International Journal of Research
Available at
https://edupediapublications.org/journals

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

A Survey on Offline Signal Quality Analysis for Different Methods

1st author-**Maan Peshavaria**

2nd author-**Manish Patel**

I. ABSTRACT

The performance of navigation system depends on the quality of navigation signal. Additionally, if the quality of navigation signal gets worse than it can make the system unavailable. To achieve precise navigation, positioning, velocity and timing, navigation signal quality are of vital importance. The PVT results may be affected due to some unpredictable anomalies in satellite. signal analysis for offline received signal includes time domain, correlation domain and frequency domain (spectrum) parameters, which includes the scatter plot, eye diagram, PN chip shape, spectrum, correlation function and correlation loss. Through monitoring and in depth analysis of the signal quality. This paper introduces signal quality analysis classifications and makes use of these classifications to categorized and review various methods: open loop process, close loop method and SDR for beidou.

II. INTRODUCTION

An increasing number of countries have focused on the development of their own Global Navigation Satellite System (GNSS), which provides convenient real-time positioning, velocity, and time services. Currently, the Global Positioning System (GPS) operated by the United States and Global Navigation Satellite System (GLONASS) operated by Russia provide global positioning services to users. In addition, the European Galileo and Chinese BeiDou Navigation Satellite System (BDS), both under development, aim to provide global positioning service by 2020. The Japanese Quasi-Zenith Satellite System (QZSS) and the Indian Regional Navigation Satellite System (IRNSS) are regional navigation satellite systems (RNSS). Different GNSSs have been combined to provide users with more complete and diverse satellite navigation services A regional GNSS is designed to provide unique benefits for a certain area. For users in the Asia Pacific region, GPS, GLONASS, and BDS provide stand-alone positioning services at all times. Galileo is being built up and can thus currently provide only restricted positioning services in this region. For users in urban areas, the integration of different GNSS offers higher positioning availability.

The offline signal quality analysis of the received satellite signals. There are two systems to check the signal quality for GNSS in which BOC modulated signal. 1) Open loop Process and 2) Close Loop Process. The offline signal quality analysis foe beidou system used the SDR method in which signal all parameters are found.

III. SIGNAL ANALYSIS PARAMETERS

A. Time domain parameters

Another set of evaluation parameters is directly related to the time-domain characteristics of the signal. In the signal quality monitoring software, eye diagram, signal envelope peak to average ratio, pseudorandom code and navigation message data are analyzed. Eye diagram symbolizes the modulation quality, signal imperfection and distortions, code interference and noise influence. To plot I/Q signal eye diagram, the pseudorandom code should be kept in tracking. Local replica code phases are utilized as X-coordinate, and I/Q baseband signal magnitudes are utilized as Y coordinate.

1) **Scatter plot**: Scatter plot is also called as the vector signal diagram, is a kind of complex plane with complex numbers as its coordinates, demonstrating the relationship between different signals such as I & Q component. The real part of modulated band-pass digital signals can be seen as the amplitude modulation of cosine signals, while the imaginary part can be seen as that of sine signals. The former is called the In-phase component, while the latter is called the Quadrature component
2) **Eye diagram**: Eye diagram can provide lots of useful information for indicating the performance of a digital signal transmission system. From eye diagram we can see the degree of inter symbol interference crosstalk and noise, so this will in turn help us to understand the impact of these distortions on useful signals, and then further to evaluate the property of baseband system. Eye diagram can give instructions to the receiver filter for reducing the inter code crosstalk.
3) **PN chip shape**: Chip shape get after Doppler removal in I- and Q, overlaid for many chips.

B. Frequency domain parameters

In frequency domain, spectral properties of spread signals and carriers are analyzed to monitor their spectrum abnormality. The Offline Beidou Signal Quality Analysis SDR Software provides frequency analysis including power spectrum estimation, stray in-band, and stray out-of-band. The power spectrum is the main observation tool in this domain as a basic monitoring parameter.

1) **Spectrums**: power spectral density estimation with Welch's period gram method.

