e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.4, Apr 2022
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A Post Processing Based IRNSS/NavIC Software Receiver for Analysis and Development of New Algorithms and Signals

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ABSTRACT

For the Indian Regional Navigation Satellite System (IRNSS), also known as NavIC, a MATLAB-based Software Receiver is being developed to do post-processing-based reception (Navigation with Indian Constellation). The Indian Space Research Organization is responsible for creating IRNSS (ISRO). With all seven satellites in their designated orbits, it may begin providing navigation services throughout India and its neighbors. You may learn more about the IRNSS/NavIC system with the help of this NavICSR (NavIC Software receiver). Analyzing NavIC signals allows the scientific community to conduct ionospheric investigations and create new algorithms.

In order to offer customers with a navigation solution, NavICSR processes Digital ADC data of IF signals from files for L5 and S band signals. It can process IF data with any combination of quantization, sampling rate, and real or IQ inputs up to the position fix. Open-source GPS SDR for L1 C/A signals by Dennis M. Akos et al. is modified and expanded with the necessary techniques to create this. To achieve real-time execution speed in MATLAB on a regular Computer, NavICSR replaces the present post-processing receiver's framework with a new, custom-built time-synchronous framework. All the tracking channels in the created framework will process the data at the same time. Data from tracking channels is typically processed at a rate of one millisecond per iteration, meaning that every millisecond, the receiver's location is calculated and then processed. The created framework continually processes the IF data through a circular buffer, which in turn continuously changes the navigation solution. This study discusses the location accuracies achieved with both signals in L5/S bands and focuses primarily on the changes required in the GPS software receiver to adapt to IRNSS. The algorithms of NavICSR's acquisition, tracking, and data decoding are briefly described. This study examines the real-time capabilities of a receiver in a time-synchronous frame work with a small enough sampling frequency, bandwidth, and number of visible satellites. Time to first fix (TTFF) and execution time metrics are presented to illustrate the early findings. Experiments use a file containing the actual signals collected from the IRNSS front-end together with the IF data placed there. Based on the findings, it's clear that NavICSR may be easily modified for use as a prototype or starting point for new initiatives. This software receiver runs at a rate that is 1/2 that of real time. That is, relative to actual time, it will take twice as long. Acquisition, tracking, data decoding, calculation of pseudoranges, satellite location, and receiver may all be optimized separately inside the proposed framework, allowing for future performance increases toward real-time..

INTRODUCTION

Indian Space Research Organization's (ISRO) indigenously built Indian Regional Navigation Satellite System (IRNSS), also known as NavIC (Navigation with Indian Constellation) (ISRO). In April of 2018, it successfully launched seven satellites, completing the first phase of its satellite network.

orbits preferred for main service area, which includes all of India and a radius of around 1500 kilometers. Positioning, navigation, and timing services for India and other target areas are the primary goals of this project's development. IRNSS offers two tiers of service: the public-facing Standard positioning service (SPS) and the encrypted Restricted service (RS), which is only accessible to approved strategic, military, and government customers. The messaging service, which is utilized in emergency management, fishing apps, etc., is also supported.

In its core service region, IRNSS offers location accuracy greater than 20 meters. With widespread use, the market for IRNSS Chipsets has been steadily expanding. In light of this, NavIC software receivers may play a crucial role in the future of education and research in the field of receiver design. As discussed in [1] and [2], GNSS software receivers have numerous advantages over their hardware counterparts. They include the ability to rapidly prototype and test novel receiver designs; flexibility; and portability. Research tools in both academia and industry, GNSS software receivers provide comprehensive system comprehension at lower cost and with more convenience. Several GNSS Software receivers have been created, both for the older signals of GPS, GLONASS, Galileo, and BeiDou and for the newer signals of these systems. [2]-[7]. In postprocessing mode, the Open source MATLAB GPS SDR provided in the textbook A Software-Defined GPS and Galileo Receiver: A Single-Frequency Approach [8] can handle GPS L1 C/A signals. In reality, it wasn't until D. Akos's doctoral dissertation that the idea of applying the software defined radio paradigm to GNSS software receivers came to light. These algorithms and framework are widely utilized, and many developers have adopted them for usage with various constellations and signals; they have also been adapted by these developers to be used in the creation of their own unique software receivers. Instead, Carles Fernández-Prades et alopen-source .'s GNSS-SDR project, built in C++ using the gnu-radio framework (https://gnss-sdr.org/), allows for the simultaneous reception and processing of signals from several satellite constellations and frequencies. GPS, GLONASS, Galileo, and BeiDou are the primary focus of the GNSS software receiver development community. Finding a third-party, IRNSS/NavIC-specific software receiver that may be used for research and development purposes is challenging. According to the author's research, no MATLAB-based real-time IRNSS Software receiver that can decode IRNSS signals has yet been developed. In order to analyze the signals in a file for the SPS L5 and S bands, this study introduces the NavICSR, a Post processing software receiver tailored specifically for the IRNSS System.

In August of 2017, the Signal in Space Interface and control document (ICD-version 1.1) for the IRNSS's L5 and S band standard positioning service signals [11] was made available to the public.

The goal of NavICSR is to facilitate quick prototyping and analysis of the system by the IRNSS Research community in India and throughout the globe, with the end goal of advancing the state of the art in satellite navigation. NavICSR was created with the express purpose of training students in universities and research labs.

Currently, NavICSR has the following notable characteristics:

File-based processing of L5 and S band Digital ADC data up to position fix for varying sampling rates, bit depths, quantization bits, and real/complex signal types.

Input digital data is processed via a circular buffer at a rate of one millisecond every cycle in a time-synchronous architecture, which then returns the location at a quicker rate of execution per millisecond.

Creating a Time-synchronous framework via post-processing is the focus of this effort.

for the NavIC Software Receiver, a MATLAB-based tool that will be valuable in the creation of future real-time software and hardware receivers. This article provides a high-level overview of the IRNSS signal architecture before delving into a detailed description of how GPS Legacy L1 CA signals compare to IRNSS L5 and S Signals. It details the IRNSS navigation data structure, as well as the techniques used for acquiring and tracking IRNSS L5 and S signals and decoding their navigation data. When tested on real-world data saved in a file, NavICSR and the revised framework are evaluated for their efficacy in terms of execution time and precision metrics.

IRNSS SYSTEM: SIGNAL STRUCTURE AND CHARACTERISTICS

Users in both the primary service area and the extended service region (the rectangle bounded by 300 degrees south latitude, 500 degrees north longitude, and 300 degrees east longitude; see https://www.isro.gov.in/irnss-programme for more details) benefit from the precision positioning, navigation, and timing information that IRNSS provides. There are a total of seven satellites in the space segment, with three located in geostationary orbits over the 32.50E, 830E, and 131.50E coordinates and the other four located in sun-synchronous orbits.

