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Measurement of NavIC Carrier Phase Residual for Baselines of Different Lengths

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***Abstract*-Whena navigation satellite transmits signal to the receiver whichis onor above theearth,thesignalisbeingaffectedbytheatmospheric changesanddisturbances,satelliteandreceiverbased errors including receiver hardware bias. In this project we analyzed the bias orresidual in NavIC Pseudo range measurements on L5 (1176.45 MHz) band. This analysis iscarried out by using Double Difference (DD) method with PR measurements of different baselengthsviz.zerobaselength,1meterbaselength,3.56meterbaselength,5meterbaselength, 7meter base length and 9meter base length.ThePRbiasresultswerepresentedforaGeostationary(GEO)satellite(IRNSS-1G)and a Geosynchronous (GSO) satellite (IRNSS-1D). The satellite IRNSS-1C was consideredas a reference in DD computation due to its highest elevation angle. The results show that thePR bias on L5 is in the range of ± 0.606m to ± 7.169m for IRNSS-1D satellite and forIRNSS-1G satellite is in the range of ±0.019m to ±4.331m. Further it is observed that the PRbias is increasing significantly for both IRNSS-1D satellite and IRNSS-1G as thebase lengthincreases.**

I.INTRODUCTION

IRNSS System Overview (NavIC): The Indian Regional Navigation Satellite System (IRNSS), with an operational name of NavIC (acronym for Navigation with Indian Constellation), is an autonomous regional satellite navigation system that provides accurate real-time positioning and timing services. It covers India and a region extending 1,500km (930 mi) around it, with plans for further extension. An extended service area lies between the primary service area and a rectangle area enclosed by the 30th parallel south to the 50th parallel north and the 30th meridian east to the 130th meridian east, 1,500-6,000km(930-3730mi) beyond borders. The system currently consists of a constellation of seven satellites, with two additional satellites on ground as stand-by.

IRNSS Architecture: TheIRNSS architecture mainly consists of:

- Space Segment
- Ground Segment
- User Segment

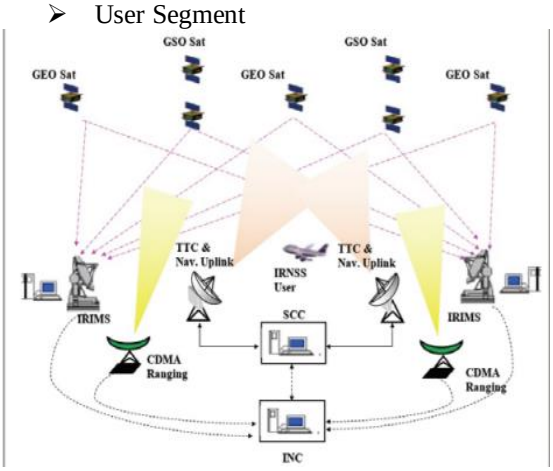

Fig:1 IRNSS Architecture

IRNSS Space Segment: Based on various considerations the IRNSS constellation is worked out to be a combination of GSO and IGSO satellites.

The IRNSS space segment consists of 7 satellites (3 GEO and 4 GSO). The 3 GEOs will be located at 32.5° E, 83°E and 131° E and the 4 GSOs have their longitude crossings 55° E and 111.75° E (two in each plane). IRNSS-1A spacecraft was launched on 1 July 2013.

IRNSS Ground Segment: Ground Segment is responsible for themaintenance and operation of the IRNSS constellation. The Ground segment comprises of:

- ISRO navigation center
- IRNSS Spacecraft control facility
- IRNSS Range and integrity monitoring station

User Segment: The User segment mainly consists of: Single frequency IRNSS receiver

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capable of receiving SPS signal at L5 or S band frequency.

II.METHODS

Zero Baseline:

The zero baseline is the distance is zero between the 2 receiving antennas of 2 receivers while we collect data.

(OR)

If the distance between 2 receiving antennas is zero while we collect data then it is called zero baseline.

In practical even if we keep 2 antennas very close there may be a slight gap between them and error may occur. So we use single ante

nna and send that signal to 2 individual receivers via signal splitting method.

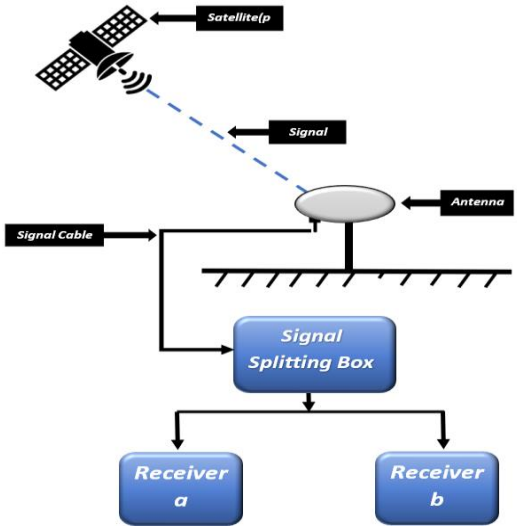

Fig: 2 Zero Baseline experiment

Short Baseline:

It is defined as when 2 receiving antennas of 2 receivers are separated by a distance 'D' in order of few centimeters to kilometers then that distance is called Short Baseline.

