IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

IONOSPHERIC DELAY ESTIMATION IN NaVIC SIGNAL

Dr. M. Ravi Kumar
Dept. of ECE
K L University
Vijayawada, India

Bhrugumalla Hari Naga Kaushik
Dept. of ECE
K L University
Vijayawada, India

Pabbati Dinesh Siva Sai
Dept. of ECE
K L University
Vijayawada, India

K. Mohith
Dept. of ECE
K L University
Vijayawada, India

Abstract:- Route with Indian Constellation (NaVIC) is the operational name given for Indian Regional Navigation Satellite System (IRNSS) created by Indian Space Research Organization (ISRO) for precise situating applications. In no distant future, the airplanes that are operable in the Indian area will be hand-held with IRNSS L5 and S-band recurrence estimations. The fleeting inclinations comprehend the sign conduct that helps for the security of airplane applications. We proposed a Recursive Least Squares (RLS) method to display the ionospheric range blunder as needs be with latitudinal and longitudinal angle data. The calculation turned out for double recurrence L5 and S-band signs and GPS L1 estimations acquired from IRNSS beneficiaries situated at a low-scope point (16.23oN, 80.44o E). To notice occasional slope varieties, the proposed model run for three long periods of September equinox, December solstice, and geomagnetic-upset action information. The separate all out electron content (TEC) with mean and greatest angles for multi-recurrence signals are talked about. There will be ionospheric gradients which will hugely impact on geomagnetic distributed ionospheric conditions and these decrease the accuracy of the NaVIC satellite system to avoid this we came with the idea of ionospheric gradient analysis using weighted least square algorithm for NaVIC L5 signals.

Keywords:- Weighted Least Square algorithm, NaVIC, IRNSS, ISRO, TEC, Recursive Least Square Method

I. INTRODUCTION

- Accuracy in positioning services of the Global Navigation Satellite System is majorly affected due to ionospheric signal delays. The forecasting of ionospheric delays is tough and challenging in low-latitude regions due to rapid temporal variations in ionospheric electron density irregularities.
- The modern satellite-based radio navigation systems such as Global Navigational Satellite Systems (GNSS) are affected by ionospheric electron density. The speed of a radio signal in the ionosphere is dependent upon the number of free electrons in its mode identified as the "Total Electron Content" (TEC). The ionospheric time delay error depends on the TEC in the ionosphere. The ionospheric delay error calculation is directly proportional to the frequency of the signal and TEC along the ray path of the signal.
- Accuracy in positioning services of the Global Navigation Satellite System is majorly affected due to ionospheric signal delays. The determining of ionospheric delays is intense and testing low-scope districts because of fast transient varieties in ionospheric electron thickness anomalies.
- The modern satellite-based radio navigation systems such as Global Navigational Satellite Systems (GNSS) are affected by ionospheric electron density. The speed of a radio signal in the ionosphere is dependent upon the number of free electrons in its mode identified as the "Total Electron Content" (TEC). The ionospheric time delay error relies upon the TEC in the ionosphere. The ionospheric delay error calculation is directly proportional to the frequency of the signal and TEC along the ray path of the signal. We propose a recursive least squares computation that is prepared for completing the ionospheric slants with the better blend. The beginning course of action is given by weighted least squares game plan and recursive filtering checks the complete ionization and transient incline information. Intermittent assortments of tendencies and their local dependence in the ionosphere using GEONET data are given in addition to the hugeness of brief inclines. The assessment wraps up the notable nature of ionospheric plots for the better showing of ionosphere space side and for definite arranging (customer side). Along these lines, we found a need to develop transient point information for IRNSS/GPS triple repeat sign to fine the ionosphere concede appraisal and to improve FIR uprightness in the low-scope Indian area.

II. METHODOLOGY

- NAVIC signal radio propagation and vertical ionospheric delay estimation

1. In general, the raw pseudorange measurements (Eq. (1)) for each satellite number SY is given by,

$$P_X^{S_Y}(k) = \rho^{S_Y}(k) + c\left(\mathrm{dT}^{S_Y}(k) - \mathrm{dt}^{S_Y}(k)\right) + \mathrm{T}^{S_Y}(k) + I_X^{S_Y}(k) + MP_{P,X}^{S_Y}(k) + n_{P,X}^{S_Y}(k) + b_{P,X}^{S_Y}(k) \quad (1)$$

2. Similarly, the raw carrier phase measurements (Eq. (2)) for each satellite number SY is given by,

$$\varphi_X^{S_Y}(k) = \rho^{S_Y}(k) + c\left(\mathrm{dT}^{S_Y}(k) - \mathrm{dt}^{S_Y}(k)\right) + \mathrm{T}^{S_Y}(k) - I_X^{S_Y}(k) + MP_{\varphi,X}^{S_Y}(k) + n_{\varphi,X}^{S_Y}(k) + b_{\varphi,X}^{S_Y}(k) + \lambda_X A_X^{S_Y} \quad (2)$$

