Enhancement of GPS Accuracy Using Combination of active Antenna Ground Plane Enhancement, Sensor Fusion Compressing 3 Axis Gyro Accelerometer & Artificial Intelligence

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Abstract
With a low-cost GPS device, positioning accuracy is a concern for location-based applications (GPS). On the other hand, this study gives an alternative research review on how to improve the GPS positioning accuracy of low-cost GPS receivers for real-time navigation. Researchers have developed a system that uses GPS coordinate data (latitude, longitude, time, and velocity) to combine vehicle movement direction, velocity averaging, and distance between waypoints to precisely estimate position. Precision is also improved by using the previously estimated valuable reference point and by performing coordinate translation and invalid data checks. The accuracy of GPS speed measurements may be evaluated using a GPS simulation. The researcher can continuously measure the speed, acceleration, and location of the driver thanks to GPS technology. An integrated geographic information system (GIS) environment can be used to identify drivers' risk-taking patterns. As a second benefit, researchers can obtain high-resolution vehicle activity data prior to an accident, which reduces the amount of error and bias introduced during the process of estimating speed before an accident. In this paper we are introduce double antenna based approach for that are active antenna and ground plane antenna for enhanced the accuracy of GPS system.

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I. Introduction

GPS receivers are getting smaller, more cost effective and more dependable as a result, and they're increasingly being utilized to measure the speed of a vehicle. Measurements of distance and time are necessary for determining speed as it is defined as the rate of change in position GNSS speed measurements can be computed using track points or Doppler shift. By using track-points, the GNSS receiver may measure speed by taking regular measurements of computed positions (track-points), which are then used to calculate speed. However, the computed speed is less exact and trustworthy because each track-point is susceptible to a variety of inaccuracies. Even if the real path is a straight or smooth line, the line linking all the track-points would be zig-zagged due to track-point errors. Because a zigzag line's length is always more than the length of a smooth or straight line, the total distance travelled and the resulting average speed are always greater than the actual speed of travel. Doppler shift is a method of measuring GNSS speed using the available GNSS satellite carrier frequencies, which the GNSS receiver does continuously. Satellite carrier frequency and receiver frequency differ by Doppler shifts, which are directly proportional to speed in a particular direction toward satellite. When determining the receiver's 3D speed vector, at least four satellites must be tracked at all times. Doppler speed measurement offers the advantage of being unaffected by satellite distances, phase delays, and other common sources of error in GNSS location based on satellite range measurement. Its precision, on the other hand, varies with the quantity and geometric distribution of available satellites, therefore accuracy cannot be guaranteed. Numerous studies have been undertaken to examine the accuracy of GNSS speed measurements. These experiments were carried out in the field utilizing real-time GNSS data. There are a number of error characteristics that can't be controlled by the user when conducting field evaluations, such as ionic and tropospheric delays, GNSS satellite placement and geometry, RFI and obstacles and multipath. Use a GNSS simulator to produce many satellite GNSS configurations, broadcast real-world GNSS signals, and change various error parameters for the best GNSS receiver evaluation approach. In this way, GNSS receiver performance can be evaluated using repeatable conditions provided by the user. Unwanted signal interferences and blockages will not impede the evaluations because they will be performed in controlled laboratory surroundings. GPS simulation has previously been used to assess the GPS's susceptibility to radio frequency interference (RFI).

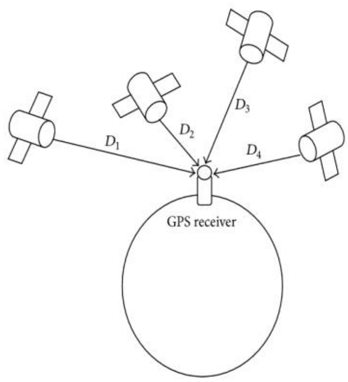

Figure 1: Basic orientation of satellites and a GPS receiver.

