real time. All the simulation codes are written in VHDL and in accordance with the Zynq-706 FPGA board.The simulation manifests that Serial Acquisition consumes the lowest resource, but is time exhausting with 41933 iterations. Whereas the PCPS technique requires only 41 (or 1023 for PFSS) iterations but uses higher order DSP processors.

2.9 "A COMPREHENSIVE METHOD FOR GNSS DATA QUALITY DETERMINATION TO IMPROVE IONOSPERIC DATA

QUALITY”
by Michan Kim, Jiwon Seo and Jiyun Lee, August 2014

Global Navigation Satellite Systems (GNSS) are now recognized as cost- effective tools for ionospheric studies by providing global coverage through global networks of GNSS stations. As GNSS networks continue to expand to improve observability of the ionosphere, the amount of poor quality GNSS observation data also increases and the use of poor quality GNSS data deteriorates measurement accuracy. This paper develops a comprehensive method for determining the quality of GNSS observations for ionospheric studies. The algorithms are specifically designed to calculate the key GNSS data quality parameters that affect the quality of the ionospheric product. The quality of data collected from the Continuously Operating Reference Station Network (CORS) in the contiguous United States (CONUS) is analyzed. The resulting quality varies considerably depending on each station, and the data quality of the individual stations persists for a longer period of time. Compared to conventional methods, the quality parameters obtained from the proposed method have a stronger correlation with the quality of the ionospheric data. The results suggest that a set of data quality parameters, when used in combination, can efficiently select stations with high quality GNSS data and improve the performance of ionospheric data analysis.

2.10 “EVALUATION OF INTERSYSTEM INTERFERNCE BETWEEN NAVIC, GPS AND GALILEO”

by Dr. Deepak Mishra, January 2018

The paper provides an assessment of compatibility among NavIC, GPS and Galileo systems. Simulations are performed taking into account the intersystem interference between NavIC and GPS system in L5 band and NavIC and Galileo in L5 and E5a band on Indian region. Parameters considered in simulation are Space Constellation, ground cycle repeat time of satellite, EIRP etc. It is shown that the intersystem interference of Galileo caused by NavIC is slightly larger than interference of IRNSS due to Galileo. Similarly, the intersystem interference of GPS caused by NavIC is slightly larger than interference of NavIC due to GPS. Maximum interference is considered for all the cases.

CHAPTER:- 3

METHODOLOGY

3.1 METHODOLOGY

In this project the NMEA data is recorded by the GPS receiver which is connected to the raspberry Pi micro controller. The NMEA raw data .txt file undergoes data acquisition, thus extracting the raw data of the place the device is kept.

Using this point data as destination and source, GNSS receiver is used to record static data and dynamic data (latitude and longitude information) of different locations, they will act as source, the distance between source and destination is determined.

The Formula is coded in Python and included in the Raspberry Pi. The raw data of two locations, the starting point and the destination point, and being fed into the Raspberry Pi to calculate the distance. Raspberry pi is connected to the display of the results.

The GPS receiver is taken to various locations to record the dynamic data, which is an on road survey taking into consideration the geographic locations. This is done in regions in and around Bangalore.

The static data is collected and the positional error in the used GPS receiver is estimated and analysed using the developed python source code. The dynamic data is collected by connecting the GPS receiver and the IMU to the raspberry pi, and both the device data is got with respect to the same time stamp. By comparing the velocity of the IMU and GPS receiver the positional error of the GPS receiver is estimated. The python source code is developed and wanted NMEA data is extracted from the raw data from both static and dynamic values.

We will then repeat the process using the NAVIC receiver. After obtaining the values, the data is saved in .txt or .xlsx The data is imported into Matlab and the graph is obtained. From the graph which we get the difference and interference is observed.

The final step is to study the INTERFERENCE induced at each time point at different data collection of static and dynamic mode with respect to data extracted from GPS and NavIC receiver.

An interference is that which modifies a signal in a disruptive manner, as it travels along a communication channel between its source and receiver. The term is often used to refer to the addition of unwanted signals to a useful signal.

3.2 PROBLEM STATEMENT

The purpose of this project is to analyze the data collected by GNSS receivers of satellite constellations of various bands and to carry out comparative studies of signal variability related to position, velocity and interference signal.

The second goal is to implement filtering techniques to estimate the signal and improve its accuracy. Finally, we use python coding , including Matlab to perform a comparative analysis.

CHAPTER:- 4

DESIGN APPROACH

4.1 RASPBERRY PI 4 MODEL B

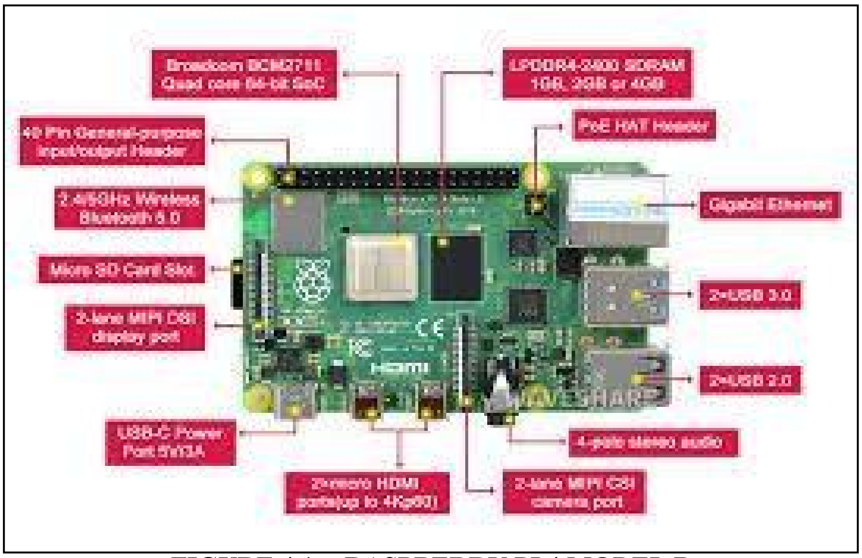


FIGURE 4.1 :- RASPBERRY PI 4 MODEL B

4.1.1 FEATURES

- A high-performance 64-bit quad-core processor
- Dual display support with resolutions up to 4K via a pair of micro-HDMI ports
- Hardware video decoding up to 4Kp60
- 4 GB of RAM
- A connection to the dual-band wireless local area network 2.4/5.0 GHz
- Bluetooth 5.0 / Gigabit Ethernet / USB 3.0 / PoE features (via a separate HAT PoE add-on module

4.1.2 SPECIFICATIONS

- Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
- 2GB, 4GB or 8GB LPDDR4-3200 SDRAM (depending on model)
- 2.4 GHz and 5.0 GHz IEEE 802.11ac wireless, Bluetooth 5.0, BLE
- Gigabit Ethernet
- 2 USB 3.0 ports; 2 USB 2.0 ports.
- Raspberry Pi standard 40 pin GPIO header (fully backwards compatible with previous boards)
- 2 × micro-HDMI ports (up to 4kp60 supported)
- 2-lane MIPI DSI display port

- 2-lane MIPI CSI camera port
- 4-pole stereo audio and composite video port
- H.265 (4kp60 decode), H264 (1080p60 decode, 1080p30 encode)
- OpenGL ES 3.1, Vulkan 1.0
- Micro-SD card slot for loading operating system and data storage
- 5V DC via USB-C connector (minimum 3A*)
- 5V DC via GPIO header (minimum 3A*)
- Power over Ethernet (PoE) enabled (requires separate PoE HAT)
- Operating temperature: 0 – 50 degrees C ambient
- A good quality 2.5A power supply can be used if downstream USB peripherals consume less than 500mA in total.