C. Correlation domain parameters

Correlation evaluation parameters are related to the correlation function CCF of the incoming band-limited and down-converted signal with a binary infinite bandwidth receiver replica. Navigation performance and precision is directly dependent on correlation and hence these evaluation parameters are of major importance for analysis. Correlation parameters analyzed in the software are correlation function, correlation loss.

Correlation loss can be calculated by the difference of the normalized actual signal and normalized ideal signal. Normalization of the signals can be done by the ratio of the useful signal power to the total available signal power received.

$$CL\,[dB] = P_{CCF}[dB]_{Ideal} - P_{CCF}[dB]_{Received} \quad \ldots\ldots 1$$

Where the correlation power *PCCF* given by

$$P_{CCF}[dB] = \max_{£}\left(20\log_{10}(|CCF(£)|)\right) \quad \ldots\ldots 2$$

And the definition of the correlation function is *TP* is integration period, *SBase* is received baseband signal, *SRef* is the local binary replica of *SBase* in the DLL. Hence, the correlation loss symbolizes the power loss from channel and the receiver.

$$CCF(£) = \frac{\int_0^{TP} S_{base}(t)\cdot S^{*}_{ref}(t-£)dt}{\sqrt{(\int_0^{TP}|S_{base}(t)|^2 dt)\cdot(\int_0^{TP}|S_{ref}(t)|^2 dt)}} \quad \ldots\ldots 3$$

And the definition of the correlation function is *TP* is integration period, *SBase* is received baseband signal, *SRef* is the local binary replica of *SBase* in the DLL. Hence, the correlation loss symbolizes the power loss from channel and the receiver.

1) **Correlation function**: The correlation of the incoming band-limited and down-converted signal with a binary receiver replica.
2) **Correlation loss**: Correlation loss refers to the ratio of the useful signal power to the total available signal power received.

IV. *Offline processsing setup for beidou*

An offline signal quality monitoring software of BeiDou Navigation Satellite System (BDS) with new signal plan based on software defined radio (SDR) receiver as shown in below figure.

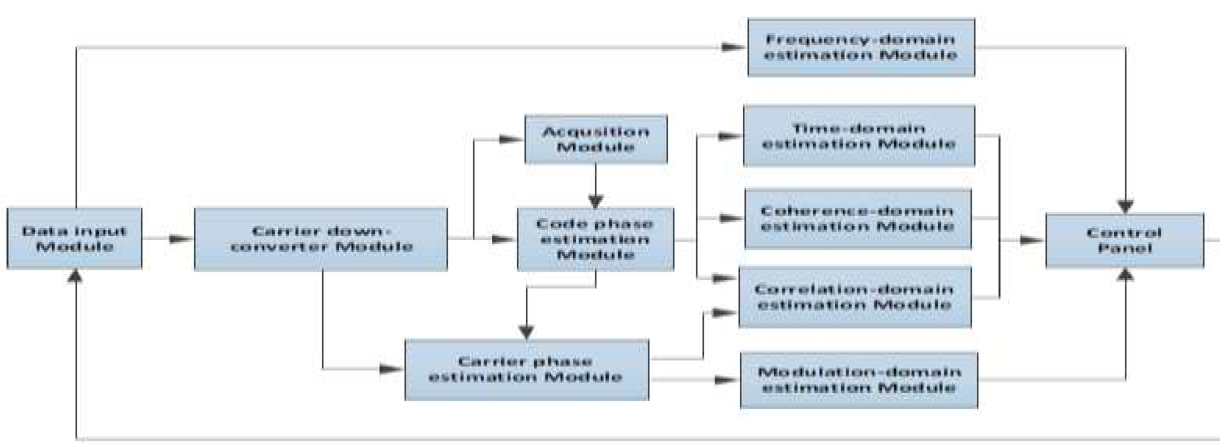

Figure 1Strcture of the offline signal quality monitoring software

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

The above figure shows the structure of the offline signal quality monitoring software based on SDR receiver for BDS system, and in particular on the algorithm design, software development and validation for offline signal analysis of the navigation signal.