It means each receiver station is separated by distance 'D' from each other taking one as reference.

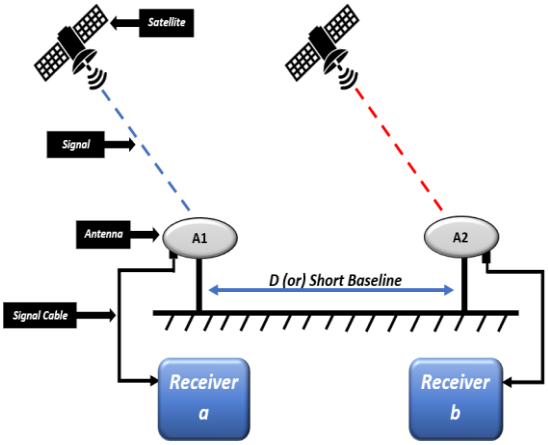

Fig:3 Short Baseline experiment

Single Difference Observation:

Single difference observations are constructed to cancel common effect shared by signals travelling from a satellite through different paths. A carrier phase signal difference observation for two antennas A and B with respect to satellite j is formed subtracting two carrier phase observations like (1). The single difference is

$$\Delta\emptyset^{j}_{BA}(t) = \Delta\rho^{j}_{BA}(t) - \lambda\Delta N^{j}_{BA} - c\Delta dT_{BA} - \Delta c.\, d^{j}_{ionBA} + \Delta.\, cd^{j}_{tropBA} + \varepsilon(\Delta\emptyset_{BA} \qquad (2)$$

whereΔ represents the difference between receivers. In (2) the satellite clock error term is cancelled after taking single differences between receivers with respect to the same satellite; the same happens to the initial phase. The tropospheric and ionospheric delay residuals are negligible when compared to multi path error and receiver noise, because they are very co-related due to the short distance between antennas.

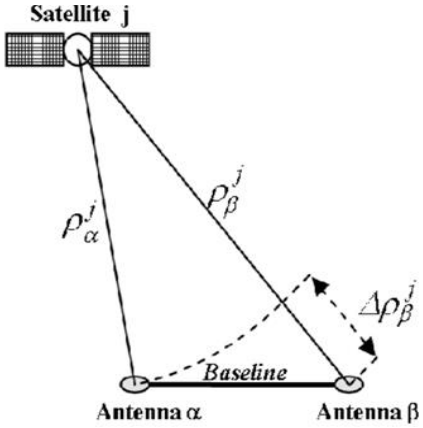

Fig:4 Single Differenced Observations

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Double-Difference Observation:

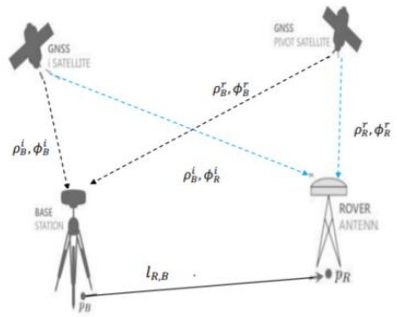

Fig:5 Double Differenced Observations

for satellite j and one for satellite i. Mathematically, a double difference is

$$\nabla\Delta\emptyset_{BA}^{ji} = \nabla\Delta\rho_{BA}^{ji} + \lambda\nabla\Delta N_{BA}^{ji} + \varepsilon(\nabla\Delta\emptyset) \quad (3)$$

III.RESULT

ZERO Baseline:

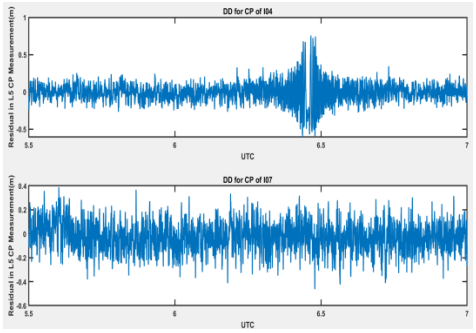

Fig:6 Residual in NavIC L5 Carrier Phase Measurement for 0meter Zero Baseline

This results section describes residual bais of NavIC carrier phase bias measured on L5 frequency band for different baselengths such as zero baselength, short baselength with baselength value 1mteter, 3.56 meter, 5meter, 7meter, 9meter.

The above figure 6 shows the variation of residual in NavIC L5 carrier phase measurement for zero baseline length of zero meter. On x-axis we have taken the UTC time and on y-axis we have taken the residual of carrier phase. This analysis is done for 2 different satellite signals such as I04 and I07. For I04 the maximum value of residual bias is 0.757 meters and the minimum value bias is -0.463 meters, the mean and standard bias values are -0.005638 meters and 0.1253 meters respectively.