4.2 GPS NEO - 6M

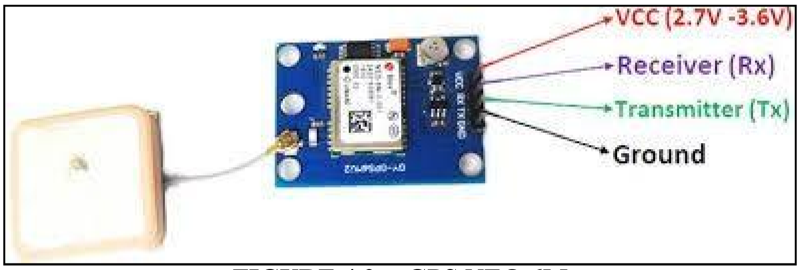


FIGURE 4.2 :- GPS NEO 6M

4.2.1 FEATURES

- 5Hz position update rate
- Operating temperature range: -40 TO 85°CUART TTL socket
- EEPROM to save configuration settings
- Rechargeable battery for Backup
- The cold start time of 38 s and Hot start time of 1s
- Supply voltage: 3.3 V
- Configurable from 4800 Baud to 115200 Baud rates. (default 9600)
- Super Sense Indoor GPS: -162 dBm tracking sensitivity
- Support SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Separated 18X18mm GPS antenna

4.2.2 SPECIFICATIONS

- Main Chip NEO-6
- Sensitivity (dBm): - 160 156
  Cold Start (without aiding): -147 dBm
  Tracking & Navigation: -161 dBm
- Navigation Update Rate: 5Hz
- Position Accuracy (Meter): 2

- Operating Temperature Range (°C): -24 to 84
- Tracking Sensitivity (dBm): -161 dBm
- Avg Cold Start Time (s): 27
- Warm Start Time (s): 27
- Maximum Speed: 500 M/s
- Dimensions (mm): LxWxH
- Antenna: – 25 x 25 x 7
- GPS Board: – 22 x 30 x 4
- Weight (gm): 12
- Cable Length (cm): 10
- Shipment Weight: 0.016 kg
- Shipment Dimensions: 8 × 6 × 4 cm

4.3 IMU MPU - 6050

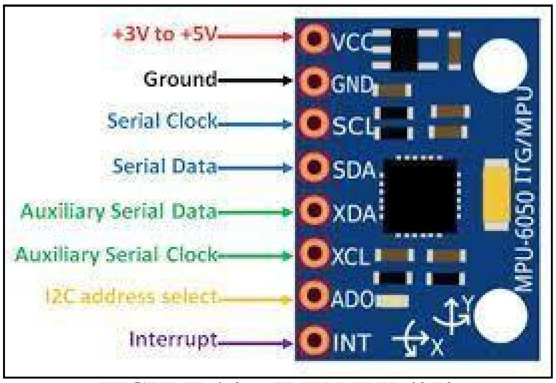


FIGURE 4.3 :- IMU MPU 6050

4.3.1 FEATURES

- INT- Interrupt digital output pin.
- AD0- I2C Slave Address LSB pin. This is 0th bit in 7-bit slave address of device. If connected to VCC then it is read as logic one and slave address changes.
- XCL - Auxiliary Serial Clock pin. This pin is used to connect other I2C interface enabled sensors SCL pin to MPU-6050.
- XDA - Auxiliary Serial Data pin. This pin is used to connect other I2C interface enabled sensors SDA pin to MPU-6050.
- SCL - Serial Clock pin. Connect this pin to micro controllers SCL pin.
- SDA - Serial Data pin. Connect this pin to micro controllers SDA pin.
- GND - Ground Pin. Connect this pin to Ground Connection.
- VCC - Power Supply Pin. Connect this pin to +5V DC Supply.

4.3.2 SPECIFICATIONS

- Supply voltage: 2.3–3.4 V

Consumption: 3.9 mA max.

- Accelerometer:
  Measuring ranges: ±2 g ±4 g ±8 g ±16 g
  Calibration tolerance: ±3%
- Gyroscope:
  Measuring ranges: ±250/500/1000/2000 °/sar
  Calibration tolerance: ±3%
- I2C interface
- Embedded temperature sensor
- Select able jumpers on CLK, FSYNC and AD0
- Operating temperature: -40 °C to +85 °C
- Dimensions: 25.5 × 15.2 × 2.48 mm

4.4 NAVIC NTL 103.SMT OEM GNSS MODULE

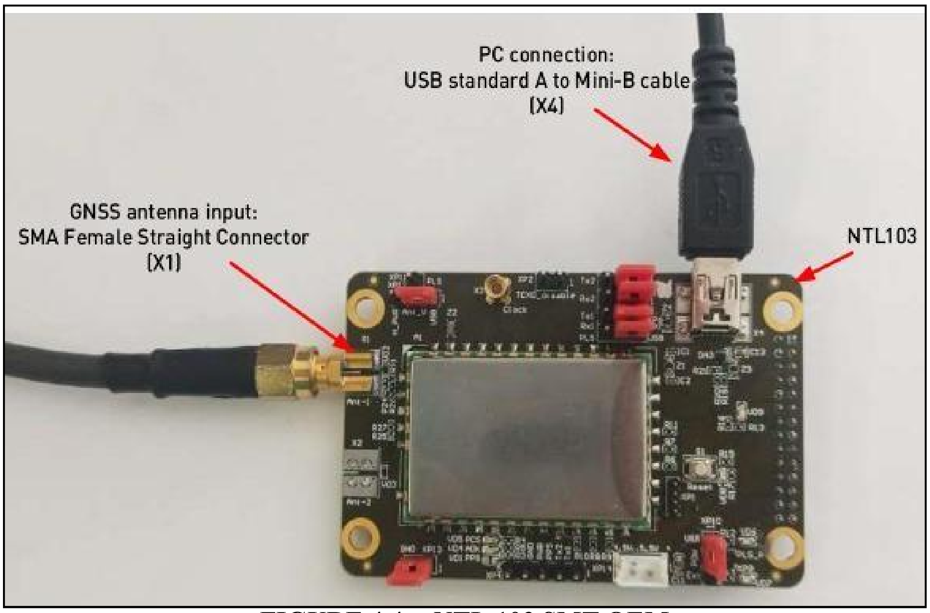


FIGURE 4.4 :- NTL 103.SMT OEM

4.4.1 FEATURES

- One antenna input for simultaneous receiving S-band and L-band.
- On board USB - UART Converter and Low Dropout linear regulator.
- Different interface types;
  - 2xVirtual COM Ports on mini USB.
  - 2XUART
- Board Power Supply:
  - USB Ports
  - External Power Sources
- Six user LEDs
- One push button (reset)

- Ten Jumpers
- Mini USB Connector, PLD2-28 Connector, PLS-5 Connector for quick connection to board and easy probing.

4.4.2 SPECIFICATIONS

- Measurement precision (One sigma):
  - C/A pseudoranges3: 20 cm
  - L1, L2 carrier phase: 0.8 mm
- Standalone mode Accuracy (RMS):
  - Position Horizontal: 2.1 m
  - Position Vertical: 3.8 m
- SBAS+GPS mode Accuracy (RMS):
  - Position Horizontal: 0.8 m
  - Position Vertical: 1.1 m
- Velocity Accuracy (RMS):
  - Velocity Horizontal: 0.02 m/s
  - Velocity Vertical: 0.03 m/s
- Data Update Rates:
  - Position data update rate: 1Hz
  - Raw data update rate: Up to 20Hz
- Electrical Parameters:
  - Supply Voltage, V: 3.3-5.5
  - Power Consumption, W: Max 1.55
- Environmental Characteristics:
  - Operating Temperature, ^{O}C: -40^{O}C to +80^{O}C
  - Storage Temperature, ^{O}C: -55^{O}C to +85^{O}C
- Weight and Size:
  - Dimensions[L X W X H], mm: 71.1 X 45.7 X 15.9
  - Weight, g: <33

CHAPTER:- 5

PROCEDURE AND PROGRAM

5.1 RASPBERRY PI 4 CONNECTIONS WITH GPS AND IMU

The GPS and IMU Receiver are connected to the Raspberry Pi 4. The GPS receiver provides the data of both the origin or source and destination, which helps to calculate the position error of the GPS receiver.

The IMU is used to record the acceleration with the same time stamp that the GPS receives velocity is recorded.

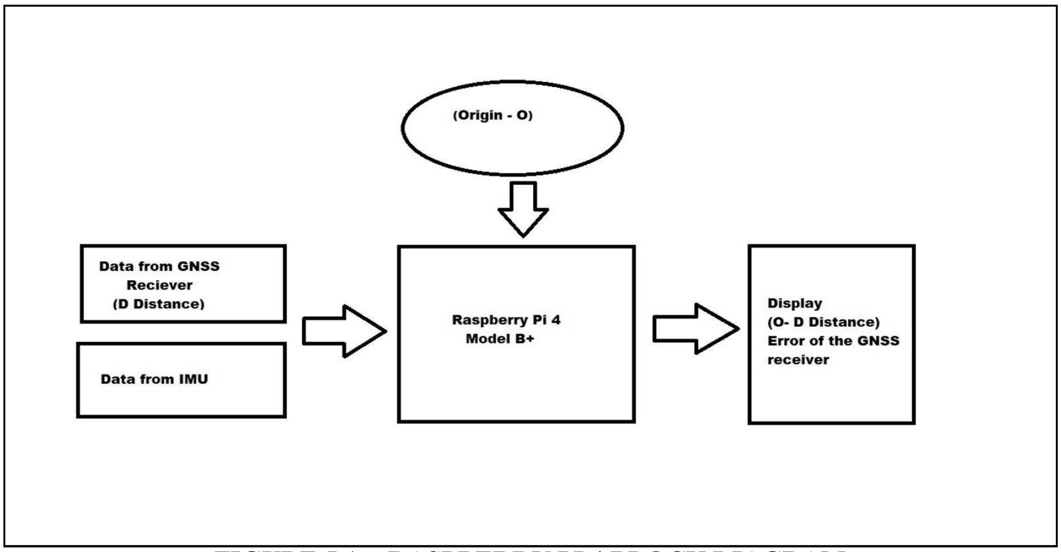


FIGURE 5.1 :- RASPBERRY PI 4 BLOCK DIAGRAM

5.2 GETTING RAW DATA FOR GPS MODULE (NEO-6M)

STEPS	PROCEDURE
1.	Power up Raspberry pi once the memory card is installed in it with rasbian OS.
2.	Now here we need to modify few things. At first we need to edit the /boot/config.txt file. Now you need to open this file in any text editor. Here I am using nano: sudo nano /boot/config.txt At the end of the file add the following lines: dtparam=spi=on