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skewed geosynchronous orbits between 550 E and 111.750 E in terms of longitude. The seven satellites transmitting NavIC signals are in geostationary or geosynchronous orbits, making them accessible around the clock.

IRNSS SPS service is transmitted on L5 (1164.45 – 1188.45 MHz) and S (2483.5-2500 MHz) sub-bands with 24MHz and 16MHz bandwidth respectively. The SPS signal adopts Code Division Multiple Access (CDMA) technique with Binary Phase Shift Keying (BPSK (1)) modulation on both L5 and S bands. The navigation data at a rate of 50Hz (1/2 rate FEC encoded) is modulo 2 added to PRN code, chipped at 1.023 Mcps for SPS service and then the CDMA modulated code modulates the L5 and S carriers at the centre frequencies 1176.45MHz and 2492.028 MHz respectively. IRNSS Signals are right hand circularly polarized (RHCP) and the received power on ground using an ideally matched RHCP 0 dBi receiver antenna is between -154.0 dBm and -159.0 dBm for L5 band and between -157.3 dBm and -162.3 dBm for S band [11].

Unique Features of IRNSS Signals:

- 24/7 signal availability
- SPS transmitted on both L5 and S bands
- supports messaging services through 1A satellite
- Transmits Ionosphere grid-based corrections as part of navigation data

IRNSS SPS PRN GENERATOR ARCHITECTURE

It is the gold codes that are used to create the IRNSS SPS PRN Codes. Both L5 and S Signals have the same design, as seen in figure 1. Linear Feedback shift registers with a maximum length of 10 bits make up the gold code generator (MLFSR). Modulo 2 addition of the two gold code generators G1 and G2 yields the matching PRN, just as in GPS. The initial conditions for G1 are all ones, and the chip delay for G2 may be found in the IRNSS initial condition document (ICD). At a chipping rate of 1.02 MHz, the output is 1023 chips in 1 millisecond, one for each of the IRNSS satellites. While using PRN Sequence, a 1ms coding period is used. With this architecture in mind, modifications are made to the GPS PRN design for use with IRNSS/NavIC.

G1 Polynomial: $X^{10} + X^3 + 1$; G2 Polynomial: $X^{10} + X^9 + X^8 + X^6 + X^3 + X^2 + 1$

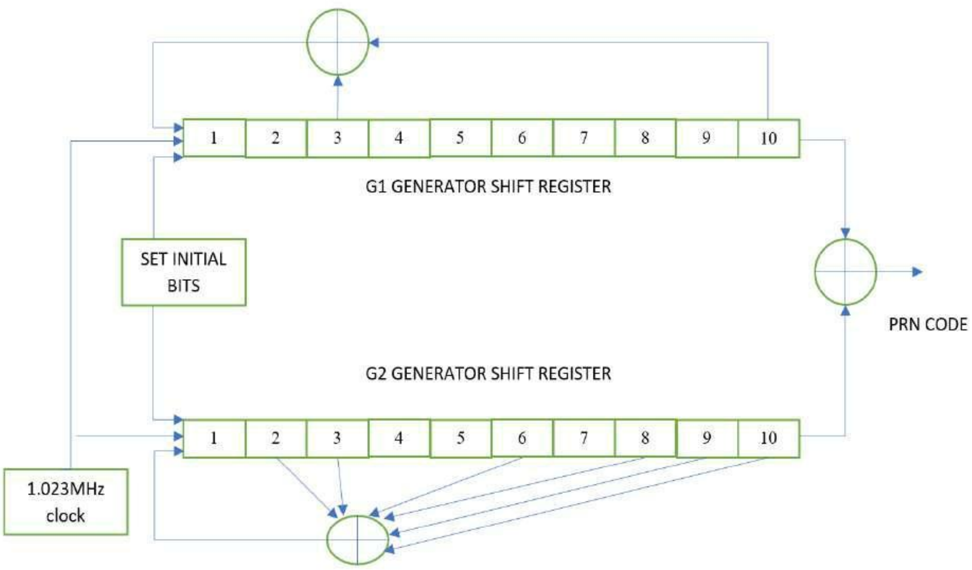

Figure 1: IRNSS SPS L5 and S PRN Code Generator Architecture

COMPARISON OF NAVIC WITH GPS L1 C/A SIGNALS

Table 1 below [12] compares NavIC signal characteristics to GPS L1 C/A signal characteristics. Several of the fundamental properties of NavIC signals are similar to those of Legacy GPS L1 C/A signals, allowing us to adapt algorithms already established for GPS L1 C/A signals by the Open source GPS Project and include them into NavICSR.

Table 1: NavIC signals vs GPS L1 C/A Signals

System/Parameter	NavIC SPS L5 and S	Legacy GPS L1 C/A
Centre frequency	1176.45MHz(L5), 2492.028MHz(S)	1575.42MHz
Multiplexing	CDMA	CDMA
Modulation	BPSK (1)	BPSK (1)
Spreading code	Gold Codes-10bits	Gold codes-10bits
Code length	1023	1023
Chipping rate	1.023Mcps	1.023Mcps
Code period	1 msec	1 msec
Coding scheme	Parity check	Convolution + Interleave
Bandwidth Minimum	2.046MHz	2.046MHz
Navigation data rate	50Sps (25bps)	50bps
Coordinate system	WGS-84	WGS-84
System time	GPST	IRNSS System Time

Since both signals have similar multiplexing technique, modulation scheme and PRN code characteristics, the Acquisition and Tracking modules of GPS L1 C/A signals are directly adopted without any modification [8]. The key difference between these two systems mainly lies in the way the navigation data is structured and encoded.

IRNSS NAVIGATION DATA STRUCTURE

A 48-second master frame is broken down into four 12-second subframes, for a total of 2400 symbols. This data rate corresponds to a symbol rate of 50 symbols per second (Sps). The hexadecimal value "EB90" represents a 16-bit preamble or synch word that is used to signal the beginning of each subframe. Primary navigation parameters such as satellite ephemeris, satellite clock correction parameters, satellite and signal health, user range accuracy, total group delay, etc. are provided in the first two subframes (1 and 2). Subframes 3 and 4 contain supplementary navigational information in the form of messages [11]. This includes things like the satellite almanac, ionospheric grid delays and confidence, IRNSS Time offset relative to UTC and GNSS, ionospheric delay correction coefficients, text messages, differential corrections, earth orientation parameters, and so on.