Features of the of the software quality analysis include:

1) The offline signal quality analysis is capable to analyze measured signal samples of up to few hours length. A few microseconds signal samples are read and analyzed once a time.
2) The SDR receiver is essentially an open loop tracking receiver. This is because correlation based parameters such as CL are sensitive to closed loop tracking bandwidth.
3) It is designed to analyze BDS system signal as several test signal plan of modernized BDS is pre-stored and optional.
4) The software processes the sampled signal files reading certain length data into the software, and then makes quality analysis of each input signal set. The results of each set are stored and presented to the front panel. The structure is showed

ADVATAGE of SDR method

The advantages and shortcomings of different signal quality monitoring facility at present are discussed, and the SDR receiver based signal quality monitoring method is more suitable for offline analysis in a developing system. Details of the signal processing techniques adopted with the parameter concept of frequency-domain, time-domain, modulation domain, correlation-domain, etc.

Validation and results of BDS signal quality monitoring analysis are for 3 different frequencies presented in below.

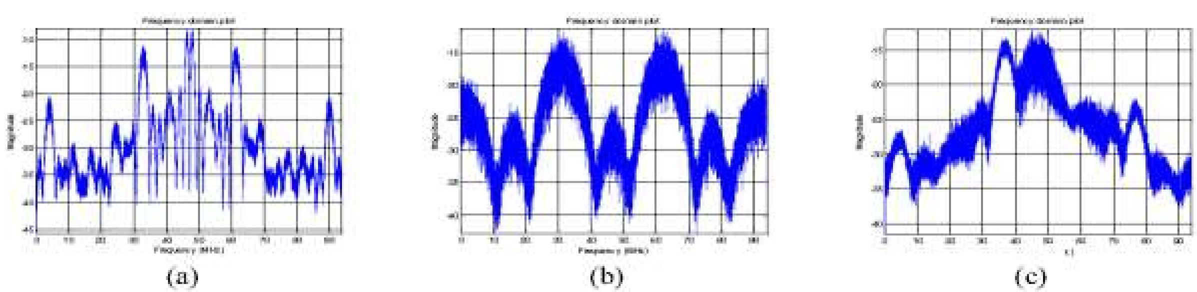

Figure 2(a) B1 PSD estimation results; (b) B2 PSD estimation results; (c) B3 PSD estimation result

International Journal of Research
Available at
https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

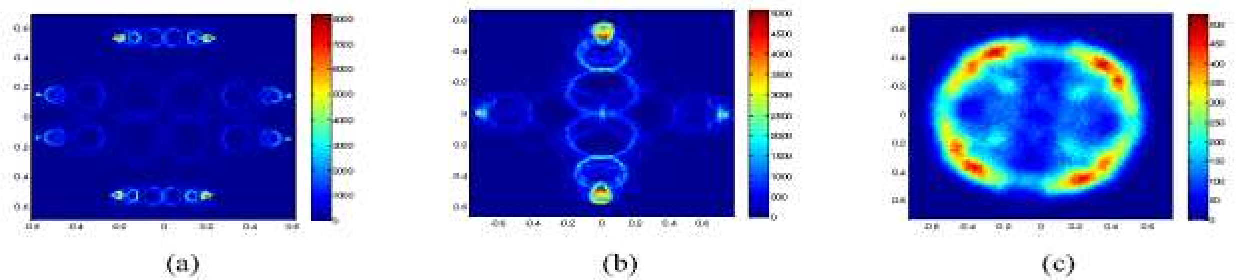

Figure 3(a) B1 constellation plot results; (b) B2 constellation plot results; (c) B3 constellation plot results