	dtoverlay=pi3-disable-bt core_freq=250 enable_uart=1 force_turbo=1 Now save this by typing ctrl +x, then type y and press enter.
3.	Raspbian uses the UART as a serial console and so we need to turn off that Functionality. To do so we need to change the /boot/cmdline.txt file. For safety before editing the file make a backup of that using the following command: sudo cp /boot/cmdline.txt /boot/cmdline_backup.txt Now to edit that file open that in text editor: sudo nano /boot/cmdline.txt Replace the content with the following line (delete everything in it and write down the following content): dwc_otg.lpm_enable=0 console=tty1 root=/dev/mmcblk0p2 rootfstype=ext4 elevator=deadline fsck.repair=yes rootwait quiet splash plymouth. ignore- serial- consoles Now save this by typing ctrl +x, then type y and press enter.
4.	Now reboot pi using: sudo reboot
5.	After the reboot now its time to check how our GPS module is working. When the blue led is blinking, run the following command: sudo cat /dev/ttyAMA0 Now you will see a lots of raw data showing up . That basically means that its working. To stop this type Ctrl + c .
6.	Before Writing the python code we need few changes in setup ; which port is connected with serial0 use the following command: ls -l /dev serial0 is linked with ttyAMA0. So to disable the console you need to use the following commands: sudo systemctl stop serial-getty@ttyAMA0.service sudo systemctl disable serial-getty@ttyAMA0.service
7.	Now we need to install a python library: pip install pynmea2

5.3 PYTHON CODE FOR EXTRACTING GPS DATA

For Parsing the latitude, longitude, time stamp and few others from the received GPS data in the NMEA Format, we used below program:

```
import serial

port = "/dev/ttyAMA0"

def parseGPS(data):
```

```
    #  print "raw:", data #prints raw data
    if data[0:6] == "$GPRMC":
        sdata = data.split(",")
        if sdata[2] == 'V':
            print("no satellite data available")
            return
        print("---Parsing GPRMC---")
        time = sdata[1][0:2] + ":" + sdata[1][2:4] + ":" + sdata[1][4:6]
        lat = decode(sdata[3])  # latitude
        dirLat = sdata[4] # latitude direction N/S
        lon = decode(sdata[5])  # longitute
        dirLon = sdata[6] # longitude direction E/W
        speed = sdata[7]  # Speed in knots
        trCourse = sdata[8]  # True course
        date = sdata[9][0:2] + "/" + sdata[9][2:4] + "/" + sdata[9][4:6] # date
        magvar= sdata[10] # Magnetic Varition
        print("time : %s, latitude : %s(%s), longitude : %s(%s), speed : %s,
              True Course : %s, Date : %s, Magnetic Variation: %s" %(time, lat,
            dirLat, lon, dirLon, speed, trCourse, date, magvar))
    elif data[0:6] == "$GPGSV":
        gdata = data.split(",")
        sv = gdata[3] # no.svs
        prn = gdata[4] # sv prn
        snr= gdata[7] # snr
        print("Satellite visible: %s, PRN: %s, SNR: %s" %(sv,prn,snr))

def decode(coord):
    # Converts DDDMM.MMMMM > DD deg MM.MMMMM min
    x = coord.split(".")
    head = x[0]
    tail = x[1]
    deg = head[0:-2]
    min = head[-2:]
    return deg + " deg " + min + "." + tail + " min"

print("Receiving GPS data")
ser = serial.Serial(port, baudrate=9600, timeout=0.5)
#serial=serial.Serial("dev/ttyAMA0", baudrate=9600, timeout=0.5)
while True:
    data = ser.readline()
        parseGPS(data)
```

5.4 IMU(MPU6050) INTERFACING WITH RASPBERRY PI 4

To interface MPU6050 using Raspberry Pi, we should ensure that I2C protocol on Raspberry Pi is turned on. So before going for interfacing MPU6050 with raspberry Pi, we need to make some I2C configurations on Raspberry Pi.

STEPS	PROCEDURE
1.	First, we should enable I2C in Raspberry Pi. We can enable it through terminal which is given below: sudo raspi-config
2.	Select Interfacing Configurations In Interfacing option, Select -> I2C
3.	Select Yes when it asks to Reboot
4.	Now, after booting raspberry Pi, we can check user-mode I2C port by entering following command: ls /dev/*i2c* then Pi will respond with name of i2c port.
5.	Now, we can test/scan for any I2C device connected to our Raspberry Pi board by installing i2c tools. We can get i2c tools by using apt package manager. Use following command in Raspberry Pi terminal. sudo apt-get install -y i2c-tools
6.	Now connect any I2C based device to the user-mode port and scan that port using following command, sudo i2cdetect -y 1
7.	Then it will respond with device address.
8.	While developing program for Raspberry Pi I2C communication in python, use SMBuslibrary package which has great support to access I2C devices. So, we should add SMBus support for Python by using apt packet manager, sudo apt-get install python-smbus

5.5 PYTHON CODE FOR EXTRACTING IMU DATA

```
import smbus                      #import SMBus module of I2C
from time import sleep          #import

#some MPU6050 Registers and their Address
PWR_MGMT_1  = 0x6B
SMPLRT_DIV = 0x19
CONFIG       = 0x1A
GYRO_CONFIG = 0x1B
INT_ENABLE = 0x38
```

```
ACCEL_XOUT_H = 0x3B
ACCEL_YOUT_H = 0x3D
ACCEL_ZOUT_H = 0x3F
GYRO_XOUT_H = 0x43
GYRO_YOUT_H = 0x45
GYRO_ZOUT_H  = 0x47

def MPU_Init():
        #write to sample rate register
        bus.write_byte_data(Device_Address, SMPLRT_DIV, 7)
        #Write to power management register
        bus.write_byte_data(Device_Address, PWR_MGMT_1, 1)
        #Write to Configuration register
        bus.write_byte_data(Device_Address, CONFIG, 0)
        #Write to Gyro configuration register
        bus.write_byte_data(Device_Address, GYRO_CONFIG, 24)
        #Write to interrupt enable register
        bus.write_byte_data(Device_Address, INT_ENABLE, 1)

def read_raw_data(addr):
    #Accelero and Gyro value are 16-bit
    high = bus.read_byte_data(Device_Address, addr)
    low = bus.read_byte_data(Device_Address, addr+1)
    #concatenate higher and lower value
    value = ((high << 8) | low)
    #to get signed value from mpu6050
    if(value > 32768):
        value = value - 65536
    return value

bus = smbus.SMBus(1)    # or bus = smbus.SMBus(0) for older version boards
Device_Address = 0x68  # MPU6050 device address

MPU_Init()

print (" Reading Data of Gyroscope and Accelerometer")

while True:
        #Read Accelerometer raw value
        acc_x = read_raw_data(ACCEL_XOUT_H)
        acc_y = read_raw_data(ACCEL_YOUT_H)
        acc_z = read_raw_data(ACCEL_ZOUT_H)
        #Read Gyroscope raw value
        gyro_x = read_raw_data(GYRO_XOUT_H)
        gyro_y = read_raw_data(GYRO_YOUT_H)
        gyro_z = read_raw_data(GYRO_ZOUT_H)
        #Full scale range +/- 250 degree/C as per sensitivity scale factor
        Ax = acc_x/16384.0
        Ay = acc_y/16384.0
        Az = acc_z/16384.0
```

```
        Gx = gyro_x/131.0
        Gy = gyro_y/131.0
        Gz = gyro_z/131.0

print ("Gx=%.2f" %Gx, u'\u00b0'+ "/s", "\tGy=%.2f" %Gy, u'\u00b0'+ "/s",
    "\tGz=%.2f" %Gz, u'\u00b0'+ "/s", "\tAx=%.2f g" %Ax, "\tAy=%.2f    g" %Ay,
    "\tAz=%.2f g" %Az)
        sleep(1)
```

5.6 NTLAB (NTL103 OEM MODULES) CONNECTIONS FOR GETTING THE RAW DATA FOR NAVIC RECEIVER

STEPS	PROCEDURE
1.	Install NTL Browser on the computer.
2.	Install FT4232HL Drivers on computer. Utility software downloadable from.
3.	Install NTL 103 on the NTL Eva board .
4.	Set NTL Eva Board jumpers and NTL 103 jumpers in accordance with its manual. Jumpers position on the board for getting is presented.
5.	Connected antenna(s) to the NYL 103 Connector.
6.	Connected NTL Eva Board to PC mini USB cable.
7.	Connect the DC external power source 24V to X5 NTL Eva Board connector and turn it on. NTL Eva Board provides +5V supply voltage for navigation module. Make sure, that LEDs VD4 and VD5 NTL Eva board glow green. It means , the board is powered and operates properly.
8.	Run NTL browser on computer. Then configure it: - Select interface language in the upper right corner of welcome page; - Select the COM16 Port, Port number could be different for alternative PC; - Set up Auto Detect checkbox; - Click on the Connect button to continue.
9.	Exit NTL browser to release COM Port. To do this select Connection / Disconnect .
10.	The raw data stars showing up in the window of the NTL Browser.
11.	Run the data for few hours and save it in .CSV extension for further extraction .