Table 2: IRNSS/NavIC Navigation data structure

<table>
<tr><td colspan="8">Master frame 2400 symbols (48 s)</td></tr>
<tr><td colspan="2">Subframe 1</td><td colspan="2">Subframe 2</td><td colspan="2">Subframe 3</td><td colspan="2">Subframe 4</td></tr>
<tr><td colspan="2">600 symbols (12 s)</td><td colspan="2">600 symbols (12 s)</td><td colspan="2">600 symbols (12 s)</td><td colspan="2">600 symbols (12 s)</td></tr>
<tr><td>Synch word</td><td>Data</td><td>Synch word</td><td>Data</td><td>Synch word</td><td>Data</td><td>Synch word</td><td>Data</td></tr>
<tr><td>16</td><td>584</td><td>16</td><td>584</td><td>16</td><td>584</td><td>16</td><td>584</td></tr>
</table>

In the transmitter, a Convolution encoder is used to do 1/2 rate FEC encoding, resulting in 584 symbols per subframe; these symbols are then interleaved to protect the data from burst errors. The actual navigation data is 292 bits long, with a data rate of 25bps (bits per second). So, in order to decode 292-bit navigation data, a de-interleaver followed by a convolution decoder must be applied to each subframe's worth of 584 symbols.

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info is received and processed properly on the other end. Table 3 provides the details for the FEC encoding and interleaver standards.

Table 3: Convolution encoder and Block interleaving Specifications

Convolution encoder specifications (FEC)	
Coding rate	1/2
Constraint length	7
Generator Polynomial (octal format)	G1(172) o, G2(133) o
Encoding sequence	G1G2G1G2....
Block Interleaving specifications	
Dimensions (rows x columns)	73 X 8

Further parity coding is employed on each subframe. 24-bit Cyclic Redundancy check (CRC) parity provides protection against burst as well as random errors. CRC24Q generator polynomial is given by $g(X)=1 +X +X^3 +X^4 + X^5 +X^6+X^7+X^{10} +X^{11} +X^{14}+X^{17}+X^{18}+X^{23}+X^{24}$.

Table 4: Structure of Subframe 1 & 2

1-8	9-25	26	27	28-29	30	31-262	263-286	287-292
TLM	TOWC	ALERT	AUTONAV	SUBFRAME ID	SPARE	DATA	CRC	Tail
8BITS	17BITS	1BIT	1BIT	2BITS	1BIT	232BITS	24BITS	6BITS

Table 5: Structure of Subframe 3 & 4

1-8	9-25	26	27	28-29	30	31-36	37-256	257-262	263-286	287-292
TLM	TOWC	ALERT	AUTONAV	SUBFRAME ID	SPARE	MESSAGE ID	DATA	PRN ID	CRC	Tail
8BITS	17BITS	1BIT	1BIT	2BIT	1BIT	6BITS	220BITS	6BITS	24BITS	6BITS

In order to guarantee that the convolution decoder on the user's end finishes successfully, the tail bits from bit positions 287 to 292 are all set to zero. The CRC is included in the 24 bits between subframe positions 263 and 286, in each subframe. The Time of Week Count (TOWC) is a binary value that may be found in bits 9 through 25 of all subframes. The time at TOWC is in sync with that of the IRNSS.

The Week Number (WN), which can be found in subframe 1 data, is one component of IRNSS System Time, along with the Time of Week Constant (TOWC). IRNSS System time, which is 13 leap seconds ahead of UTC, began at midnight on August 22, 1999, UT. As the most important navigation characteristics are included in subframes 1 and 2, it is sufficient to decode only those two frames to determine the user's location.

BLOCK DIAGRAM OF NAVICSR

Figure 2 shows a block schematic of the NavICSR system. The acquisition module reads the Digital IF data from a file, processes it, and then triggers the tracking module by providing the number of detectable satellites, together with their associated code phases and carrier frequencies. Finally, the tracking module will demodulate the carrier and C/A code from all visible satellites once every millisecond to provide navigation data. Moreover, it will determine the following frame's demodulation-useful carrier frequency, carrier phase, code frequency, and code phase values. The code phase is also helpful for calculating the pseudoranges. The navigation module

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is responsible for deciphering any navigational data or messages and determining the exact location of the satellites and the receiver.

In contrast to the Open Source GPS project's structure, where tracking loops evaluate all available data for a given channel until the file ends, at which point they switch to the next channel, this approach treats each channel independently. Unfortunately, this means that we won't know where we are until all of the data has been analyzed. Each tracking loop in the NavICSR framework has been updated so that it can process 1ms of data from each assigned channel concurrently, or so that it can process 1ms of data from all channels before moving on to analyze the data belonging to the following millisecond. With a time-synchronous frame work, the receiver processes information from all satellite channels at the same millisecond rate. IRNSS PRN code period limits how much shorter the processing data may be kept at 1ms. The primary benefit of this framework is that the answer is provided as soon as the data needed to calculate the location has been processed or is available. Ephemeris and pseudoranges are the very minimum of data parameters needed. If the ephemeris is kept in the receiver, then only the subframe synchronization is enough to compute the pseudoranges. So we can compute first position very fast.

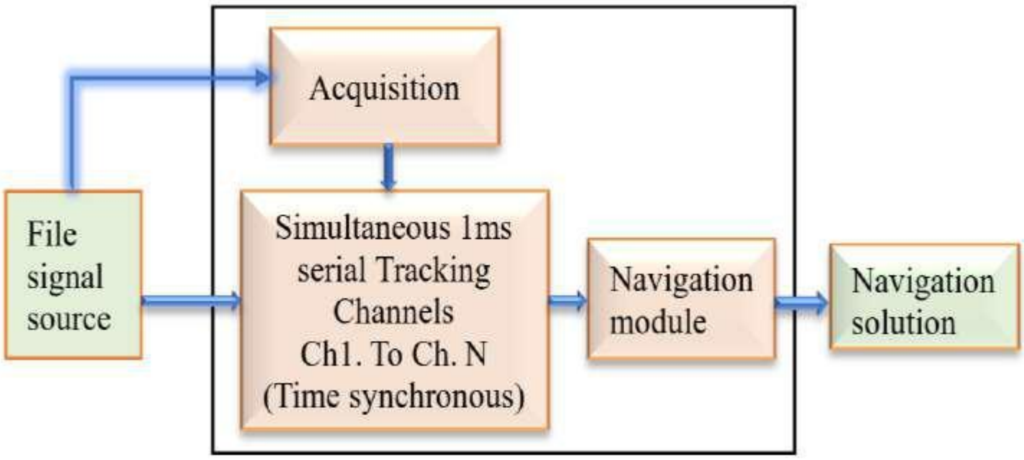

Figure 2: Block diagram of NavICSR

EXISTING VS TIME SYNCHRONOUS FRAME WORK-FLOW CHART OF NAVICSR

The main difference between the existing frame work and the developed time synchronous frame work is in the implementation of tracking module and in calculating pseudoranges. It tracks all the assigned channels in a time synchronous manner and performs bit and frame synchronizations while accumulating navigation data samples and further simultaneously accumulates and decodes the subframe data. Remainder code phase error (D) from the code phase discriminator block shown in figure 11 is accumulated for all the channels with a circular buffer of size (20 x Number of Channels) from the start of execution. This is used to calculate the relative pseudoranges.

