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3D Plotting of Hill using IRNSS

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ABSTRACT: Many industries today rely on Global Positioning System (GPS) and other navigation systems like GLONASS, GALILEO, Beidou, and quasi-zenith for their applications. In line with this, India has developed its own navigation system called the Indian Regional Navigation Satellite System (IRNSS). Our proposal is to create a handheld device with a 7-inch TFT screen that utilizes an IRNSS receiver to display latitude, longitude, and altitude maps of a specific area. This device would also include pre-defined hotspot spots as reference points on the map. Unlike using publicly accessible maps like Google Maps, our solution eliminates the need for internet access by displaying positions gathered from the IRNSS and GPS receivers on a custom-designed map. This makes the device more autonomous and cost-effective. The availability of such a device would aid in better understanding the country's complex issues, and the data collected could be utilized for monitoring specific areas and detecting changes that could lead to disasters. India's IRNSS system was established with the launch of the IRNSS 1G satellite, the final satellite in the Navigation with Indian Constellation (NAVIC). This technology is expected to provide precise position information and be particularly helpful in locating stranded hikers in the Himalayan peaks, where mobile connectivity is limited. Furthermore, during natural calamities, the technology can track people and provide valuable information.

KEYWORDS: IRNSS, GPS, GDOP, HDOP.

I. INTRODUCTION

Over the last 20 to 30 years, GPS has been a crucial source of information for various services, including both user-based applications and Indian defense systems. To achieve independence from GPS, the Indian Space Research Organization has been developing its own navigation system and has already launched four IRNSS satellites. The IRNSS-UR receiver, positioned at latitude 77.468846 and longitude 12.677370, provides comprehensive coverage in the hemisphere with satellites positioned at elevations of 50 degrees and an azimuth range of 0 to 360 degrees. The constellation of seven IRNSS satellites ensures data transmission and reception within a 1500 km radius of the Indian landmass. The system is capable of predicting the timing of satellite passes over crucial Earth locations, such as bases, ground stations, and data processing facilities. To accurately determine beacon positions and process precise data, a minimum of four satellites is required, with two used for frequency measurements and two for time measurements. The IRNSS-UR receiver has been installed at Jain University's Faculty of Engineering and Technology for the purpose of tracking, and multiple IRNSS satellites are currently operational. The IRNSS UR receiver is employed to track both GPS and IRNSS satellites, providing notifications to the user's receiver when data from either system becomes available. The applications of IRNSS satellites encompass a wide range of functionalities, including disaster management, vehicle and fleet tracking, mapping, land, air, and maritime navigation, precise timing, and integration with mobile phones. While some applications are accessible to all users, certain functionalities are limited to customers within the coverage area. The reported tracking and localization accuracy of IRNSS satellites is 20 meters, with observed circumstances indicating a maximum accuracy of 13.5 meters. Satellite tool kit software has been utilized to simulate satellite movement, visibility, and coverage area in both 2D and 3D perspectives, based on the position of the user's receiver.

II. RELATED WORK

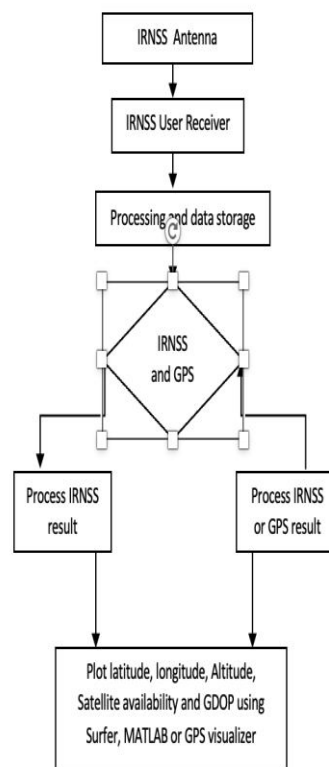
We had the opportunity to delve into the research and operations of the NavIC lab, gaining a comprehensive understanding of its resources and the methodologies employed. Working in this domain was a valuable experience for our team, and we were able to make use of the available resources, including references to previous projects and research conducted by JAIN UNIVERSITY, BANGALORE's students, PhD scholars, and senior faculty members. By



drawing from various sources, we obtained the necessary materials for our study, enabling us to comprehend and develop the project effectively. Our team is well-versed in this field and possesses the expertise to analyze real-world scenarios with proficiency.