CHAPTER:- 6

RESULTS AND DISCUSSION

6.1 ANALYSIS OF GPS SATELLITES AND IMU SENSOR FROM STATIC DATA

Static Data is been Observed from a particular location , which as been located by google maps .

Source : VRR Kings Apartment, Bangalore

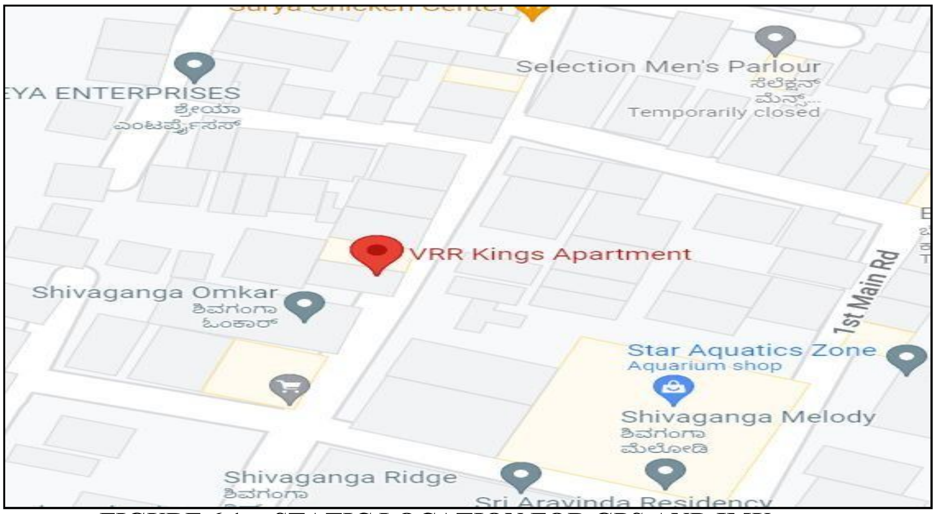
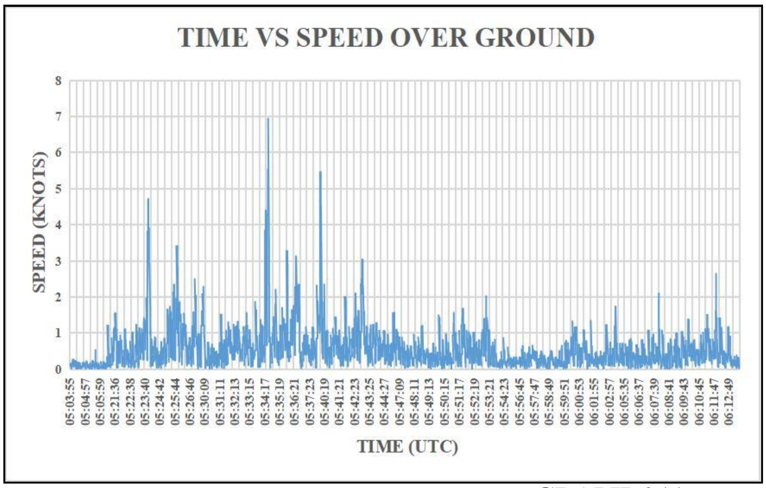


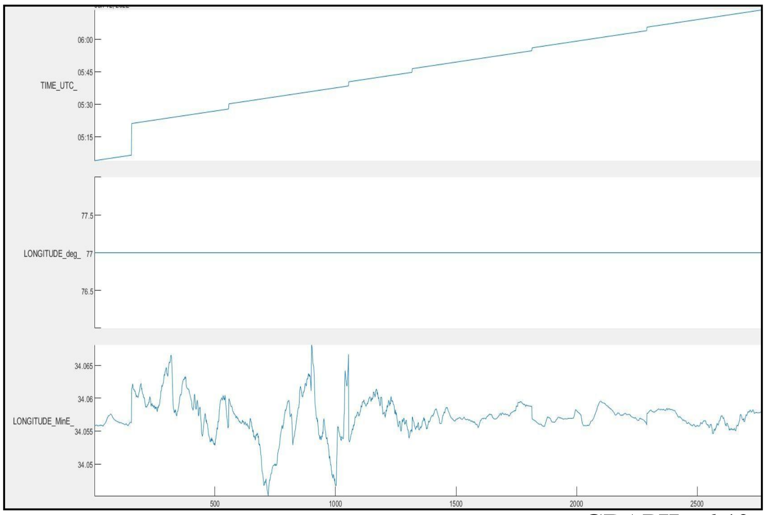
FIGURE 6.1 :- STATIC LOCATION FOR GPS AND IMU

With reference to Graph 6.11 - In the study of the graph it is observed that the speed increases and decreases with vary in time.



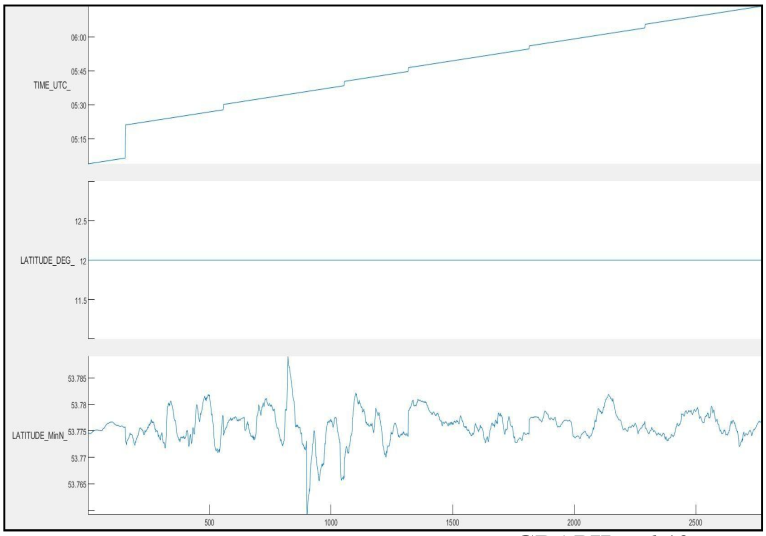
GRAPH 6.11

With reference to graph 6.12 - In the respective graph when the data readings are obtained via statically.
It is observed that there is less interference that is caused due to the signals emitted from mobile devices and Wi-fi routers.
The variation in the values can be seen in the graph of time vs longitude there is vary in longitude in east direction.



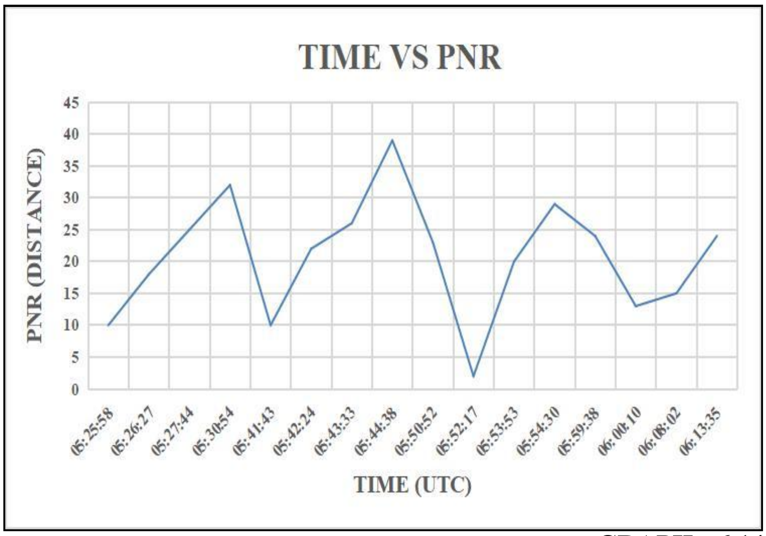
GRAPH:- 6.12

With reference to Graph 6.13 - In the respective graph when the data readings are obtained via statically.
It is observed that there is less interference that is caused due to the signals emitted from mobile devices and Wi-fi routers.
The variation in the values can be seen in the graph of time vs latitude there is vary in latitude in north direction.