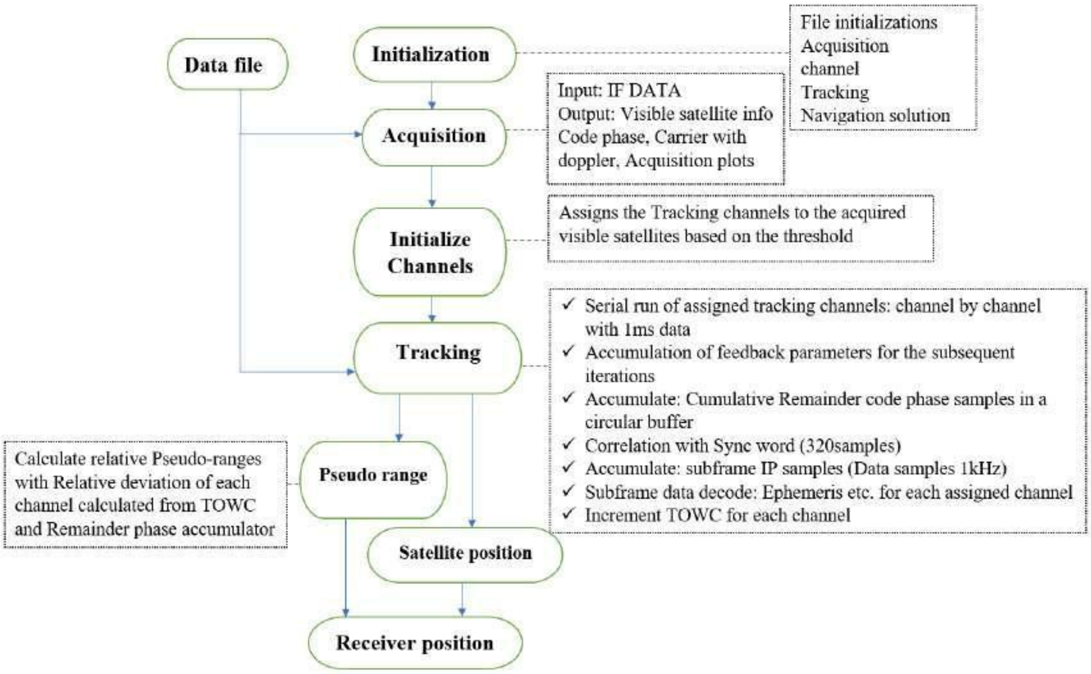

Figure 3: NavICSR flow chart

Suppose if we have a GNSS IF data of duration of one hour and we have to process the data with the presently available open source MATLAB software receiver [9], till the end of data to get the first position. The present frame work does not support continuous update of ephemeris. It calculates only once as if they are valid for the entire duration of the file. This frame work does not support for real time development and is given in figure 4, where the tracking is performed on GNSS IF data of one millisecond duration. It is first processed by channel 1 and later by channel 2, channel 3 and channel 4 serially for the entire one-hour duration or the time specified in the initial settings. The navigation solution is available only after performing the specified duration.

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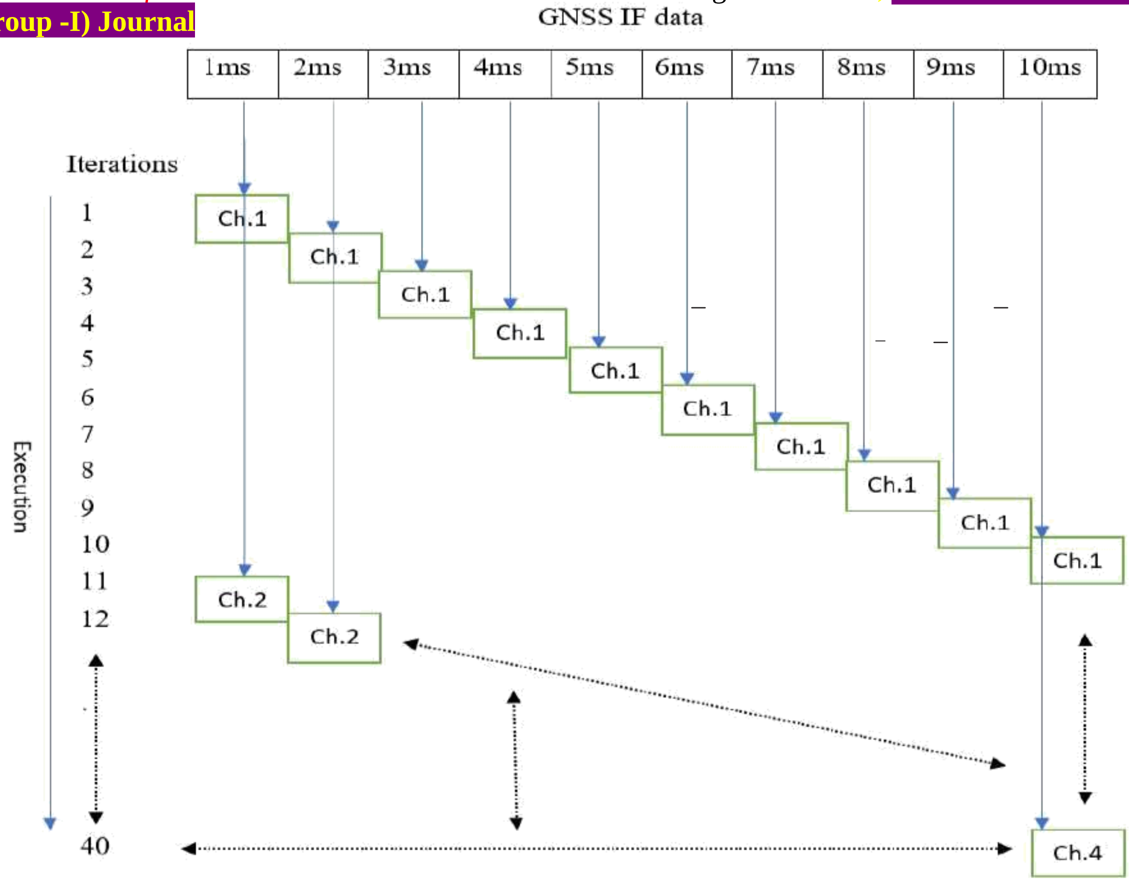