1.1 Ionosphere:

The ionosphere, a layer of the Earth's atmosphere that ranges from 50 kilometres to more than 1,000 kilometers above the surface, is made up of electrons and other electrically charged atoms and molecules. The ultraviolet (UV) rays of the sun are the primary energy source. In the Earth's atmosphere, the troposphere is the lowest layer, extending from the ground up to a maximum height of around 10 kilometers (6 miles). You'll enter the mesosphere if you're more than 10 kilometers above sea level. Solar energy from the sun enters the atmosphere and forms the ozone layer in the stratosphere. Even though free electrons can exist briefly in the thermosphere at altitudes more than 80 kilometers (50 miles), the thin atmosphere there quickly absorbs them, making it impossible for them to remain free. There are enough free electrons to interfere with radio reception. Atmospheres are known as ionospheres because they are filled with plasma. Positive and negative free electrons are drawn to one other by the electromagnetic attraction in plasma, but the energy of these ions is too great for them to stay together in a neutral electrical molecule. Ionization is mostly caused by the Sun. The amount of solar energy received determines how quickly the ionosphere becomes ionized. Thus, there is both a seasonal and a daily effect. Because the local winter hemisphere is angled away from the Sun, it receives less solar radiation. The more sunspots there are, the more activity there is, and the more activity there is, the more radiation there is. The location of one's residence has an impact on the amount of radiation one is exposed to (polar, auroral zones, mid-latitudes, and equatorial regions). The ionosphere can be disrupted and ionisation reduced by a variety of different activities. Structural changes in the sun's atmosphere, such as solar flares, have an impact on Earth's geomagnetic field. The ionosphere is a scattered and anisotropic medium for radio waves. Due to the ionosphere's dispersive nature, it is possible to fully erase the first-order ionospheric term by diffusing the signal at two different frequencies. The ionospheric and geomagnetic conditions, as well as the satellite's elevation and azimuth angles, all have the potential to influence higher-order ionospheric errors. Because millimeter-level accuracy is required for PPP, higher-order errors cannot be ignored. It is normal for second and third order errors to be between 0 and 2 centimetres at zenith.

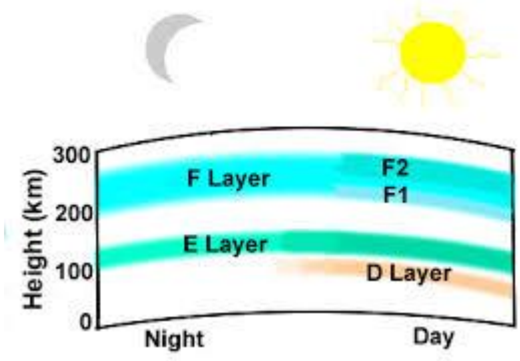

Figure 2: Ionospheric layers

1.2 D layer: The D layer, which lies 60–90 kilometres above the Earth's surface, is the lowest layer. Lyman series-alpha hydrogen radiation with a wavelength of 121.5 nm ionises nitric oxide, causing ionisation in this case (NO). In addition, hard X-rays (wavelength 1 nm) may ionise with high solar activity (N2, O2). A small quantity of ionisation is produced by cosmic rays during the night. Although recombination and net ionisation are low in the D layer, wave energy is greatly diminished due to electron collisions (about 10 collisions every msec). This results in a loss of energy for high-frequency (HF) radio waves that are not reflected by the D layer. A primary factor in the absorption of low-frequency radio waves, particularly at frequencies below 10 MHz, is this. Nighttime absorption is minimal, while midday absorption is maximal. After sunset, the layer disappears almost completely, with the exception of a few specks left over from galactic cosmic rays.

Ionization in small, narrow clouds of intense ionisation (called the Es layer) can allow radio wave reflections up to about 225 megahertz (MHz). Only minutes to several hours may pass between sporadic-E incidents. Sporadic E propagation thrill radio amateurs because it opens up previously inaccessible transmission routes. Researchers are still trying to figure out what causes sporadic-E. During the summer months, when high signal levels are possible, this propagation is most common.

1.3 F layer: The Appleton layer, sometimes known as the F layer, stretches upwards of 500 kilometres from the Earth's surface. Because it is the densest part of the ionosphere, any signals that make it through this layer will be lost to the vacuum of space. The topside ionosphere lies above this layer. Atomic oxygen is ionised by the sun's severe ultraviolet light (UV, 10–100 nm). At night, the F layer is a single layer; however, during the day, a distortion in the F1 profile is common. Long-distance high frequency (HF, or shortwave) radio communications are made possible by the F2 layer, which is active day and night. The AEROS and AEROS B satellites were launched by NASA between 1972 and 1975 to research the F region.

II. EXISTING TECHNIQUES

Abha Damani et. All (2015) For tracking and navigation purposes, the Global Positioning System (GPS) is widely utilized. GPS is primarily used by the military, agriculture, civil aviation, and other commercial enterprises around the world, as well as by the general public. To better understand how GPS Tracking System works and how it may be used in the real world, we have written a review article here. The kalman filter algorithm and techniques such as GIS, GPS, and GPRS are compared, along with others like the localization algorithm and the kalman filter algorithm. We've discovered some issues with GPS. [1]

Ahmet Paksoy et. All (2002) GPS revolution promises a nevigation toll of unprecedented performance for the mariner. Even the present stand-alone GPS service is better than the Decca main chain and Loran-C navigation systems. The seamless integration of sensors necessitated by the development of the electronic bridge is made possible by GPS, which makes navigation system selection and operation easier for ship operators. Ships will be able to navigate autonomously with better precision in restricted waters thanks to this new vessel navigation capabilities, much like air traffic control does for planes today, thanks to this new system of vessel tracking. GMDSS-compliant vessels benefit from many of the advantages of GPS, such as automated vessel position monitoring and reporting. If we use GPS correctly, we can increase our operational safety and efficiency. It has its pros and disadvantages, which the user must be aware of in order to get the most out of the system. Knowledge about the system's operation and evaluation, as well as what to do if it malfunctions and how to find and fix flaws, are all part of this process. Investing in new technology is only one part of the solution; equally vital, and all too frequently overlooked, is educating employees on how to use it safely and efficiently. [2]