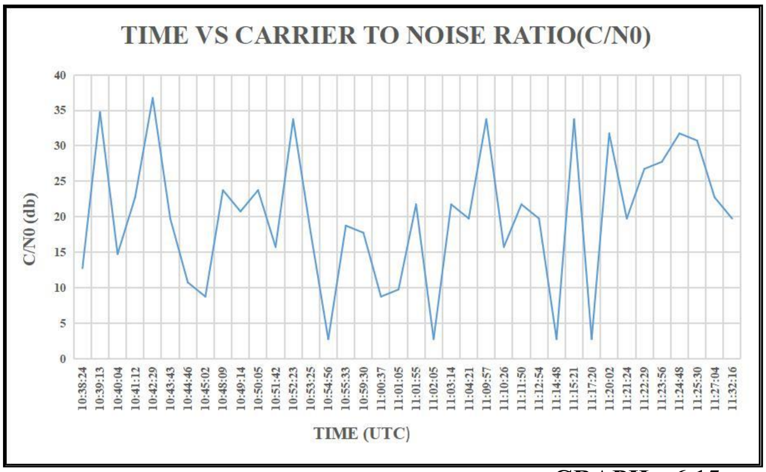
GRAPH:- -6.13

With reference to Graph 6.14 - The tracking of signals from satellite of IRNSS is successfully implemented and plotted as amplitude vs time.

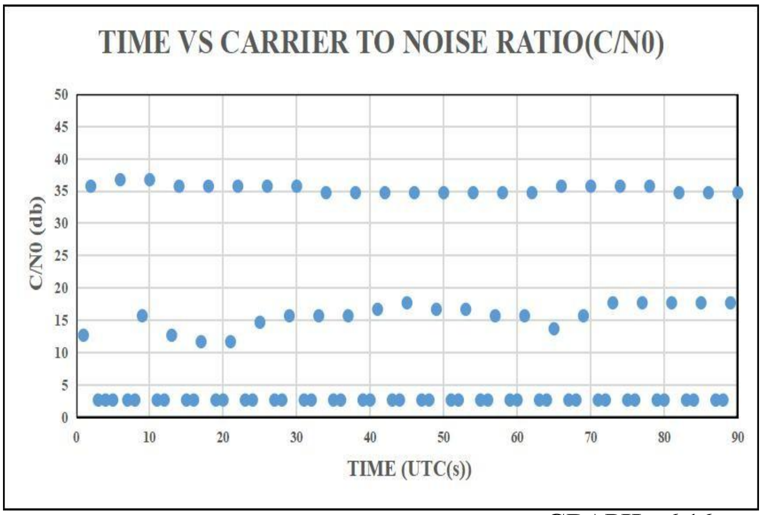


GRAPH:- 6.14

With reference to Graph 6.15 and 6.16 - it is observed that Static Data collected from the GNSS Receivers in different bands were obtained and it had high C/N ratios which has good signal strength. CNRvs Time of the Satellites were plotted.



GRAPH:- 6.15



GRAPH:- 6.16

6.2 ANALYSIS OF GPS SATELLITES AND IMU SENSOR FROM DYNAMIC DATASETS

The Dynamic data , location points are been considered from Google Maps.

Source : Yelachenahalli Metro Station, Bangalore
Destination : Lalbagh Metro Station, Bangalore
Real Time Distance : 6.2 KM
Code Executed Distance : 6 KM

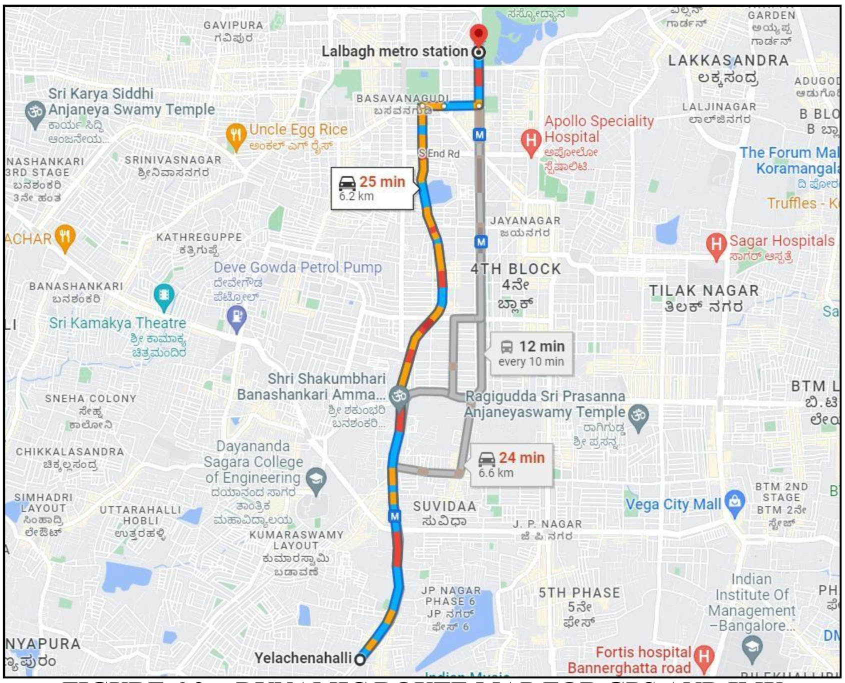
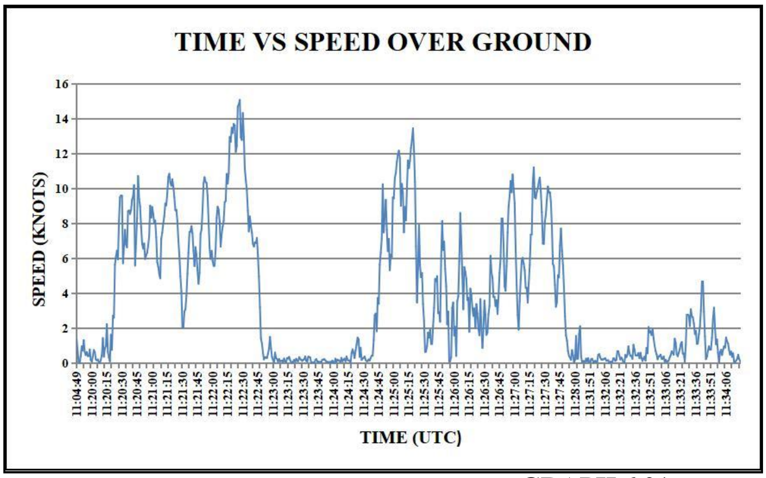


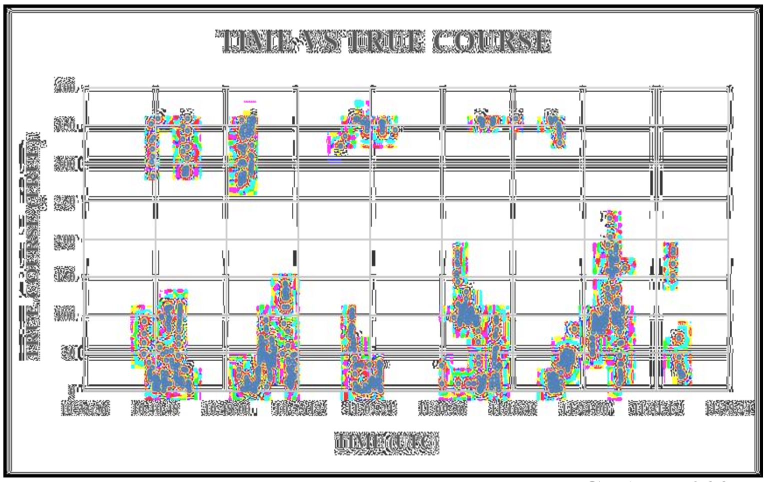
FIGURE 6.2 :- DYNAMIC ROUTE MAP FOR GPS AND IMU

With reference to Graph 6.21 - It shows the graph of the velocity of the GPS receiver in m/s verses time in seconds.
The NMEA raw data extracted from the .txt file contains the velocity of the GPS receiver in terms of knots. 1 knot= 0.514m/s.