Figure 4: Existing Open source GPS SDR Frame work

In the time synchronous frame work as shown in figure 5, in tracking module every ms data is processed simultaneously by all the visible satellites serially iteration by iteration. Once the sufficient data is processed or once the first two subframes of data of all the visible satellites are decoded, it gives the position. This frame work updates ephemeris and the position continuously. This time synchronous frame work is developed to give real time frame work scenario to the Post processing software receivers, which provides faster execution of code even in offline or post processing mode.

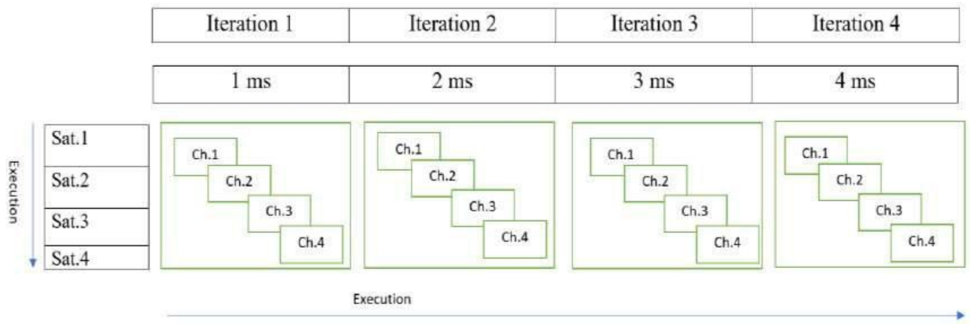

Figure 5: Time synchronous frame work of NavICSR

IRNSS IF DATA COLLECTION

Collection 1

Digitized IRNSS IF data was collected from Accord NavIC User Receiver (NavIC-UR) under open sky conditions with antenna installed on the roof top. In this real data collection, synchronized NavIC L5 and S signals are logged with 56MHz ADC sampling frequency, IF centred at 16.221MHz and “ubit16” data type. The antenna position is at 21.16 latitude, 72.78 longitude.

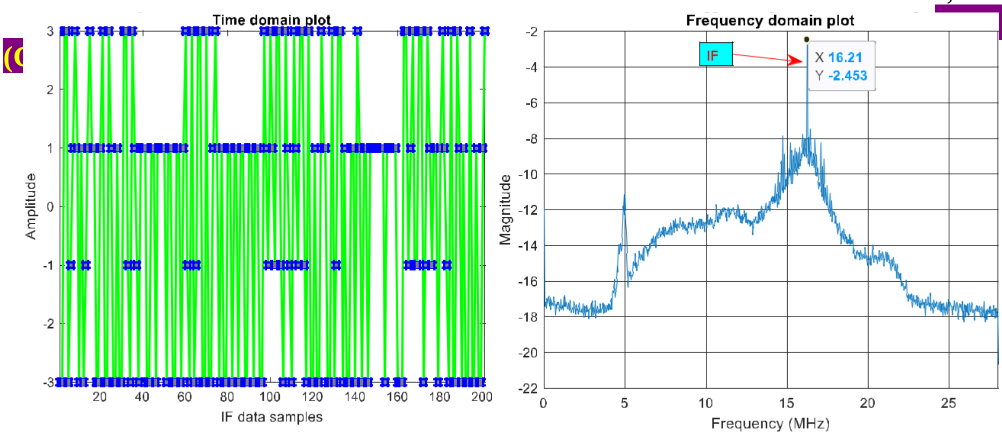

Figure 6: Time domain and Frequency domain plots of 2bit ADC Resolution

Collection 2

IRNSS L5 band Digital IF data was collected by IFEN front end on 21/06/2018 from fixed roof top antenna with the following specifications: ADC input frequency at 14998705.8758736Mhz and Sampling frequency is 20Mhz with 2bit ADC resolution. Real Valued IF signal samples are: -3, -1, 1, 3 and converted and stored in a file in two's complementary form as: -2, -1, 0, 1 [10 ,11, 00 ,01]