Jennifer Ogle et. All (2015) Life without selective availability is a huge advance for researchers and practitioners. Without the use of differential correction units, travel routes can be easily identified (saving time, money, and headaches). The NHTSA in-vehicle equipment configuration was not rigorously tested to determine whether differential corrections can be eliminated, but the results suggest that noncorrected data can be used to obtain results within a reasonable range of the requirements, even though the tests were not rigorous in this regard Multiple DGPS sources will be tested against non-corrected sources in future tests. One of the four packages was to have tested an FM subcarrier DGPS broadcast, however that service was no longer available. Data collecting can be severely hampered by a variety of issues, such as this one. Design specifications for in-vehicle equipment will allow for differential corrections. Results with the new GPS receiver are likely to be even better than with the ones tested in this endeavour because it's a higher-end model (especially if signals are differentially corrected). [3]

Li Nyen Thin et. All (2016) As a conclusion, GPS technology is essential to everyone because it aids in a variety of daily tasks, including navigation, product tracking, and more. In order to avoid any problems while using GPS-enabled devices, the inaccuracies of GPS must be decreased to the point where they are no longer a problem. In this study, we examined how GPS accuracy is affected by a variety of conditions, as well as the various ways that have been devised to address these problems or enhance the technology's general usability. The Kalman Filter Algorithm, which is capable of resolving up to four elements that affect GPS accuracy, was deemed to be the most effective approach for improving GPS accuracy after we examined and evaluated all of the existing improvement methods. In other words, the Kalman Filter Algorithm is most adapted to mitigating certain issues that affect GPS accuracy compared to other existing approaches if a researcher desires to improve it. We plan to use the Kalman Filter Algorithm in a variety of simulations that simulate the inaccuracy factors as part of our future study. [4]

Guangcai Wang et. All (2017) It is proposed that an enhanced BPNN module be used to provide vehicles with high-performance position data when GPS is unavailable. The BPNN module collects and trains on GPS position increments and some INS data when a signal is available. The well-trained model will give the vehicles with a pseudo-GPS position in the event of a GPS loss. Time information is added to the input of the new module in order to slow down the degradation of accuracy caused by the changes in INS error characteristics over time. The performance of the suggested technique was evaluated in a field test involving five sections of 300s GPS outages. [5]

Aly M. El-naggar (2011) In addition to high-accuracy locating and navigation, the GPS has been employed in a wide range of applications. With differential GPS, common-mode errors caused by ionospheric and tropospheric delays and refraction, satellite clock bias, and orbital errors can be reduced or eliminated entirely between the reference and rover GPS stations. As one of the main reasons for inaccurate GPS location and navigation, the ionospheric delay in the propagation of GPS signals is to blame. The ionospheric delay can be eliminated (to the first order) by combining the L1 and L2 data in a dual-frequency GPS sensor. Ionospheric delay has the greatest impact when only one frequency is used. Data from 11 regional GPS stations are used to convert single-frequency data from the concerned station to dual-frequency data in this article. Precision in single-frequency data is improved by calibrating the earth's ionosphere's total electron content (TEC). A global network of GPS receivers offers immediate, continuous, and globally distributed measurements of the ionospheric electron concentration. It is common practise to employ prediction models in order to account for the neutral atmosphere delay because one does not know the refractive index profile at any given site. [6]

Jongsun Ahn et. All (2010) Car navigation system performance using the GNSS (Global Navigation Satellite System) is measured by looking at the short time to first position fix (TTFF) and the precision of the position. Car navigation systems get the navigation message data as quickly as possible because the first position fix takes only a short time. However, in an urban (buildings, trees) environment, it is difficult to receive navigation message data in a short period of time. Proposals for two different systems to reduce TTFF have been made (A-GPS, SA-GPS). With A-GPS (Assisted GPS), the navigation message data is transmitted and the satellite location is calculated through the use of third-party facilities and communication networks (such as the Internet, Digital Mobile Broadband, and others). Another benefit of employing Self Assisted GPS is that it guesses the current satellite position by utilising historical data on the location and velocity of prior satellites. Using 24 hour interval GPS ephemeris patterns, this research evaluates the ephemeris parameter estimate techniques for SA-GPS. [7]