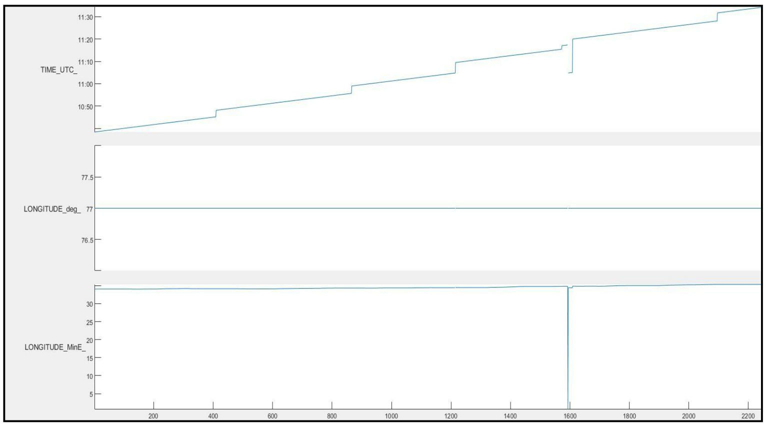
GRAPH 6.21

With reference to Graph 6.22 - True course over the ground relative to true north. It is corrected by wind.
From this graph it is seen how it differed while receiving the signals.



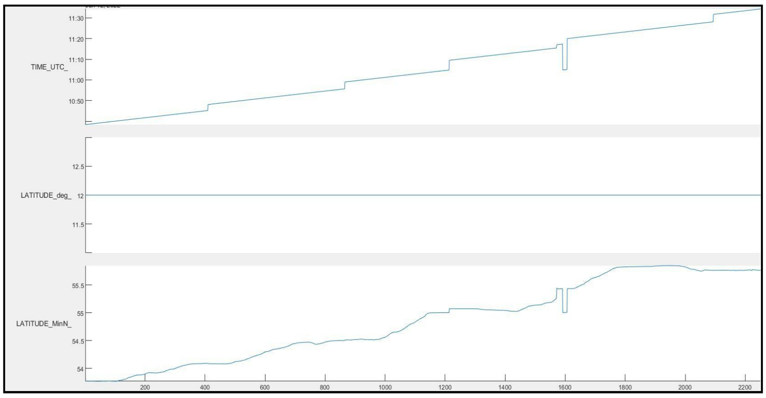
GRAPH 6.22

Taking Graph 6.23 as reference - In the respective graph when the data readings are obtained via dynamically. It is observed that there is maximum interference that is caused due to the signals emitted from cell towers, broadcasting networks and electric supply units and many more. While collecting data,in certain areas signals were lost and the data was not obtained.
The variation in the values can be seen in the graph of time vs longitude there is vary in longitude in east direction



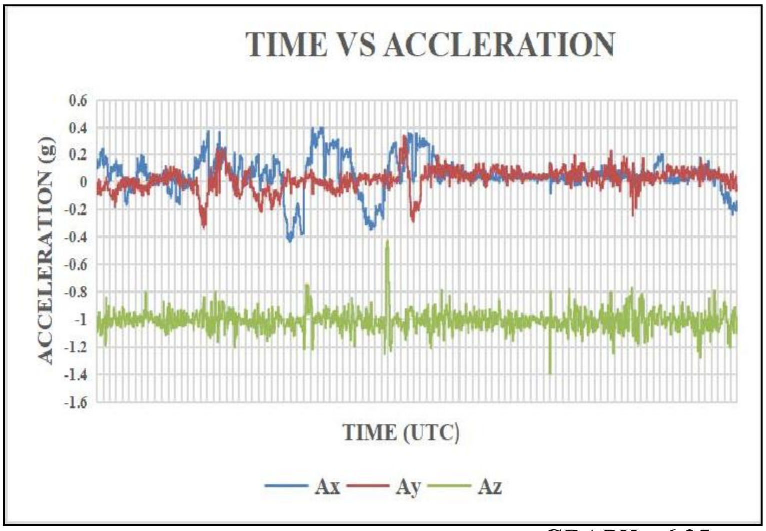
GRAPH 6.23:- TIME VS LONGITUDE

Taking Graph 6.24 as reference - In the respective graph when the data readings are obtained via dynamically. It is observed that there is maximum interference that is caused due to the signals emitted from cell towers, broadcasting networks and electric supply units and many more. While collecting data, in certain areas signals were lost and the data was not obtained
The variation in the values can be seen in the graph of time vs longitude there is vary in latitude in North direction.



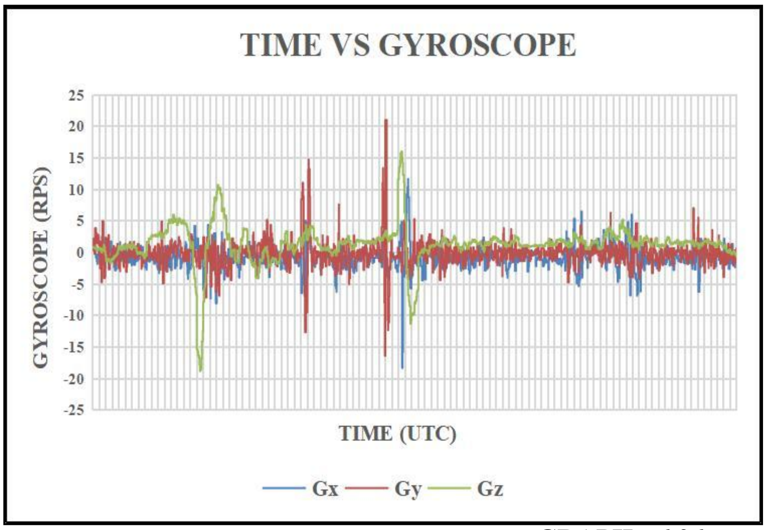
GRAPH 6.24 : TIME VS LATITUDE

Taking Graph 6.25 into consideration - it can be said IMU acceleration with respect to x,y,z-axis verses time graph can be obtained



GRAPH:- 6.25

Taking Graph 6.26 into consideration - it can be said IMU Gyroscope with respect to x,y,z-axis verses time graph is obtained



GRAPH:- 6.26

6.3 ANALYSIS OF NAVIC SATELLITES FROM ALL DATASETS

The NavIC datasets , are considered from a particular location, which is located from Google Maps.

Source : Shivaganga Bliss, Bangalore

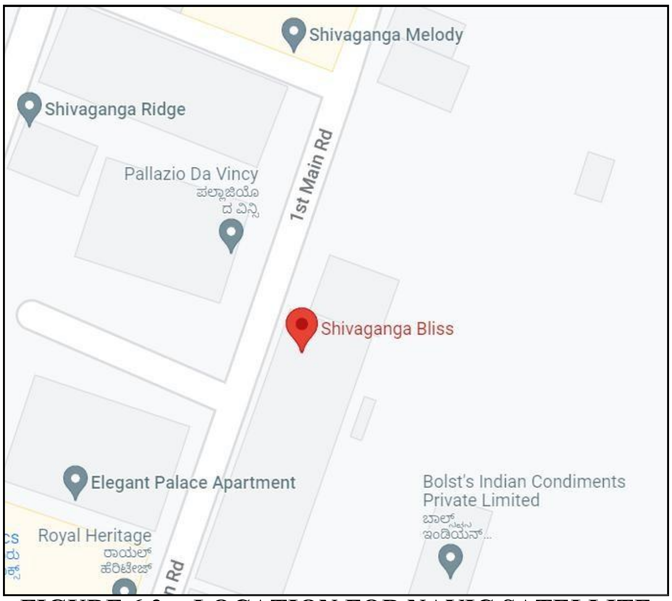
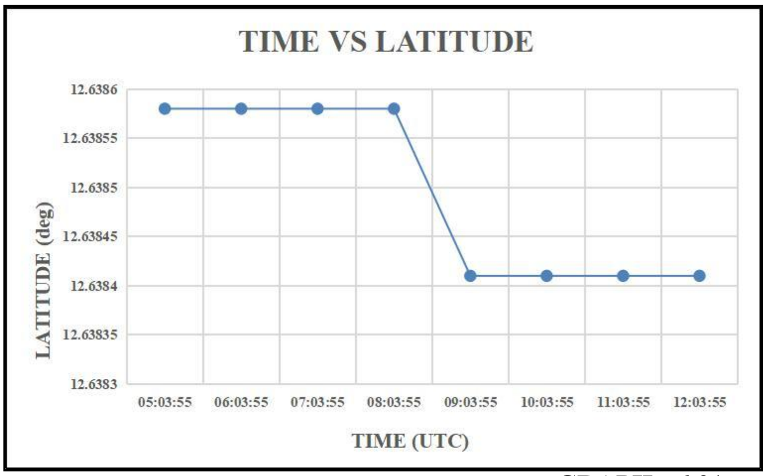
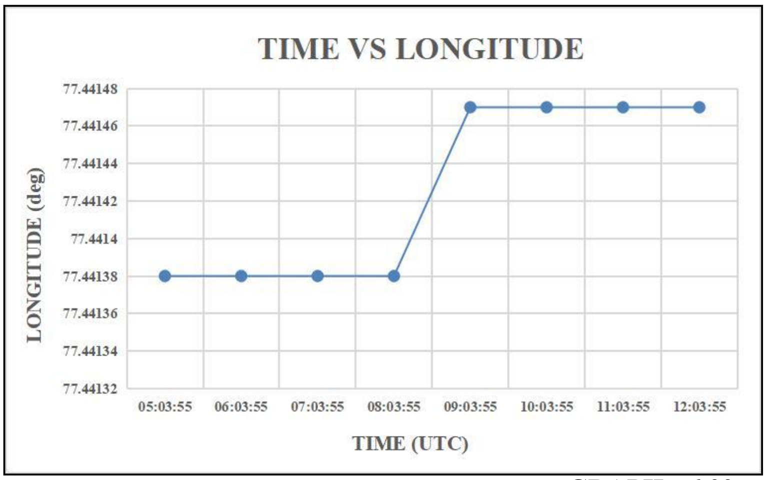