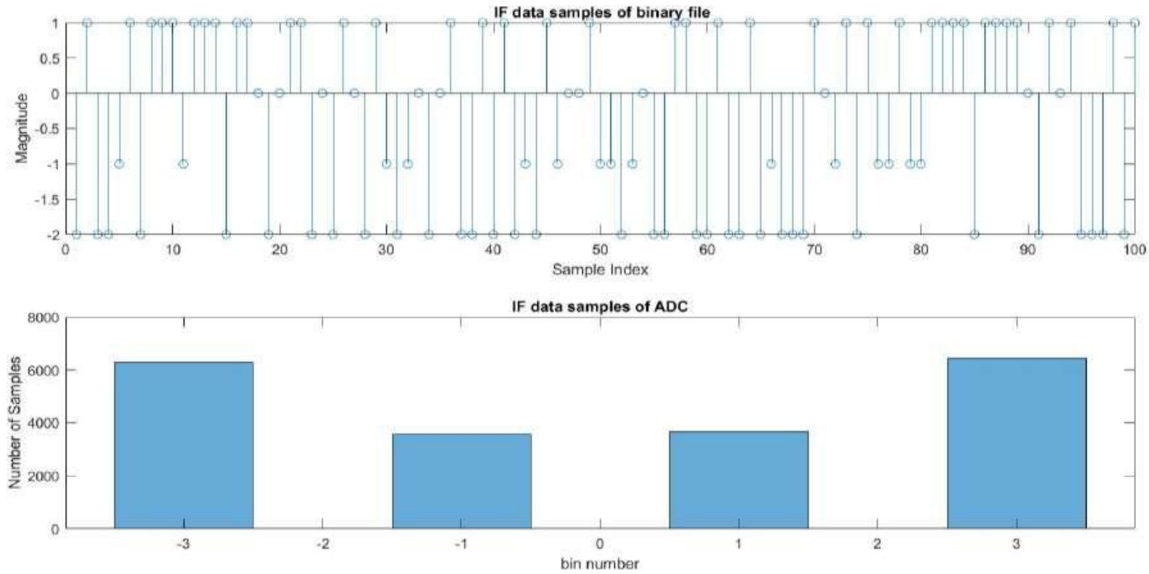

Figure 7: Time domain and histogram of samples

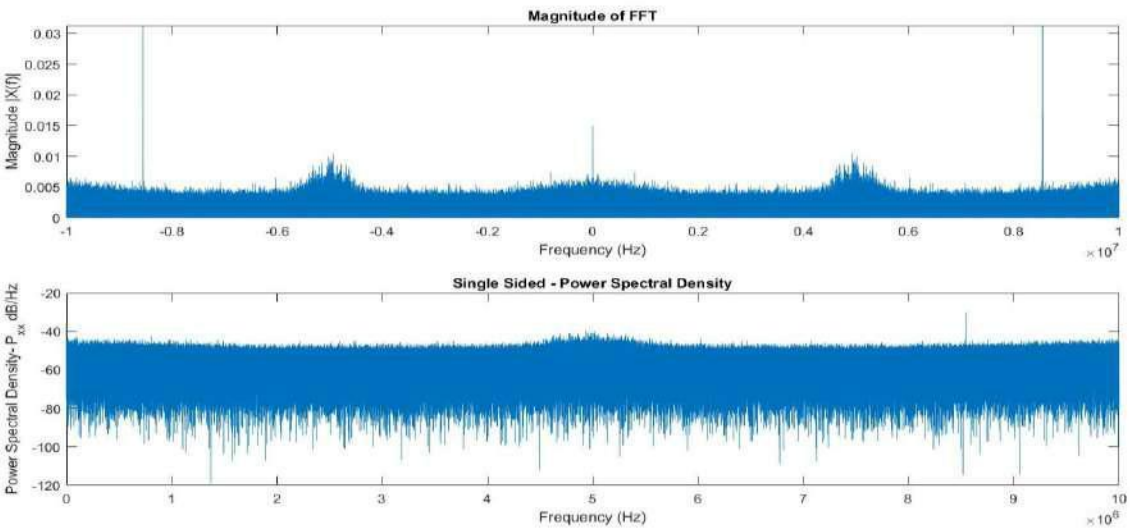

Figure 8: FFT and PSD plot

e-ISSN 2320 –7876
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Vol.11, Iss.4, Apr 2022
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NAVIC SIGNAL ACQUISITION

This is the first module in the receiver chain. The main aim of the acquisition module is to aid the tracking module. In order to initiate the tracking module, it is prerequisite to estimate the number of satellites present in the IF data with the corresponding rough estimates of code phase and Doppler. The algorithms that are widespread for this purpose are, Parallel code phase search(PCPS) and Parallel frequency space search(PFSS) acquisition algorithms [8].The acquisition algorithm used for GPS L1 C/A signals are adopted in NavICSR, where the rough estimates of code phase and carrier frequency shift is calculated first using PCPS acquisition and later the carrier frequency is further refined with the PFSS acquisition algorithm.

Acquisition block diagram of NavICSR is shown below in figure 9. PCPS and PFSS acquisition algorithms are combined to derive rough estimates of code phase and doppler shift in the carrier frequency. Where code phase is obtained by processing the Digital IF Data through the PCPS acquisition blocks for 1ms input data. Later the input data samples of 10ms are taken such that the first sample of the 10ms IF data belong to first chip of the C/A code with the help of estimated code phase value obtained from the output of PCPS blocks. This 10ms data is processed by the PFSS blocks and results a doppler shifted carrier frequency with 100Hz resolution. In order to avoid the effect of data bit transition on the acquisition, two consecutive 1ms data samples are processed independently by the PCPS blocks and the results are considered only for one particular milli second data based on the obtained signal power i.e based on the maximum peak of correlation matrix. Any satellite is considered visible only when the ratio of the first peak to the second peak in the two-dimensional search space shown in figure 10 passes a certain threshold.

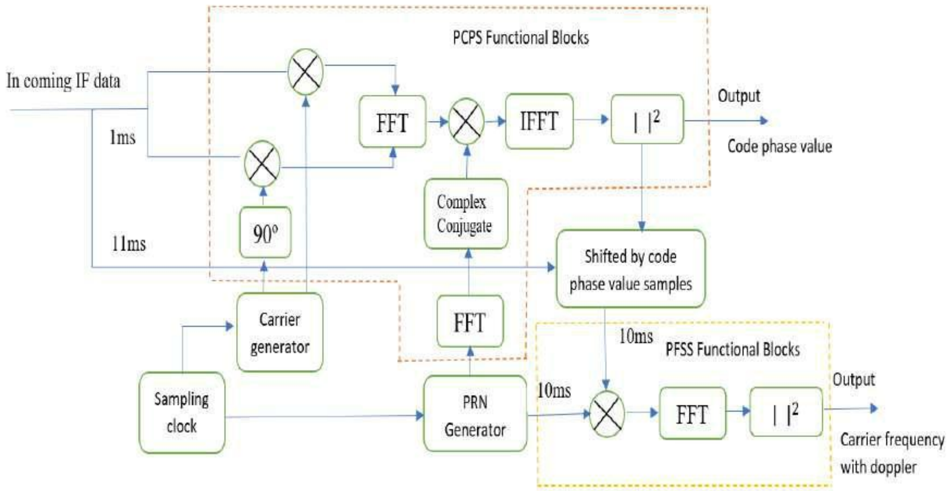

Figure 9: Block diagram of Acquisition module of NavICSR

Preliminary Results with data collection 1:

Table 6: IRNSS L5 signal acquisition results

Channel	PRN	Frequency	Doppler	Code Offset
1	2	16220838.55	-161.45	61
2	3	16220691.68	-308.32	50230
3	6	16220758.44	241.56	18277
4	4	16220604.90	-395.10	17135
5	5	16220478.06	-521.94	2298

Table 7: IRNSS S signal acquisition results

Channel	PRN	Frequency	Doppler	Code Offset
1	2	16220691.68	-308.32	59
2	3	16220377.92	-622.08	50227