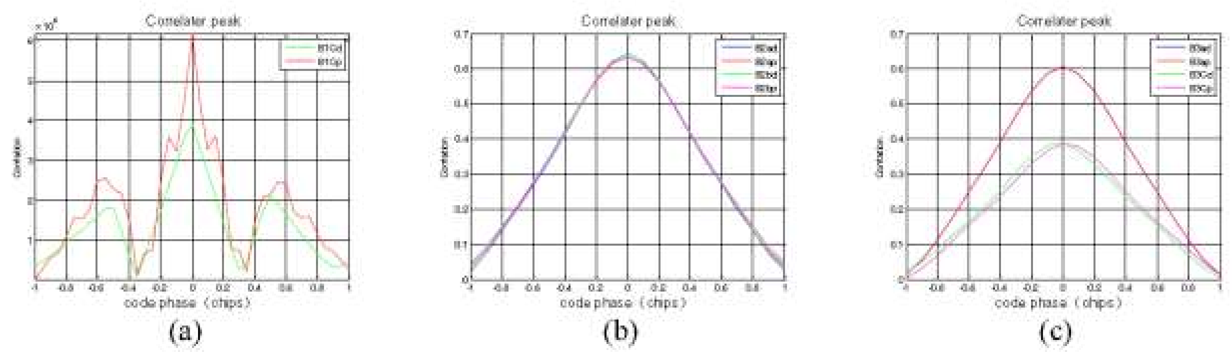

Figure 4(a) B1 correaltion function results;(b) B2 correaltion function results; (c) B3 correaltion function results

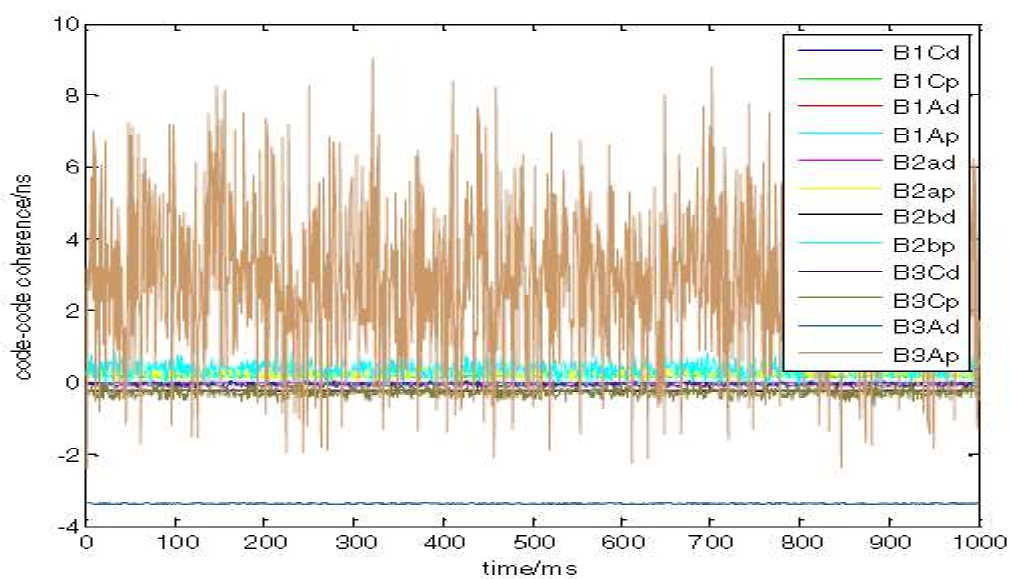

Figure 5Code-code coherence calculation results

Further work

signal quality monitoring software focuses on the capability of full system quality monitoring, improvement on the time consuming efficiency, elongation of the signal monitoring time and incorporation of more analysis parameters.

I. *Offline processing setup for GNSS*

Sampling frequency impact on False Lock of High Order BOC Signals in Open-Loop Processing. The current Global Navigation Satellite Systems (GNSS) use Binary Offset Carrier (BOC) modulated signals. These signals have a narrower main lobe of the autocorrelation function (ACF) with respect to the classic Binary Phase Shift Keying (BPSK) modulated signals, and hence they offer better tracking accuracy the drawback comes in the side lobes appearing in the ACF, that can origin false locks in the tracking process. In the case of high-order BOC signals, the problem becomes more evident as there is a large number of side lobes and their amplitude can be close to the main lobe. Open-loop processing techniques appear as a promising approach to deal with the false lock phenomena. Some novel