FIGURE 6.3 :- LOCATION FOR NAVIC SATELLITE

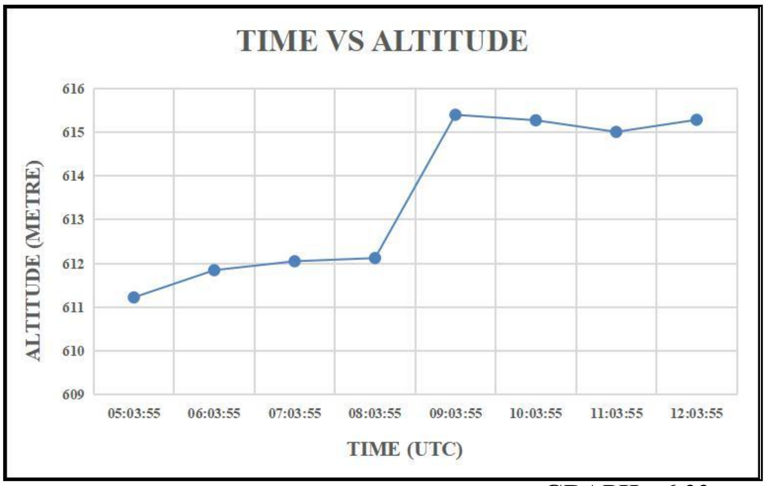
From the graphs we observe that, longitude, latitude and altitude does not vary much with or without interference.



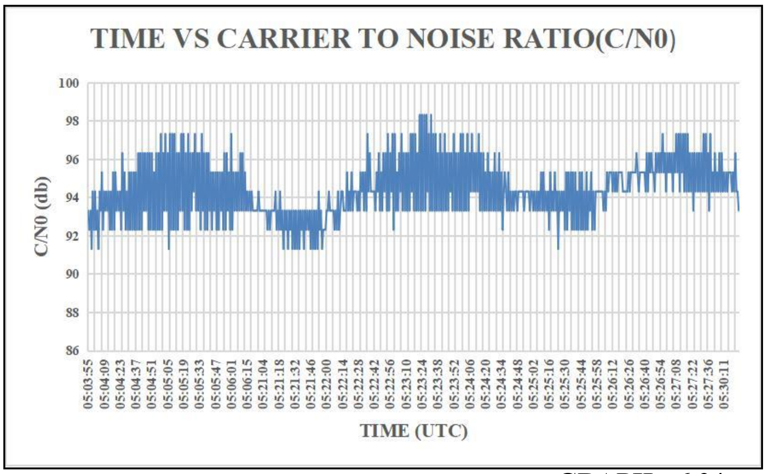
GRAPH:- 6.31



GRAPH:- 6.32

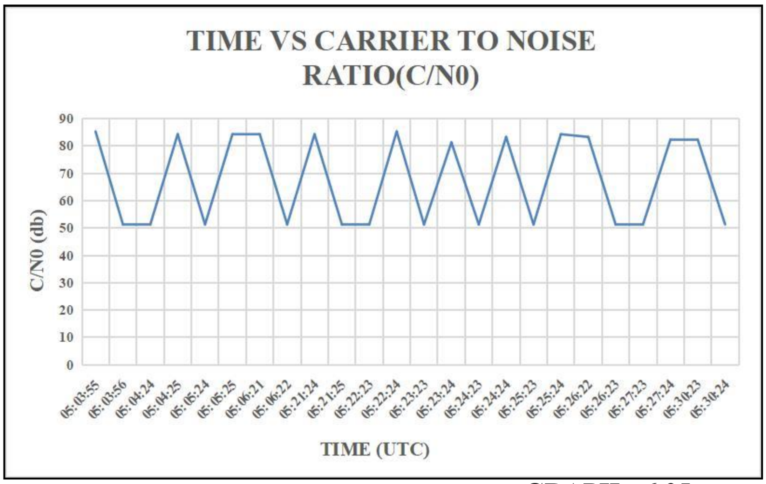


GRAPH:- 6.33



GRAPH:- 6.34

With reference to Graph 6.34 & 6.35 - it is observed that Data collected from the NAVIC Receiver in different bands were analysed and there was low C/N ratios which had less signal strength . CNR vs Time of the Satellites were plotted.



GRAPH:- 6.35

CHAPTER:- 7

CONCLUSION

Static and Dynamic datasets collected from the GNSS Receivers in numerous locations are analysed. once the signal travels in different layers of atmosphere it'll be exposed to refraction and optical phenomenon that makes the signal to degrade.

The receiver is taken for the survey wherever the receiver is exposed to transformers, wireless fidelity signals and building at different point of your time to spot the interference. From this survey we will observe the Interference impact of the navigation signal in each static and dynamic modes.

The Static data within the NMEA raw format is gathered and run through the developed algorithmic program to work out the error of the static GPS receiver. For comparison the IMU is also connected as described.

By analysing the information gathered from the static GPS receiver, it may be complete that the GPS receiver though static , shows variations in C/N0 and alternative parameters , therefore inflicting interference of the receiver.

The dynamic data for satellites is calculated using this code and compared it with the values of Google maps. the real time duration being 6.2Km from source to destination and calculated being 6Km for constant source and destination.

The dynamic data within the NMEA raw format is gathered and run through the developed algorithmic program to work out the error of the dynamic GPS receiver. For comparison the IMU is connected as described.

Ideally the values recorded and derived of the Variations in IMU and variations of GPS receiver ought to be the same time stamp. however in the globe there are variations resulting in errors in the GPS receiver.

From the above, on taking into thought varied mentioned parameters, we can conclude that the GPS and IMU receiver used, in static state and dynamic state has shown errors inflicting Interference.

Time versus varied parameters of the Satellites were plotted .The Data Analytical tools were enforced and comparison analysis was performed. The results of all the surveys shows that this methodology is applicable for time period applications.

currently obtaining back with Navic,
NavIC navigation system has set began to be utilized in wide variety of applications. As a performance study, real time NavIC band signals are processed for signal acquisition and tracking with successful extraction of the navigation data.

Additional the work as been extended to compute user position by utilizing the navigation data and analyse the performance of the carrier to noise magnitude relation for Spottting the interference.

Therefore, it can be summarized that each L5 and S bands are viable of any section errors caused by noise can be eliminated within the tracking phase despite frequency. this is often acquisition of NavIC signals can be further accustomed used to estimate the interference using GNSS receivers.