Andrzej Michalski (2004) Problems with methods for converting the globe's convex surface to a two-dimensional surface arise in some circumstances due to the high precision of geographical position estimate. One should pay more attention to the chart datum when using DGPS to ensure it is compatible with GPS. Alternatively, a difference of 0.01 Nm or 18.5 m can be found between the GPS and the chart (according to other sources up to 100 m). A ship can easily run aground on rocks or shoals if the wind direction changes by just a few degrees. However, whereas the SPS precision can be improved by DGPS by several orders of magnitude, the PPS accuracy gain is quite limited. DGPS stations may not be justified save for hydrographic purposes, hence continued support may not be economically viable. In the same way that marine radio beacons are gradually being phased out and have already been phased out in Consol, Omega, and Decca radio navigation systems. Though initially developed for maritime and air traffic control, nonmilitary satellite navigation systems are now finding usage on land as well. Thieves can use these systems to transmit signals from remote transmitters hidden in the vehicles in the event that they are stolen. When it comes to maritime navigation, computers are already replacing paper nautical charts, light and navigation sign lists and tide tables with electronic charts that display an onboard vessel's position at the user-selected scale, level of detail, as well as allowing accurate measurements for distances and courses to be made. It's now possible to purchase an affordable DGPS or a GPS receiver that may show a user's location and distance travelled on a map of a specific region, at the size of their choice, and with many valuable information. [8]

Nelson Acosta et. All (2012) 95 percent of the time, a GPS (Global Positioning System) receiver on the market has an accuracy of less than 15 metres. Techniques must be employed to achieve sub-metric precision. Using a low-cost GPS in a differential relative positioning manner can increase positioning accuracy, as this article explains. Kalman, fuzzy logic, and information selection are some of the proposed methods. The GPS error size and direction can be determined using the approaches provided in this article. In order to measure the most exact distances, another receiver uses this correction to improve its own location accuracy. Distance measurements may be made to within one metre of accuracy in 95 percent of cases, and as little as two metres in other cases, thanks to research using various sets of data and various experimental setups. [9]

Christophe Adradosa et. All (2002) After SA was removed, the fix accuracy for non-differential GPS locations greatly improved. Because the antenna ground plane was more effective for the reference base station, the number of channels receiving GPS-satellite signals was higher and the fix interval was shorter for the base station, the fix interval and topographic mask were lower for the base station, and the tests were not conducted simultaneously, the variations in location errors recorded by the reference base station and non-differential GPS collars cannot be compared. Non-differential GPS collars would have performed better if they had an antenna ground plane (i.e., the animal's neck) and if there were no topographic obstacles. Due to differential correction, the effect of SA removal is conceptually significantly more substantial for non-differential GPS collars than differential collars. However, in both GPS modes, removing SA leads in a significant reduction in the maximum inaccuracy of location. Due to their ability to account for various causes of inaccuracy such as satellite clock and ephemeris problems; ionosphere/troposphere delays, differential correction GPS collars remain more accurate. [10]

Phudinan Singkhamfu et. All (2019) A typical Kalman filter was shown to be capable of handling both indoor and outdoor GPS variance in the Ublox NEO-M8N module in this experiment. It is possible to install a low-cost GPS receiver in any stationary equipment thanks to the results of this technology, which improves the accuracy of low-cost GPS receivers. A closer look at figures 16 and 17 revealed that the typical Kalman filter is still ineffective when it comes to determining the precise location of unmanned aerial vehicles. Although this is the case, other Kalman filter algorithms, such as Extended Kalman Filter, Unscented Kalman Filter, and Complementary Filter, have been developed from the Standard Kalman algorithm with the hope of working better than Kalman algorithm in this experiment for UAV and GPS handheld device for navigating and locating to the specific site. They are interesting for future experiments. [11, 12]

Jeong Min Kang et. All (2018) A low-cost GPS receiver for automotive navigation systems can be improved by leveraging pre-built map data to improve its position accuracy. The map data used in our method was derived from the retrieved points on the roads. Matching points between the road and vehicle trajectories was done using the ICP approach. It was also employed only those sections of the road that were directly in line with the vehicle's path rather than the entire road. As a last step, we employed the least squares method to reduce any remaining disparity that had been left over after rotating the ICP algorithm. A low-cost embedded system was used to implement the method in real time. It was found that the proposed strategy was able to increase low-cost GPS positioning accuracy in real-time. [13]

Mariusz Specht (2021) Any navigation system, including GPS, needs to have its real positioning accuracy known in order to accurately establish the applications for which the system can be utilised. This research examines the 1D and 2D spatial distributions of GPS position error statistics based on data from two measurement sessions (900,000 and 237,000 fixes). The premise of a normal distribution of and errors was tested, and the consistency of GPS location errors with commonly used statistical distributions was assessed along with selecting the best fit. The GPS system's and errors are found to be regularly distributed. When the asymmetry is low, the and errors have a higher concentration around the central value than they do in a typical normal distribution (one with a high positive kurtosis). Furthermore, it's easy to see that errors are more densely packed than errors. As a result, the standard deviation for mistakes is higher than the standard deviation for errors. [14]