Techniques target this issue with a multi-correlator approach. The use of an increased number of correlators contributes to a global view of the ACF, including the main lobe and some or all of its side lobes. This information can be employed to properly determine the position of the main

Lobe and distinguish it from side lobes. The false lock probability is evaluated assuming that the ACF is sampled in a way enabling to distinguish the different side lobes. The false lock issue of high order BOC signals from an open-loop perspective. Two different strategies to estimate the time of arrival were evaluated. On the one hand, the conventional approach, which consists on finding the argument of the maximum of the correlation samples, was reviewed. On the other hand, the ML estimation of the time delay from the post-correlation samples was derived. Their asymptotic performance was assessed with respect to the sampling frequency by means of numerical simulations. The conventional estimator was observed to incur significant values of false lock probability for a large span of sampling frequency values. Only for a few sampling rates the false locking was observed to decrease substantially. These sampling rates turned out to be multiples of the subcarrier frequency. The proposed post-correlation estimator reduces the false lock probability to zero for all the sampling frequencies analyzed. Both approaches were also compared for a range of C=N0 values. The proposed approach outperforms the standard approach and virtually removes the false locking at high C=N0. Future work could be devoted to the analysis of false lock in the presence of multipath propagation. The impact of false locking in the PVT solution could also be investigated.

II. Offline Analysis of Beidou MEO-3 Signal Quality

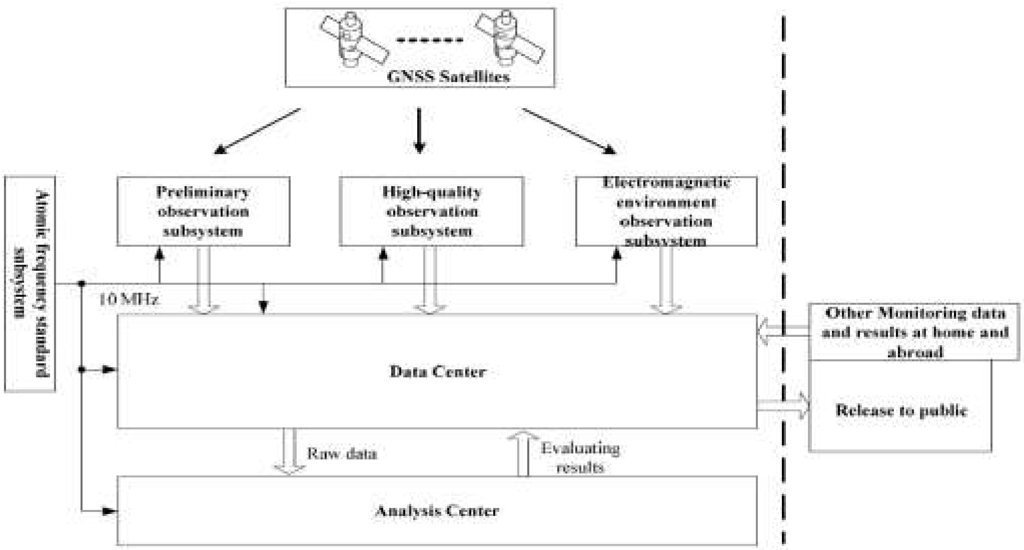

Figure 6GNSS Signal Monitoring and Evaluating System

This comprehensive method for BeiDou MEO-3 signal quality evaluating, which can also be used to evaluate GNSS signal quality. In addition, BeiDou MEO-3 signal quality evaluating results of different dates, from the aspects of PSD, vector signal diagram, eyediagram, waveform, correlation function, correlation loss, S curve and second central moment, etc., are given and compared in detail. Results show that, there are no relevant signal changes during several measurements in different days, and no new emissions have been detected, there is not much distortion in the received BeiDou MEO-3 signal. To sum up, monitoring and evaluating GNSS signal quality is benefit to the development and service performance of GNSSs, and will further promote researches on compatibility and interoperability. GNSS signal quality monitoring and evaluating is an international and long-term work. It's necessary to implement international cooperation with more organizations and countries.