III.METHODOLOGY

The tracking of IRNSS and GPS satellites is accomplished using the IRNSS-UR interface, which is mounted on a mobile vehicle for mapping purposes in a hilly terrain. Specifically, the mapping area chosen is SRS hills near Bengaluru, with its peak situated at an elevation of 3,780 feet (1152 meters) above sea level. This location is approximately 16 km away from Ramnagara, and it presents certain challenges such as dense vegetation and electric overhead poles, resulting in variations in data logging. The collected data samples are primarily concentrated in the vicinity of the hills. During the data collection process, observations were made regarding variations in parameters such as altitude, availability of satellites, and GDOP (Geometric Dilution of Precision). In some cases, these parameters experienced fluctuations and even dropped to zero due to the presence of obstacles or interference. The collected data is then processed and mapped using MATLAB. The altitude variations across the hilly terrain are plotted using this software. The entire dataset is categorized into two sets: the first set consists of points without any overhead obstructions, while the second set includes samples with overheads present. In the first dataset, a graph is plotted by considering the slope between two nearest points, while in the second dataset, there are interruptions in the continuous mapping due to the presence of overhead obstacles. The plots for both the datasets, with and without overheads, are displayed, incorporating three different navigation systems: GPS, IRNSS, and a hybrid system, along with the variation in altitude observed in the IRNSS mode.





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IV. EXPERIMENTAL RESULTS

Fig 1a. The above excel sheet shows the data file that is being extracted from the NaVIC systems.

Latitude (deg)	Longitude (deg)	Altitude (m)
12.5491787	77.5124337	1037.2725
12.54917695	77.51243091	1039.5548
12.54917353	77.51241981	1041.3056
12.54917903	77.51242379	1039.853
12.54918235	77.51242602	1038.4729
12.54918124	77.51242871	1037.8669
12.54917972	77.51241954	1037.2537
12.54916813	77.51241636	1036.1996
12.54916784	77.51242514	1037.4346
12.54917215	77.51242882	1036.935
12.54917608	77.51243607	1036.8846
12.54917863	77.51243223	1036.7442
12.54917919	77.51242635	1038.752

Fig 1b. The above excel sheet shows the data set that is being extracted from the NaVIC data files

Figures show the results of 3D mapping of SRS Hills. Fig. 2(a) shows the 3D Elevation achieved at 1038m (b) is the 3D image obtained by surveying the hill

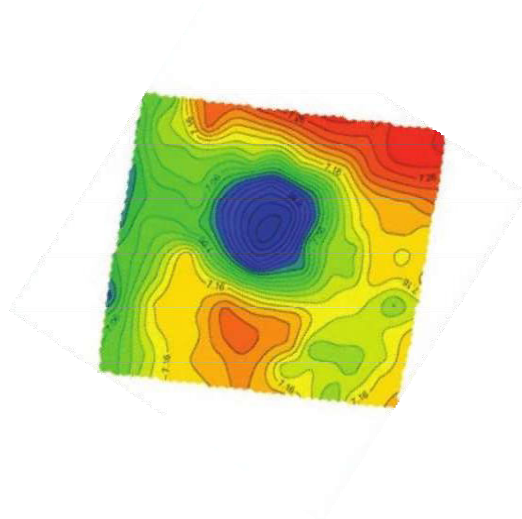


Fig 2a.

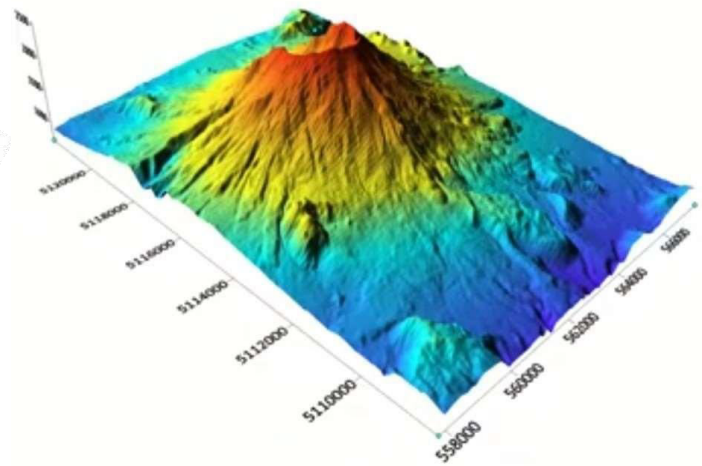


Fig 2b.

V. CONCLUSION

3D mapping is an important tool in creating 3D scenes of a location that are useful for many studies like high rise development, building interior and exterior and effects of a disaster.

Typical 3D mapping applications include:

- Inspection and measurement
- Object reconstruction
- 3D projection
- Physical mapping and VR
- Simultaneous localization and mapping (SLAM).

Using a mapping program like Surfer, the 3D mapping is carried out by charting the latitude, longitude, and altitude information collected from the receiver in a three-axis coordinate system. The survey will be impacted by dense vegetation because it depends on satellite coverage. In wide spaces where the reception rate is higher, this method is more accurate and trustworthy. The type of vehicle used for surveying, which has the potential to introduce inaccuracies, also affects the accuracy of the map. By adopting precautions such as employing a more mobile and stable trolley to transport the components, the vibration of the trolley during surveying can be reduced, leading to more accurate survey results. This technique is solely appropriate for surface evaluation thus it is impossible to trace objects onto the map. Thus, it is clear why 3D mapping is important because it will make a variety of features and experiences that conventional mapping technologies lack and it is also good that ISRO has come up with their own positioning system as it will reduce our reliance on GPS.

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