Christopher Rose et. All (2014) The authors of this research demonstrate that the use of sensors already installed in commercial cars and the addition of a lane map significantly reduce GPS drift when the satellite is obscured by dense foliage or an urban canyon. Camera and lidar lateral distance subsystems demonstrated submeter precision and provided data for the integrated positioning system. The navigation filter makes use of a well-known lane marking map that links measurements of lateral distance from a local coordinate frame to a global coordinate frame. An inertial sensor (IMU), camera and lidar distance information, as well as known height data, were used to constrain the GPS location estimate in cases where less than four satellites were available for the system to track. It was shown that in instances where satellite visibility was low, the use of vision data avoided drift caused by the use of an INS alone system. [15]

III. Methodology

3.1 Power Supply Schematic Diagram

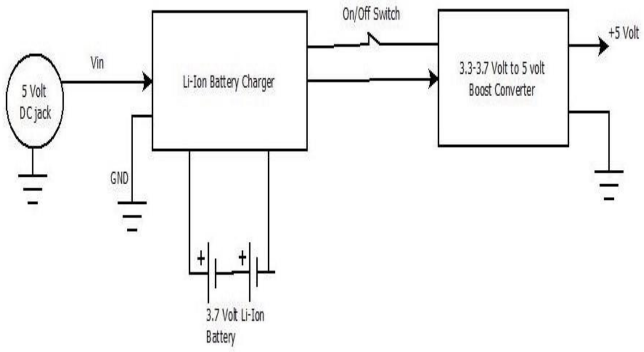

Figure 3: Power Supply Schematic Diagram

In the Figure 3, DC 5 volt jack is used for input power supply of 5 volt. This supply is taken by switch mode power supply based adapter. Then this power used as input power for Li-Ion Battery charge that is connected by our 3.7 volt Li-Ion Battery used for storage of power for run entire system. This battery charger unit work as battery management system once battery is fully charges then charging supply automatically turn off for battery and when battery is low charge in this condition supply turn on for battery charging. This boost converter circuit receives power from this device when the boost converter circuit has been activated. As an inductor resists current fluctuations by either increasing or lowering the energy stored in its magnetic field, this principle is the driving force behind the boost converter. Because the output voltage is always greater than the input voltage, a boost converter is called a boost converter. One of the simplest forms of switch mode converters is a boost converter. It boosts or enhances an input voltage, as its name implies. Basically, it is made up of an inductor, a MOSFET switch (the best ones can be found nowadays), diodes and capacitors. We utilise this circuit to raise the voltage from 3.7 volts to 5 volts because our complete system is powered by 5 volts.

3.2 Proposed System Schematic Diagram

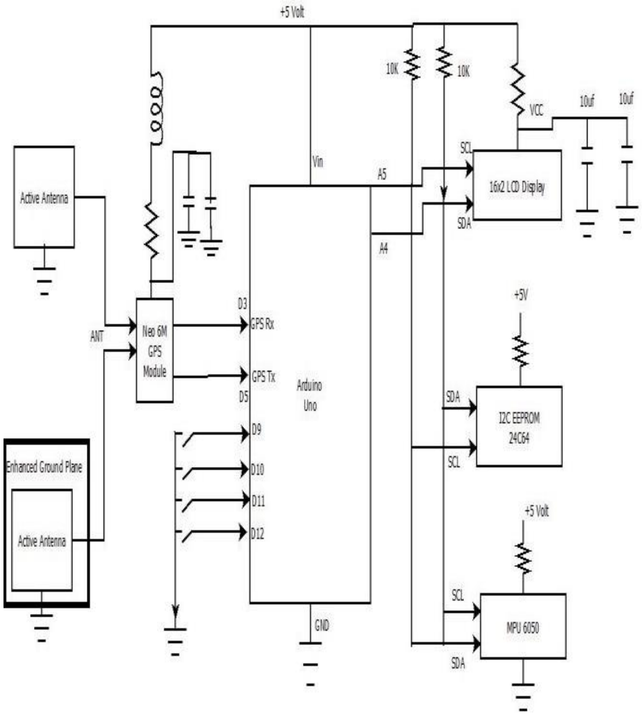

Figure 4: Proposed System Schematic Diagram

In the Figure 4, proposed system uses multiple antennas that is simple active antenna and enhanced ground plane active antenna for boost performance. And here, we're using a Neo-6M GPS module to receive GPS data, which is connected to an arduino and used to execute certain operations and computations on the received data. Because of its powerful satellite search capability and integrated 25x25x4mm ceramic antenna, the NEO-6M GPS module delivers excellent performance as a complete GPS receiver. You can check the module's status using the power and signal indicators. Data can be saved even when the main power is unintentionally shut down thanks to the data backup battery. As a result of its 3mm mounting holes, your aircraft can fly stably at a fixed position, return to Home, and fly automatic waypoints, among other things. 16X2 LCD display is used for printing data and a push button for mode selection, and an external EEPROM (external) for storing data in this case. MPU 6050 was employed in this case. There are three 3-axis accelerometers and a gyroscope in one tiny box. On top of that, it incorporates an on-chip temperature sensor as an additional function. The I2C bus interface allows it to communicate with micro controllers. Other sensors like a 3-axis magnetometer, pressure sensor, and so on can be connected to the Auxiliary I2C bus to enhance the performance of the proposed system.