III. Navigation Signal Quality Monitoring Based on Eye Diagram

Eye diagram is a conventional manner to evaluate the quality of signal. In this article, the navigation signal was modeled on the basis of the ICAO navigation signal threat model. Eye diagram was used to monitor the navigation signal quality. In addition to theoretic analysis, this monitoring method was demonstrated with raw navigation signal. For better analysis of signal abnormities in satellite navigation, researchers proposed three threat models of navigation signal established early or late: simple model, Most Evil Waveform Threat Model (MEWF) and 2nd-Order Step Threat Model (2OS). Numerous studies were given to these three models. By contrast, 2OS Threat Model was found more inclusive to

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

reflect the abnormities of navigation signal and taken by ICAO as the standard threat model of satellite navigation signal
Focusing on the analysis of TMA model in 2OS threat model, this paper proposed to use eye diagram to monitor the navigation signal quality concerning TMA abnormities. To verify the above result, we ran a rest with the signal collected physically from a
GPS satellite at the sampling rate of 8.184 MHz The carrier and the Doppler effects were acquired, tracked and removed from the collected data with a software receiver to obtain the pseudo-random code signal.

IV. COMPARISION

From above using all methods we analyzed the signal quality analysis for the offline processing in which the highly accurate method is the open loop method because in this method we not used the false lock loop and it's used for GNSS system. This research analyzes the sensitivity of the received BDS and GPS signals for a given user. The signal strength and continuity differences between BDS and GPS are given. The carrier-to-noise density ratio (C/N_0) is used to show the signal strength and quality. The C/N_0 output by a receiver is used as an indicator of signal strength and quality of the tracked satellite and the noise density as seen by the receiver's front-end. The cycle slip number of the carrier-phase measurements for each satellite is used to analyze the continuity for these two systems. For eye-diagram analysis we used the ICAO Threat model. The GNSS system analysis setup is valid for online signal quality analysis.

V. CONCLUSION

The above sections shows the different methods to analyzed the offline signal quality in which time domain, frequency domain and correlation domain analysis. The analysis method for beidou system is valid to other GNSS system. The threat model is used to analysed the time domain parameter in which eye-diagram. The offline processing in which the highly accurate method is the open loop method because in this method we not used the false lock loop and it's used for GNSS system.

VI. REFERENCES

1. GNSS Offline Signal Quality Assessment, M.Soellner1, C.Kurzhals1, M.Rapisarda2, T.Burger2, S.Erker3, J.Furthner3, U.Grunert3, M.Meurer3, S.Thölert3 EADS Astrium Germany, Ottobrunn, European Space Agency, The Netherlands, German Aerospace Center, DLR

2. GNSS Offline Signal Quality Assessment, Conference Paper · September 2008Matthias Soellner, ASTRIUM, Johann Furthner, German Aerospace Center (DLR), Grunert Ulrich, German Aerospace Center (DLR), Steffen Thölert, German Aerospace Center (DLR)

3. Offline Analysis of Beidou MEO-3 Signal Quality He Chengyan, Guo Ji, Lu Xiaochun and Wang Xue, Key Laboratory of Precision Navigation and Timing Technology, National Time Service Center, Chinese Academy of Sciences Hao Weina and Yang Guang, Academy of Opto-Electronics, Chinese Academy of Sciences

4. Navigation Signal Quality Monitoring Based on Eye Diagram Jian Xie, Xianzhi Luo and Yao Wang

5. An offline signal quality monitoring software of BeiDou Navigation Satellite System (BDS) with new signal plan based on software defined radio (SDR)

6. **Betz, J. W. (2001). Binary offset carrier modulations for radionavigation.** ***Navigation*****,** ***48*****(4), 227-246.**

7. **Gusi, A., Closas, P., & Garcia-Molina, J. A. (2016, December). Sampling frequency impact on false lock of high order BOC signals in open-loop processing. In** ***Satellite Navigation Technologies and European Workshop on GNSS Signals and Signal Processing (NAVITEC), 2016 8th ESA Workshop on*** **(pp. 1-5). IEEE.**