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APPENDIX

APPENDIX 1:- GPS RAW DATA

$GPGSA,A,3,16,08,04,26,07,03,22,27,,,,,2.15,0.98,1.92*01

$GPGSV,3,1,12,01,08,192,,03,55,215,29,04,58,014,29,07,22,297,25*7E

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APPENDIX 2:- GPS EXTRACTED DATA

time : 18:30:01, latitude : 12 deg 53.77704 min(N), longitude : 077 deg 34.05882 min(E), speed : 0.720, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 22
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 22
Satellite visible: 13, PRN: 32, SNR: 26*4C

time : 18:30:02, latitude : 12 deg 53.77726 min(N), longitude : 077 deg 34.05913 min(E), speed : 0.768, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 22
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 22
Satellite visible: 13, PRN: 32, SNR: 26*4C

time : 18:30:03, latitude : 12 deg 53.77726 min(N), longitude : 077 deg 34.05917 min(E), speed : 0.486, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 22
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 22
Satellite visible: 13, PRN: 32, SNR: 25*4F

time : 18:30:04, latitude : 12 deg 53.77681 min(N), longitude : 077 deg 34.05930 min(E), speed : 0.762, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 22
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 22
Satellite visible: 13, PRN: 32, SNR: 25*4F

time : 18:30:05, latitude : 12 deg 53.77706 min(N), longitude : 077 deg 34.05927 min(E), speed : 0.228, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 22
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 22
Satellite visible: 13, PRN: 32, SNR: 25*4F

time : 18:30:06, latitude : 12 deg 53.77693 min(N), longitude : 077 deg 34.05928 min(E), speed : 0.270, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 22
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 21
Satellite visible: 13, PRN: 32, SNR: 24*4E

time : 18:30:07, latitude : 12 deg 53.77674 min(N), longitude : 077 deg 34.05924 min(E), speed : 0.362, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 21
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 21
Satellite visible: 13, PRN: 32, SNR: 24*4E

time : 18:30:08, latitude : 12 deg 53.77627 min(N), longitude : 077 deg 34.05940 min(E), speed : 0.677, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 21
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 21
Satellite visible: 13, PRN: 32, SNR: 24*4E

time : 18:30:09, latitude : 12 deg 53.77648 min(N), longitude : 077 deg 34.05938 min(E), speed : 0.305, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 21
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 21
Satellite visible: 13, PRN: 32, SNR: 24*4E

time : 18:30:10, latitude : 12 deg 53.77633 min(N), longitude : 077 deg 34.05934 min(E), speed : 0.405, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 20
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 20
Satellite visible: 13, PRN: 32, SNR: 24*4E

time : 18:30:11, latitude : 12 deg 53.77618 min(N), longitude : 077 deg 34.05923 min(E), speed : 0.480, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 20
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 20
Satellite visible: 13, PRN: 32, SNR: 24*4E

time : 18:30:12, latitude : 12 deg 53.77666 min(N), longitude : 077 deg 34.05907 min(E), speed : 0.406, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 20
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 21
Satellite visible: 13, PRN: 32, SNR: 24*4E

time : 18:30:13, latitude : 12 deg 53.77733 min(N), longitude : 077 deg 34.05904 min(E), speed : 0.701, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 19
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 21
Satellite visible: 13, PRN: 32, SNR: 24*4E

time : 18:30:14, latitude : 12 deg 53.77716 min(N), longitude : 077 deg 34.05897 min(E), speed : 0.466, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 19
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 22
Satellite visible: 13, PRN: 32, SNR: 23*49

time : 18:30:15, latitude : 12 deg 53.77647 min(N), longitude : 077 deg 34.05914 min(E), speed : 0.396, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 19
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 22
Satellite visible: 13, PRN: 32, SNR: 23*49

time : 18:30:16, latitude : 12 deg 53.77657 min(N), longitude : 077 deg 34.05935 min(E), speed : 0.462, True Course : , Date : 17/05/22, Magnetic Variation:
Satellite visible: 13, PRN: 01, SNR: 19
Satellite visible: 13, PRN: 16, SNR:
Satellite visible: 13, PRN: 25, SNR: 23
Satellite visible: 13, PRN: 32, SNR: 24*4E

APPENDIX 3:- IMU EXTRACTED DATA

[-0.195, 0.108, -0.987, -0.816, -0.023, 31.242, 41.292, -42.147, '\n']

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[-0.192, 0.108, -0.99, -0.778, 0.084, 31.242, 41.643, -41.809, '\n']

[-0.193, 0.109, -0.992, -0.763, -0.069, 30.893, 40.589, -42.147, '\n']

[-0.194, 0.107, -0.991, -0.656, 0.023, 31.417, 42.873, -41.64, '\n']

[-0.194, 0.107, -0.991, -0.694, 0.084, 29.148, 41.995, -41.809, '\n']

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[-0.194, 0.11, -0.994, -0.816, 0.13, 30.37, 41.116, -41.978, '\n']

[-0.194, 0.108, -0.992, -0.832, 0.015, 29.672, 42.522, -41.978, '\n']

[-0.192, 0.109, -0.989, -0.748, 0.023, 30.37, 41.467, -41.64, '\n']

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[-0.193, 0.108, -0.989, -0.732, -0.038, 31.242, 41.995, -41.809, '\n']

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[-0.194, 0.109, -0.989, -0.809, 0.061, 29.846, 41.643, -41.809, '\n']

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[-0.193, 0.108, -0.99, -0.717, 0.061, 31.766, 41.116, -41.64, '\n']

[-0.194, 0.107, -0.989, -0.725, -0.008, 29.672, 42.17, -42.655, '\n']

[-0.191, 0.108, -0.992, -0.763, 0.031, 31.242, 41.643, -41.809, '\n']

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[-0.193, 0.107, -0.989, -0.725, -0.038, 30.195, 42.697, -41.132, '\n']

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[-0.195, 0.109, -0.993, -0.763, -0.046, 31.766, 42.17, -41.978, '\n']

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[-0.193, 0.108, -0.988, -0.778, 0.031, 31.417, 41.467, -41.64, '\n']

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[-0.191, 0.108, -0.99, -0.748, 0.015, 30.37, 41.467, -40.963, '\n']

[-0.194, 0.109, -0.987, -0.732, 0.061, 30.37, 40.765, -40.624, '\n']

[-0.194, 0.107, -0.989, -0.755, -0.038, 30.893, 41.995, -42.147, '\n']

[-0.193, 0.108, -0.993, -0.771, 0.015, 28.799, 41.643, -41.809, '\n']

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APPENDIX 4:- NAVIC RAW DATA


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\g:483400*56\$GNGSA,M,3,73,,,,,,,,,,,,,,,1.87,0.91,1.63,2*08
\g:483400*56\$GNGSA,M,3,02,03,04,06,09,,,,,,,,,,,1.87,0.91,1.63,6*02
Y0!N  6 \g:483400*56\$GNVTG,282.71,T,,M,0.051,N,0.095,K,A*25
‰;!N  / \g:483400*56\$GNZDA,105320.00,06,03,2022,,*7A
 ”!N  5 \g:483400*56\$PELE110,162320.00,06,03,2022,00,00*01
˜í!N  X
\g:483400*56\$PELE111,127,017,0200000351BBF0FC000A010CC01011E24B3948BC8000000000000*3A
Ím!N & \g:483600*54\$GPGGA,,,,,,,,,,,,,,*56
Ô\!N

^ \g:483600*54\$GNGNS,105321.00,1254.5258002,N,07734.3211444,E,AANNNA,12,0.91,813.7126,,,,S*39
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\g:483600*54\$GNGSA,M,3,73,,,,,,,,,,,,,,,1.87,0.91,1.63,2*08
\g:483600*54\$GNGSA,M,3,02,03,04,06,09,,,,,,,,,,,1.87,0.91,1.63,6*02
YN!N  6 \g:483600*54\$GNVTG,322.69,T,,M,0.023,N,0.043,K,A*29
, !N  / \g:483600*54\$GNZDA,105321.00,06,03,2022,,*7B
 ˆ!N  5 \g:483600*54\$PELE110,162321.00,06,03,2022,00,00*00
˜≥!N  & \g:483800*5A\$GPGGA,,,,,,,,,,,,,,*56
˛¸!N

^ \g:483800*5A\$GNGNS,105322.00,1254.5258032,N,07734.3211489,E,AANNNA,12,0.91,813.6817,,,,S*32
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\g:483800*5A\$GNGSA,M,3,02,03,04,06,09,,,,,,,,,,1.87,0.91,1.63,6*02
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!N 5 \g:483800*5A\$PELE110,162322.00,06,03,2022,00,00*03
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Î◊!N

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\g:484000*55\$GNGSA,M,3,02,03,04,06,09,,,,,,,,,,1.87,0.91,1.63,6*02
M !N 6 \g:484000*55\$GNVTG,125.27,T,,M,0.029,N,0.055,K,A*2B
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§É!N & \g:484200*57\$GPGGA,,,,,,,,,,,,,*56
ÔN!N

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ÎÎ!N

^ \g:484400*51\$GNGNS,105325.00,1254.5257954,N,07734.3211531,E,AANNNA,12,0.91,813.7093,,,,S*34
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∆!N 5 \g:484400*51\$PELE110,162325.00,06,03,2022,00,00*04
˚{!N & \g:484600*53\$GPGGA,,,,,,,,,,,,,*56
Ôb!N

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o!N

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Î›!N

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\g:485200*56\$GNGSA,M,3,02,03,04,06,09,,,,,,,,1.87,0.91,1.63,6*02
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˚r!N 5 \g:485200*56\$PELE110,162329.00,06,03,2022,00,00*08
î!N & \g:485400*50\$GPGGA,,,,,,,,,,,,,,*56
ÎÒ!N