IV. Results

The GPS receiver raw NMEA strings were captured and processed using Visual GPS Software. Results of Normal Active Patch Antenna & Enhanced Ground Plane Active Patch Antenna were evaluated.

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4.1 Result(s) For Non-Ground Plane Patch Antenna


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$GPGSV,3,1,11,03,08,183,07,04,59,141,24,07,42,321,16,08,53,104,34*7D
$GPGSV,3,2,11,09,81,298,19,14,16,236,25,16,15,041,13,20,01,311,*75
$GPGSV,3,3,11,21,02,135,,27,35,061,25,30,22,299,20*4F
$GPGLL,2650.43758,N,07549.03176,E,064739.00,A,A*66
```


Figure4.1: NMEA Strings For Non-Ground Plane Patch Antenna

Figure4.1 shows the RAW NMEA strings captured by Visual GPS Software using Normal Active Patch Antenna.

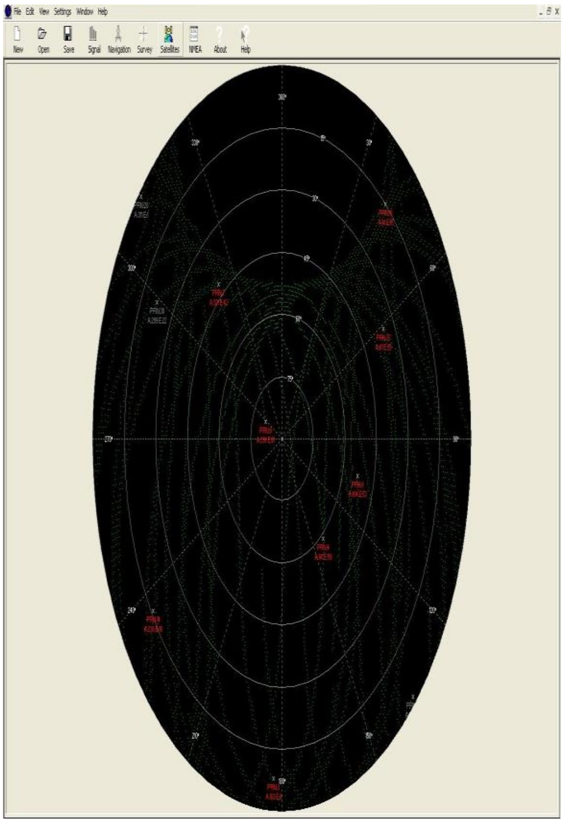

Figure4.2: Satellite View For Non-Ground Plane Patch Antenna

Figure4.2 Shows the Satellite View Computed by Visual GPS Software using Normal Active Patch Antenna.

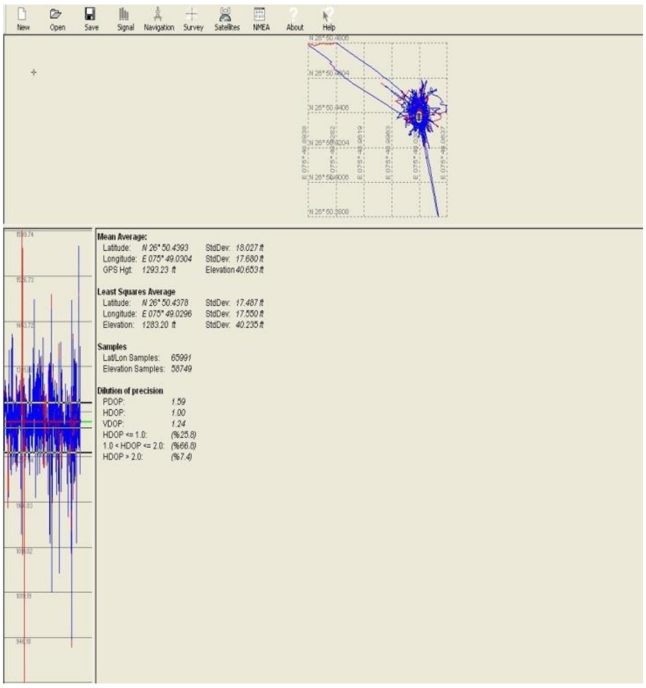

Figure4.3: Navigation Parameters For Non-Ground Plane Patch Antenna

Figure4.3 Shows the Navigation Parameters View Computed by Visual GPS Software using Normal Active Patch Antenna.

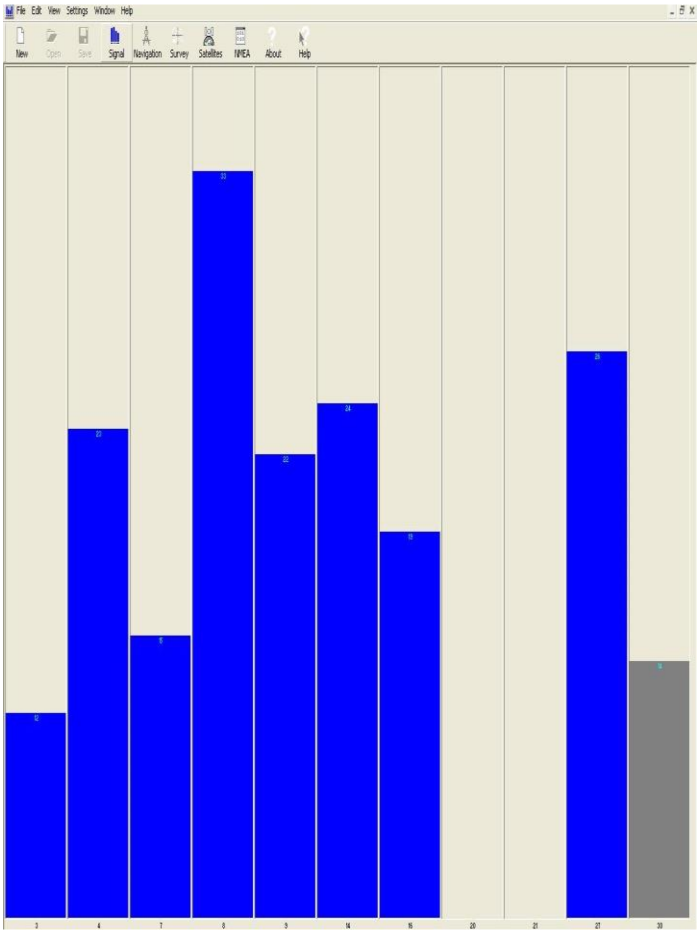

Figure: 4.4: SNR Parameters For Non-Ground Plane Patch Antenna

Figure4.4 Shows the SNR Parameters Computed by Visual GPS Software using Normal Active Patch Antenna.

Sr. No.	Satellite	Row SNR	SNR Threshold	SNR Accepted
1	3	12	Pass	12
2	4	23	Pass	23
3	7	15	Pass	15
4	8	33	Pass	33
5	9	22	Pass	22