1. ρ--true range between satellite and receiver
2. dT--the satellite clock bias
3. dt--receiver clock bias
4. T--tropospheric delay
5. IX--ionospheric delay at particular frequency X
6. MPP and MPϕ-- multipath error due to multipath on the code phase and carrier phase
7. nP and nϕ--thermal noise on code phase and carrier phase
8. bSY P, X and bSY ϕ,X --satellite plus receiver code and phase biases
9. AX-carrier phase ambiguity (observed only in carrier phase measurements)
10. λX is the wavelength.
11. Equation (3) gives the differential pseudorange (DPR) for NAVIC L5 and S bands,

$$k_{S,L_5}\left(P_S^{S_Y}(k) - P_{L_5}^{S_Y}(k)\right) = I_S^{S_Y}(k) + k_{S,L_5}\left(MP_{P,S}^{S_Y}(k) - MP_{P,L_5}^{S_Y}(k) + b_{P,S}^{S_Y}(k) - b_{P,L_5}^{S_Y}(k) + n_{P,S}^{S_Y}(k) - n_{P,L_5}^{S_Y}(k)\right) \quad (3)$$

1. Equation (4) gives the differential carrier phase (DCP) measurements the delay estimation from dual frequency NAVIC measurements is given by

$$k_{S,L_5}(\varphi_S^{S_Y}(k) - \varphi_{L_5}^{S_Y}(k)) \\ = I_S^{S_Y}(k) + k_{S,L_5}(MP_{\varphi,S}^{S_Y}(k) - MP_{\varphi,L_5}^{S_Y}(k) + b_{\varphi,S}^{S_Y}(k) \\ - b_{\varphi,L_5}^{S_Y}(k) + n_{\varphi,S}^{S_Y}(k) - n_{\varphi,L_5}^{S_Y}(k) + \lambda_S A_S^{S_Y} - \lambda_{L_5} A_{L_5}^{S_Y}) \quad (4)$$

where, λS --NAVIC S-band wavelength i.e., 0.1204 m,

λL5--NAVIC L5-band wavelength i.e., 0.255 m,

ASY S and ASY L5 -- satellite-wise carrier phase ambiguities for respective S and L5 bands

Implementation of NAVIC L5 VTEC gradient model using Weighted Least Squares (WLS) algorithm

1. The geometry free VTEC at a pierce point {VTEC P (K)} is the sum of VTEC at specific user location {VTECu(K)} and the difference between ionospheric pierce point latitude and user latitude, pierce point longitude and user longitude respectively.

$$I_{L_5}^{S_Y}(k) = k_{L_5}^{S_Y}(k) \begin{pmatrix} VTEC_u(K) + \max(\delta lat_{u,p}^{S_Y}(k), 0).g_N(k) + \\ \min(\delta lat_{u,p}^{S_Y}(k), 0).g_S(k) + \\ \max(\delta long_{u,p}^{S_Y}(k), 0).g_E(k) + \\ \min(\delta long_{u,p}^{S_Y}(k), 0).g_W(k) \end{pmatrix} \quad (8)$$

- The gradient magnitude along longitudinal (E-W) {GE-W} and latitudinal (N-S) {GN-S} (Eq. (16)) are calculated from estimated individual gradients as given below,

$$G_{E\text{-}W} = \sqrt{g_E(k)^2 + g_W(k)^2} \quad (15)$$

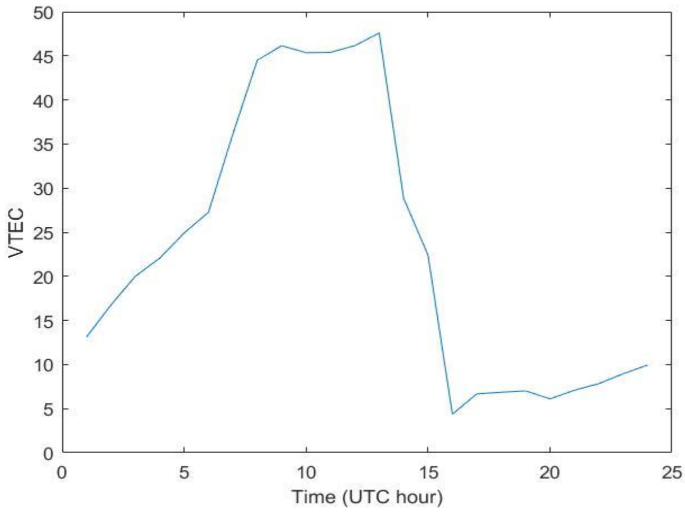
$$G_{N\text{-}S} = \sqrt{g_N(k)^2 + g_S(k)^2} \quad (16)$$

$$\%VTEC_{dev} = \frac{VTEC_{disturbed} - mean(VTEC_{queit})}{mean(\ VTEC_{queit})} \times 100 \tag{17}$$