Likewise for I07 the maximum value of residual bias 0.389 meters and the minimum value bias is -0.463 meters,the mean and standard bias values are -0.02573 meters and 0.1166 meters respectively.

The similar analysis was done for different base lengths and the results are presented in the below figures 7.

Short Baseline:

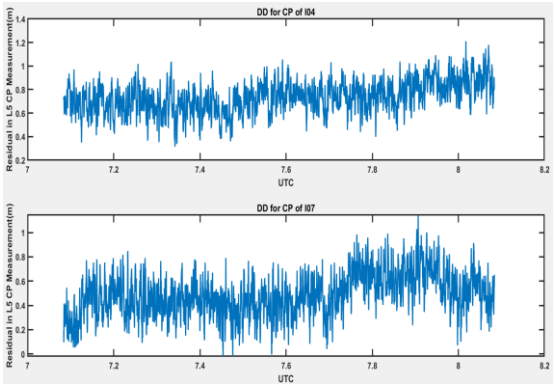

Fig:7 Residual in NavIC L5 Carrier Phase Measurement for 1meter Short Baseline

IV.CONCLUSION

The Residual noise in NavIC L5 signal is estimated using zero base length and short base length. For this we used single difference and double difference techniques. The analysis of residual noise is done by considering two satellites I04 and I07. The conclusions drawn from the result are.

Minimum, maximum, mean and standard bias values are calculated for different base length values of 0meter, 1meter, 3.56meter, 5meter, 7meter and 9meter.

In I04 satellite, when the base length increases the residual value also increases. Similarly in I07 satellite, when the base length increases the residual value also increases.

V. REFERENCE

[1] Brack, A. (2017). Long Baseline GPS+ BDS RTK positioning with partial AmbiguityResolution. Proceedings of the 2017 International Technical Meeting of the InstituteOf Navigation, Monterey, California, January 2017, pp.754-762.

[2] Dai, L., Eslinger, D. and sharpe, T.92017). Innovative Algorithms to Improve Long Range RTK Reliability and Availability. Proceedings of the

National TechnicalMeeting of the Institute of Navigation NTM, Vol.6682(1), pp.860-872.

[3] Gao, C., Zhao, Y. and Wan, D. (2005). The weight determination of the doubleDifference observation in GPS carrier phase positioning. Science of Surveying andMapping, 30(3), 28 32.

[4] Gao, W., Gao, C., Pan, S., Meng, X. and Xia, Y. (2017). Inter-system differencing Between GPS and BDS for medium-baseline RTK positioning. Remote Sensing, 9(9),948-964. doi:10.3390/rs9090948.

[5] He, H., Li, J., Yang, Y., Xu, J., Guo, H. and Wang, A. (2014). Performance assessmentof single and dual-frequency Bei Duo/GPS single-epoch kinematic positioning. GPSSolutions, 18(3), 393-403. Doi: 10.107/s10291-013-0339-3.

[6] He, H., Zhang, X., Tang, L. and Liu, W. (20160. Instantaneous real-time kinematic

Decimeter-level positioning with Bei Dou triple-frequency signals over medium baselines.Sensors, 16(1), 1. Doi:10.3390/s16010001.

[7] Li, G., Wu, J., Zhao, C. and Tian, Y. (2017). Double differencing within GNSSConstellation. GPS Solutions, 21(3), 1161-1177. Doi:10.1007/s10291-017-0599-4.

[8] Odolinski, R., Teunissen, P. J. G. and Odijk, D. (2015a). Combined BDS, Galileo, QZSSAnd GPS

single frequency RTK> GPS Solutions, 19(1), 151-163. Doi:10.1007/s10291-014-0376-6.

[9] Odolinski, R., Teunissen, P. J. G. and Odijk, D. (2015b). Combined GPS+ BDS for short to long baseline RTK positioning. Measurement science and Technology, 26(4), 045801.Doi:10.1088/0957-0233/26/4/045801

[10] Paziewski, J. and Sieradzki, R.(2017). Integrated GPS+ BDS instantaneous mediumBaseline RTK positioning: signal analysis, methodology and performance assessment.Advances in Space Research,60(12),25612573.Doi:10.1016/j.asr.2017.04.016.

[11] KCT S, Devanaboyina VR, Shaik TA. Double difference method with zero and short base length carrier phase measurement for Navigation with Indian Constellation satellite L5 (1176.45 MHz) signal quality analysis. Int J SatellCommun Network 2022; 1-11. doi:10.1002/sat.1441

[12] Swamy,K.C.T.Global navigation satellite system andaugmentation.Reson22,1155-1174 (2017).https://doi.org/10.1007/s12045-017-0579-6.