6	14	24	Pass	24
7	16	19	Pass	19
8	27	26	Pass	26

9	30	14	Failed	0
1	**Average SNR=** 20.88			

Table1: SNR Table For Non-Ground Plane Patch Antenna

4.2 Results For Ground Plane Patch Antenna

Figure4.5: NMEA Strings For Ground Plane Patch Antenna

Figure4.5 shows the RAW NMEA strings captured by Visual GPS Software using Enhanced Ground Plane Active Patch Antenna.

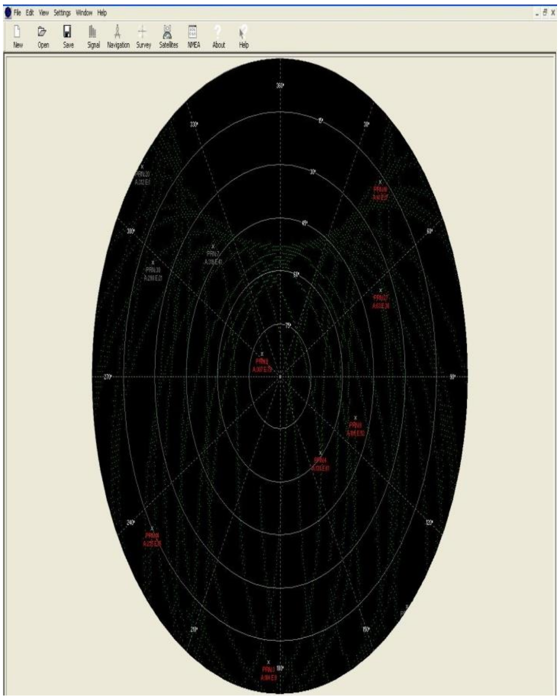

Figure4.6: Satellite View For Non-Ground Plane Patch Antenna

Figure4.6 Shows the Satellite View Computed by Visual GPS Software using Enhanced Ground Plane Active Patch Antenna.

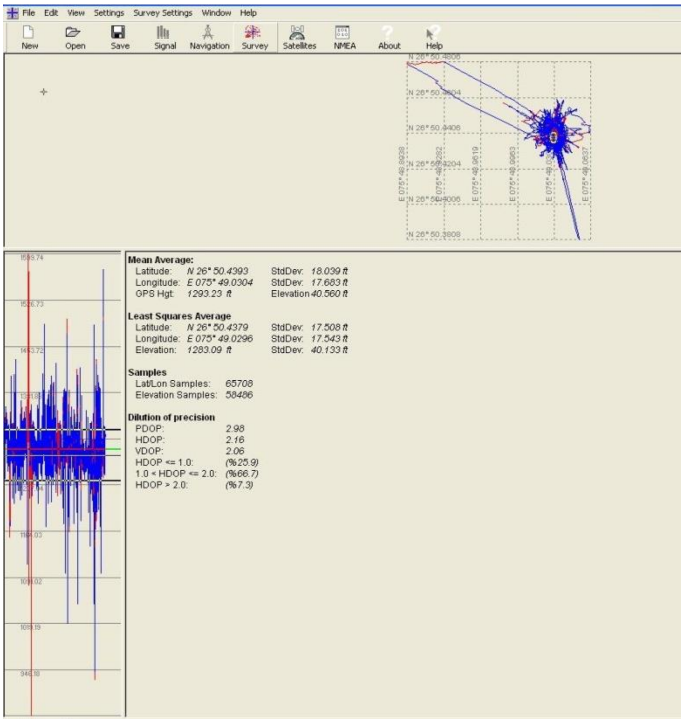

Figure4.7: Navigation Parameters For Ground Plane Patch Antenna

Figure4.7 Shows the Navigation Parameters Computed by Visual GPS Software using Enhanced Ground Plane Active Patch Antenna.

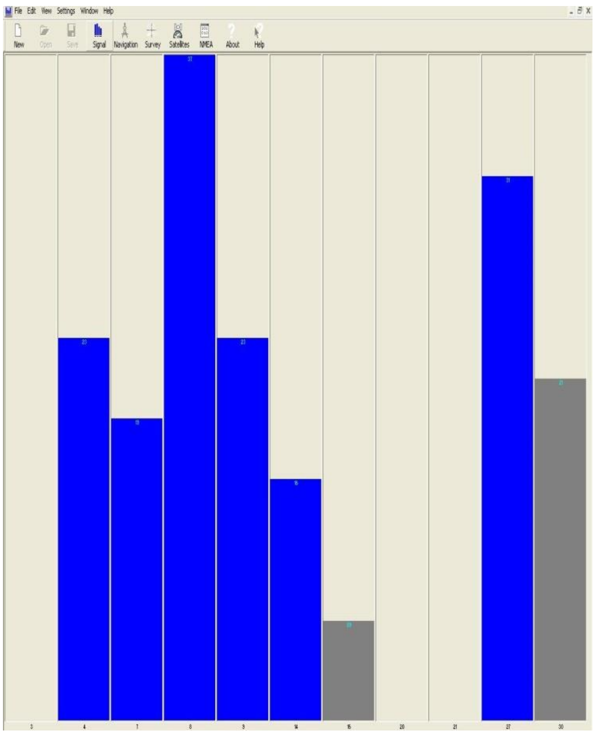

Figure4.8: SNR Parameters For Ground Plane Patch Antenna

Figure4.8 Shows the SNR Parameters Computed by Visual GPS Software using Enhanced Ground Plane Active Patch Antenna.

Sr. No.	Satellite	Row SNR	SNR Threshold	SNR Accepted
1	4	23	Pass	23
2	7	19	Pass	19
3	8	37	Pass	37
4	9	23	Pass	23
5	14	16	Pass	16
6	16	09	Failed	0
7	27	31	Pass	31
8	30	21	Failed	0
	Average SNR: 22.375			

Table2: SNR Table For Ground Plane Patch Antenna

As, depicted by Table1 and Table2, Average SNR With Normal Active Patch Antenna is 20.88dB & with Enhanced Ground Plane Antenna is 22.375dB, thus there is a SNR improvement of 1.495dB using Enhanced Ground Plane Active Antenna.

V. Conclusion and Future Scope

5.1 Conclusion

Geodesy, GIS, mapping, atmospheric science, hardware, and software development are just a few of the new areas of study made possible by the GPS revolution. GPS is the subject of intense research at a wide range of academic and scientific institutes across the world. New GPS observables are being generated as a result of the spectacular advancements in GPS receiver hardware, broadening the field of applications for this exclusive technique. The seamless integration of sensors necessitated by the development of the electronic bridge is made possible by GPS, which makes navigation system selection and operation easier for ship operators. The author has proposed improvement in GPS Receiver Accuracy Using Antenna Optimization Techniques like Ground Plane Enhancement for SNR Improvement along with Sensor Fusion combined with Artificial Intelligence. Sensor Fusion Primarily comprises of 3Axis Accelerometer With 3-Axis Gyroscope forming an IMU, which along with AI, is used to predict navigation parameters in absence of GPS Signal.

5.2 Future Scope

In the future, we hope to improve precision even further, with a goal of achieving a positioning error of no more than 0.1 meters. The usage of an additional signal may be necessary to achieve this goal. The data collected will be analyzed and deduced by additional measurements. The DGPS technology developed here is designed to be used in a wider range of vehicles, including faster ones.

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