3	4	16220197.68	-802.32	17131
4	5	16219910.62	-1089.38	2290

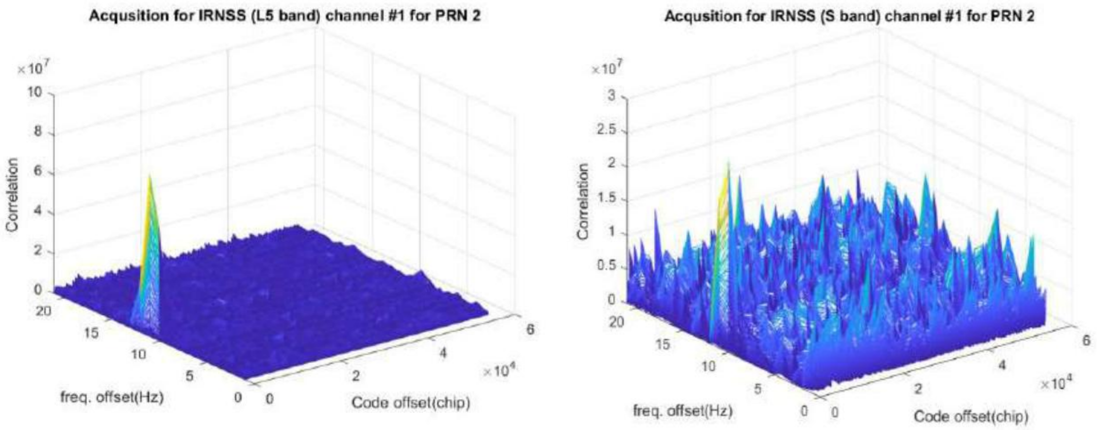

Figure 10: Acquisition plots L5 band (Left) and S band (Right) for Channel **#1** PRN

2 NAVIC SIGNAL TRACKING

The aim of tracking module is to track the satellite signals continuously by estimating code phase and doppler with high accuracy. Each visible satellite is assigned to a tracking channel and these are assigned based on the signal strength. Delay Lock Loop (DLL) and Phase Lock Loop (PLL) modules are used, where PRN codes and carriers are generated locally and through the use of correlators the PRN code and Carrier in the IF data is removed. Thus, it provides the navigation data samples (IP) belongs to a particular channel. The below block diagram represents the tracking algorithm implemented in NavICSR, which is adopted from [8].

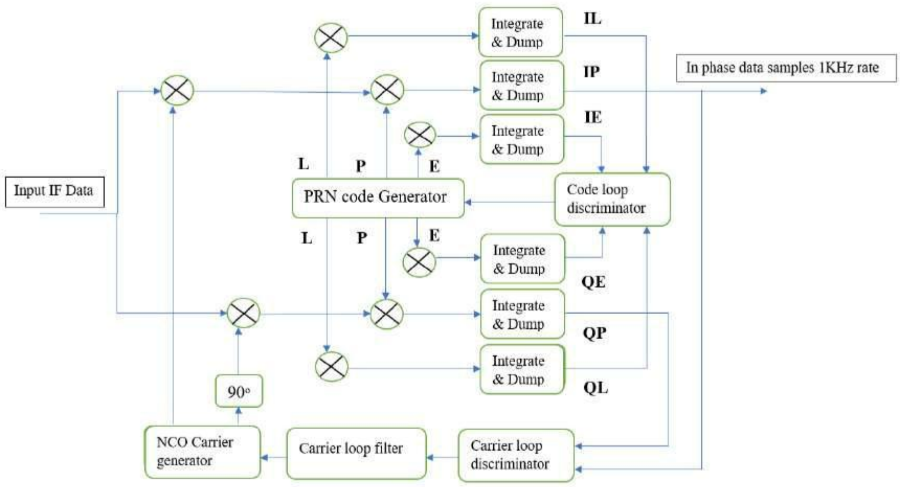

Figure 11: Block diagram of Tracking module of NavICSR Carrier Phase error $\Theta = \tan^{-1}$ ( )

Delay locked loop (DLL) parameters		Phase locked loop (PLL) parameters	
Noise Bandwidth	2Hz	Damping ratio	0.7
Damping ratio	0.7	Noise Bandwidth	25Hz
Filter Loop gain	1	Filter Loop gain	0.25
Correlator spacing	0.1 chips		

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Preliminary Tracking Results with Collection 1

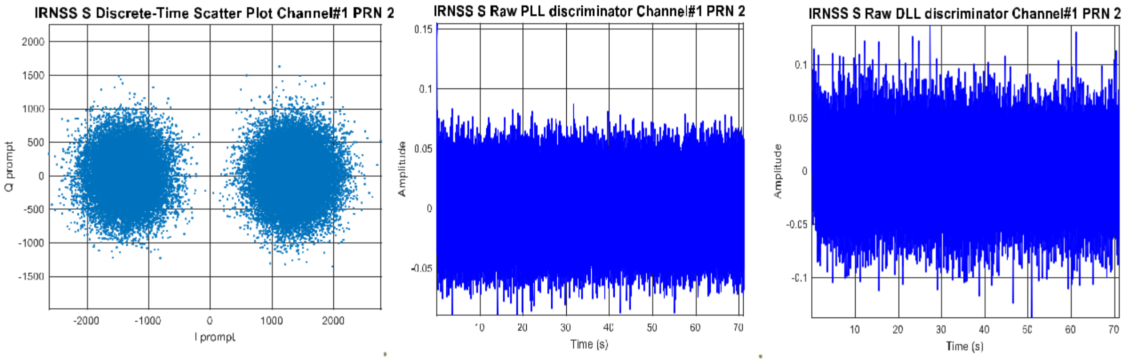

Figure 12: Tracking plots for IRNSS L5 band Channel #1 PRN 2

Figure 13: Tracking plots for IRNSS S band Channel #1 PRN
2 **IRNSS NAVIGATION MESSAGE DECODING**

The Tracking IP samples of 1kHz rate are correlated with the 320 preamble samples resulted from up sampling each bit with 20 samples, of a 16-bit preamble “EB90”. Thus, both bit synchronization and frame synchronization can be achieved. If the maximum correlation value either at 320 or -320, then all the 12000 samples belongs to one subframe is accumulated and converted into 600 data bits of 1’s and 0’s by averaging each sequential 20 samples and compared with threshold. After deinterleaving and applying convolution decoder on the 584 bits results in 292 bits of subframe data. The data is decoded as per the IRNSS ICD. Once the subframe data is decoded and the corresponding satellite positions are calculated. Receiver position is calculated using decoded Satellite positions and with derived Pseudo ranges. The algorithm for calculating IRNSS Satellites positions in ECEF (Earth Cantered Earth Fixed) Coordinate system is given in Appendix B of IRNSS ICD [11].