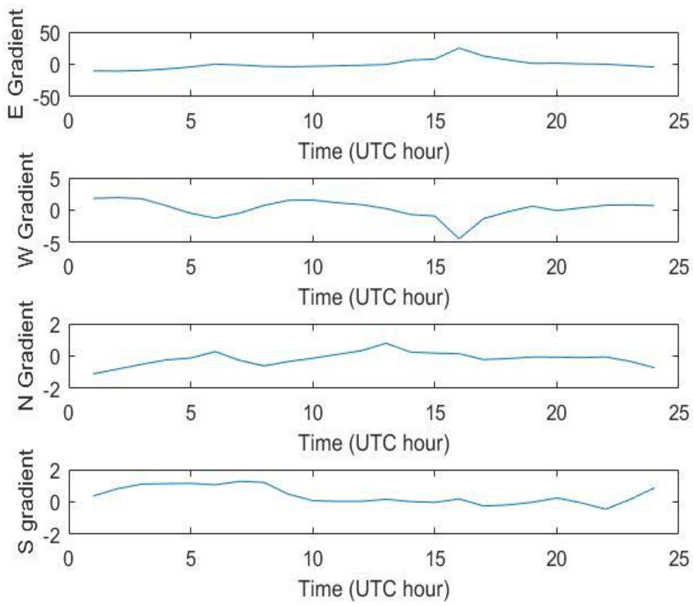
$$\%G_{E\text{-}W\ dev} = \frac{G_{E\text{-}W\ disturbed} - mean(G_{E\text{-}W\ queit})}{mean(G_{E\text{-}W\ queit})} \times 100 \tag{18}$$

$$\%G_{N\text{-}S\ dev} = \frac{G_{N\text{-}S\ disturbed} - mean(G_{N\text{-}S\ queit})}{mean(G_{N\text{-}S\ queit})} \times 100 \tag{19}$$

II (I). OUTPUTS OBTAINED



Average VTEC



VTEC in all the Directions

III. LITERATURE SURVEY

From the paper the effect of ionospheric gradients for a low-latitude region is keenly understood using the recursive-least squares technique. The processed data is from a NaVIC receiver manufactured by Accord Systems Inc. and placed at 16.23N and 80.44E coordinates, K L University, Vaddeswaram, India. The receiver is capable to acquire triple frequency signals (GPS-L1, IRNSS L5, and S bands) along with SBAS signals. The developed algorithm simulated with all the three frequencies, the vertical TEC, and their respective directive gradients (E-W and N-S) for different seasonal scenarios. In general, the absolute value of ionization at the height of 400 km is termed as absolute TEC and the complete 24hour profiles are explored. The longitudinal gradients are positive before 13 hours and are negatives till the next morning. Because these mainly exhibits local-time gradient due to the earth's rotation. The latitudinal gradients represent TEC variations from south to north it takes negative values all the time except after midnight.

IV. FUTURE SCOPE

In future, spatial ionospheric gradient maps for entire Indian low-latitude region will be developed. It is concluded that ionospheric gradient model is a reliable VTEC estimator along with other global and regional ionospheric models.

V. CONCLUSION

We did a longitudinal and latitudinal transient point assessment for multi-repeat signals using recursive least squares system for low-scope region. This helps with understanding the changes in the inclines according to incidental assortments. The model runs for three consecutive huge length of September equinox expects that the day-1 have higher likelihood that focuses influence the masterminding precision. Basically, for December solstice there is rise in TEC upon the appearance of solstice and the higher probability for most noteworthy tendencies is on day-3. For geo-alluring surprise data the day after the occasion of exacerbation redesigns TEC similarly as E-W and N-S slants rapidly. The extent of slants compasses to a furthest reaches of L1: 4.5377 TECU/deg; L5: 45.163 TECU/deg; S: 10.0567 TECU/deg at the hour of geo-alluring disrupting impact that can without a very remarkable stretch miracles the flight information territory. One TECU/deg is around reciprocals to 1.44mm/km that makes a screw up {L1: 6.534 mm/km; L5: 6.5034 cm/km; S: 4.481 mm/km} at the hour of geo-appealing surprise day. Thusly, this assessment helps with correcting point evaluation that overhauls the positional exactness.

VI. REFERENCES

- Montenbruck, Oliver, Peter Steigenberger, and Stuart Riley. "IRNSS orbit determination and broadcast ephemeris assessment." *ION ITM 2015* (2015): 185-193.
- Ganeshan, as. "Benefits of Indian satellite navigation systems." science and culture (2017).
- Yoshihara, Takayuki, et al. "An Investigation of Local-scale Spatial Gradient of Ionospheric Delay Using the Nation-wide GPS Network Data in Japan." *ION National Technical Meeting, San Diego, CA*. 2005.
- Klobuchar, John A. "Ionospheric time-delay algorithm for single-frequency GPS users." *IEEE Transactions on aerospace and electronic systems* 3 (1987).
- Estimation of ionospheric gradients and vertical total electron content using dual-frequency NAVIC measurements M. Ravi Kumar · M. Sridhar
  D. Venkata Ratnam ·P. Babu Sree Harsha ·S. Navya Sri.