The navigation results are shown below in terms of 3d Position in East-North-Up (ENU) local reference coordinate system along with sky plot and with various statistical measurements. The Position error measures or accuracy measures are calculated using the formulas given in [13]. The Dilution of Precision (DOP) values are calculated with the formulas given in [8].

e-ISSN 2320 –7876
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Vol.11, Iss.4, Apr 2022
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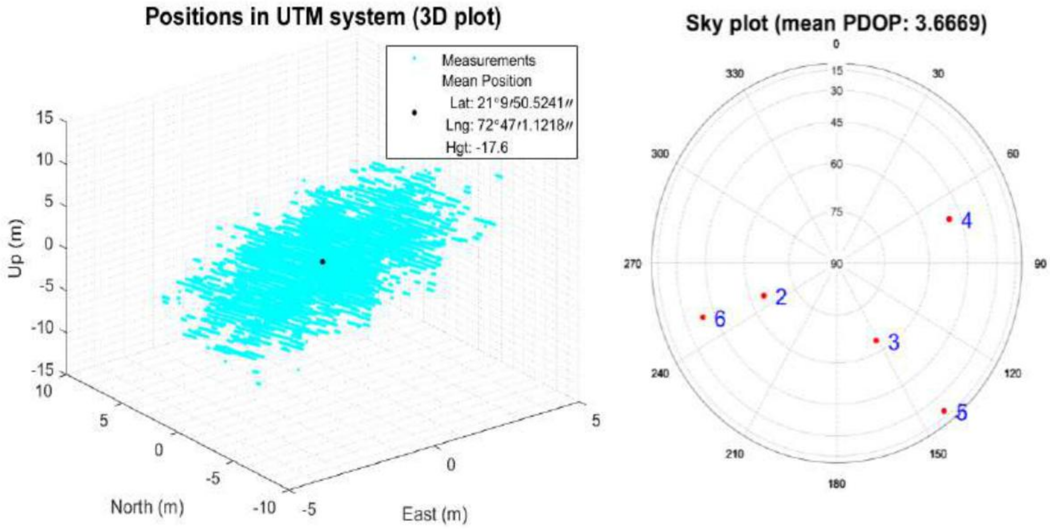
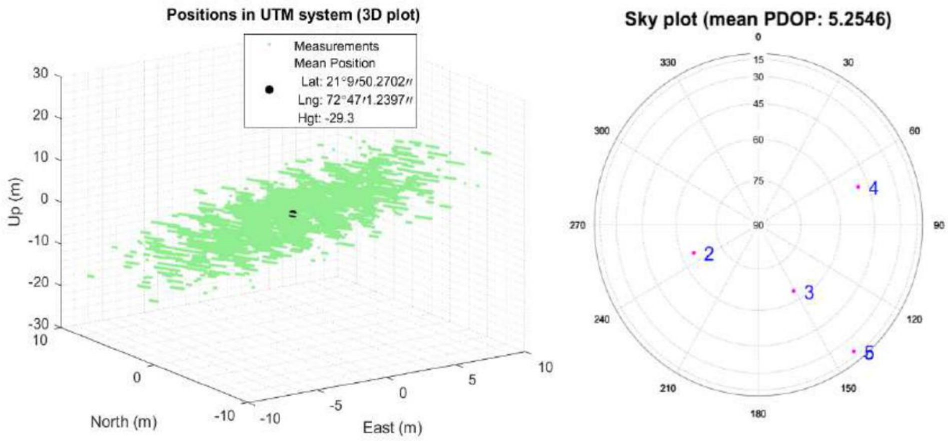


Number of Satellites	5	2,3,4,5,6
Mean Position Coordinates	Lat	21° 9' 50.5241'' N
	Long	72 47' 1.1218''E
	Height	-17.6m
Accuracy Measures	CEP	3.79
	2DRMS	10.37
	3DRMS	15.56
	SEP	4.46
Dilution of Precision (DOP)	GDOP	4.40
	PDOP	3.67
	HDOP	3.39
	VDOP	1.39
	TDOP	2.44

Figure 14: Navigation results for L5 band and without ionospheric corrections – Data-1



Number of Satellites	4	2,3,4,5	Accuracy Measures	CEP	5.76	GDOP	6.53
Mean Position Coordinates	Lat	21°09'50.2702"N		2DRMS	16.44	PDOP	5.25
	Long	72°47'01.2397"E		3DRMS	24.66	HDOP	5.07
	Height	-29.3m		SEP	6.29	VDOP	1.39
	-	-		-	-	TDOP	3.88

Figure 15: Navigation results for S band and without ionospheric corrections – Data-1

TESTING TIME SYNCHRONOUS FRAME WORK

The time synchronous frame work that is developed for NavICSR is tested for real time capability. The data collection 2 is used to test this frame work and it is converted from 20Mhz to 5MHz sampling frequency. A 100 seconds IRNSS L5 Digital IF Data is processed with the developed frame work and it can be able to process 4 visible satellites with an average time of 180.07 seconds. Which is 0.80 times slower than real time or data elapsed time. The PC configuration used for testing and validating NavICSR frame work has Processor: Intel(R) Core (TM) i7-8750H CPU @ 2.20GHz (12 CPUs), ~2.2GHz, Windows-10, with maximum turbo frequency of 4.1 GHz

Card name: Intel(R) UHD Graphics 630

Card name: NVIDIA GeForce GTX 1050Ti

Table 8: Speed of Execution of Time synchronous frame work

Parameter	Data elapsed time (Real time) in Seconds	Mean Execution Time in seconds (15 measurements)	Real time factor (≤ 1)
TTFF (Time to First Fix)	32.508	39.98	1.23
Total execution time of code	100	180.07	1.80

CONCLUSION

At the Research and training unit for navigational electronics (NERTU) at Osmania University, they use MATLAB and the Time synchronous frame work to create the NavIC software receiver (OU). We show the early findings of our acquisition, tracking, and navigation solution, and we evaluate the effectiveness of the NavICSR framework we've created in terms of its real-time capacity. The receiver is put through its paces with IF data recorded from a stationary rooftop antenna. You may use NavICSR as a starting point for your IRNSS System research and development because of its adaptability and reconfigurability. The created framework may allow the software receiver to function in real time with minimal input data requirements.

DIMENSIONS OF THE FUTURE

This article presents the early efforts using NavICSR. The receiver has room for growth and development. MATLAB's parallel processing toolbox may be used to make the tracking channels parallel, which would increase the program's throughput. With only one frequency of L5 or S signals, a real-time software receiver that can process the data via the antenna and front-end hardware may be looked at. The ionosphere allows for the incorporation and evaluation of algorithms. To enhance NavICSR's functionality in Post processing mode, other systems like GPS, GLONASS, Galileo, BeiDou, etc. might be included.

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