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Abstract

Radio telescopes are very sensitive devices that are used to monitor astronomical phenomena’s by receiving radio waves from space. Small and medium-sized telescopes have a significant problem: signal attenuation due to interference by satellites crossing their line of sight. This project outlines a novel calibration technique that will estimate the missing part of the radio signal based on almost simultaneous observations of the same phenomenon by other telescopes in the same network. A mathematical formula based on time and angular differences between the telescopes will help in correctly estimating the missing part. The goal of this strategy is to improve the quality of radio data and to facilitate more reliable astronomical analysis.

Introduction / Background

Nowadays, the increase in satellite launches has been a cause of concern to the radio astronomical observations. While moving in space, the satellites generate interference and blockage of the radio signals from the telescopes, which immediately eats into the accuracy and quality of the data. It is even harder on smaller or medium-sized telescopes such as the ones in the Saudi Arabian national network. The motivation for our study came from understanding that telescopes that have a common set of instruments will end up taking an observation of the same cosmic event simultaneously, though from a different observational frame. This gives us a window of opportunity for completing the missing information by merging an integral portion of the wave from another telescope, both a function of positional angle and the time element, prior to merging it with the initial signal. We will develop an intelligent framework to reconstruct the bogus radio signal.

This framework: Identifies the missing components Provide additional information based on several telescopes, Employs a mathematical model which uses time (t) and angular change (θ),

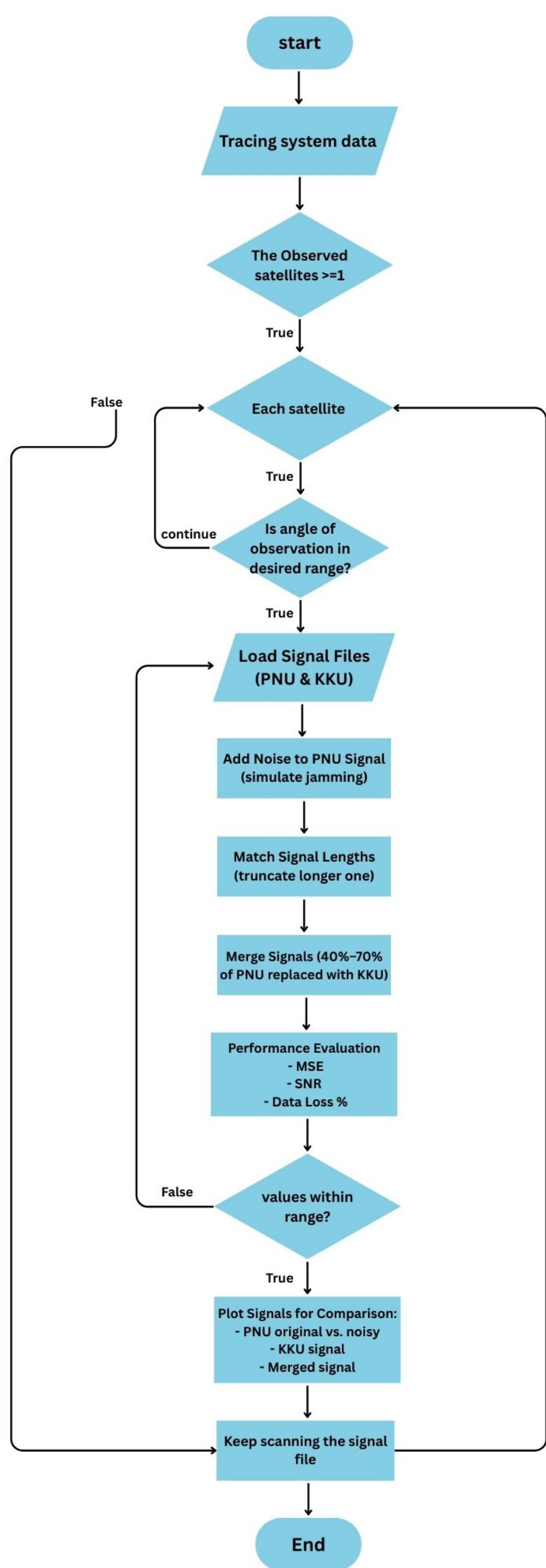
Where :

$$\theta = \cos^{-1} \left(\frac{\vec{r}_s \cdot \vec{r}_b}{|\vec{r}_s||\vec{r}_b|} \right)$$

Provides a full waveform that can be trusted for analysis.

System Model / Methodology

- We collected radio telescope (SDR) data from all universities.
- We used MATLAB to analyze the observed signals.
- We selected the samples for the experiment (PNU signal) and (KKU signal).
- Using programming codes, we were able to retrieve the missing part of the signal.



Conclusions

Overall, the project proved that syncing telescopes can improve the quality of astronomical data in a practical and cost-effective way. The technologies we used helped us deal with satellite interference without needing complex or expensive equipment. We believe this system can be expanded in the future and support larger and more advanced space research, especially with the integration of more data analysis tools.

Proposed Solution / Main Idea

The solution is to develop a synchronization network that links all radio telescope signals in all universities, and to create a monitoring center located in the middle of the geographical area between them. In addition, a satellite tracking system will be integrated to identify satellites that may be obscuring or interfering with the observed signals, preventing these problems by either avoiding detection during signal obscuration times or processing them simultaneously. The satellite tracking system provides data such as orbital coordinates (satellite position), elevation angle and azimuth, and time and speed. By combining software-defined radio (SDR) technologies with GPSDR across all universities, GPSDR will provide accurate time data synchronization. A high-performance central server will then be used to collect and analyze the data using Fourier transform (FFT) to assist in signal analysis and spectrogram generation to monitor time variation, generating data integrity protocols. As a result, the network will reduce data loss (useless data), study wave behavior, and achieve high reliability, while providing opportunities for future expansion.

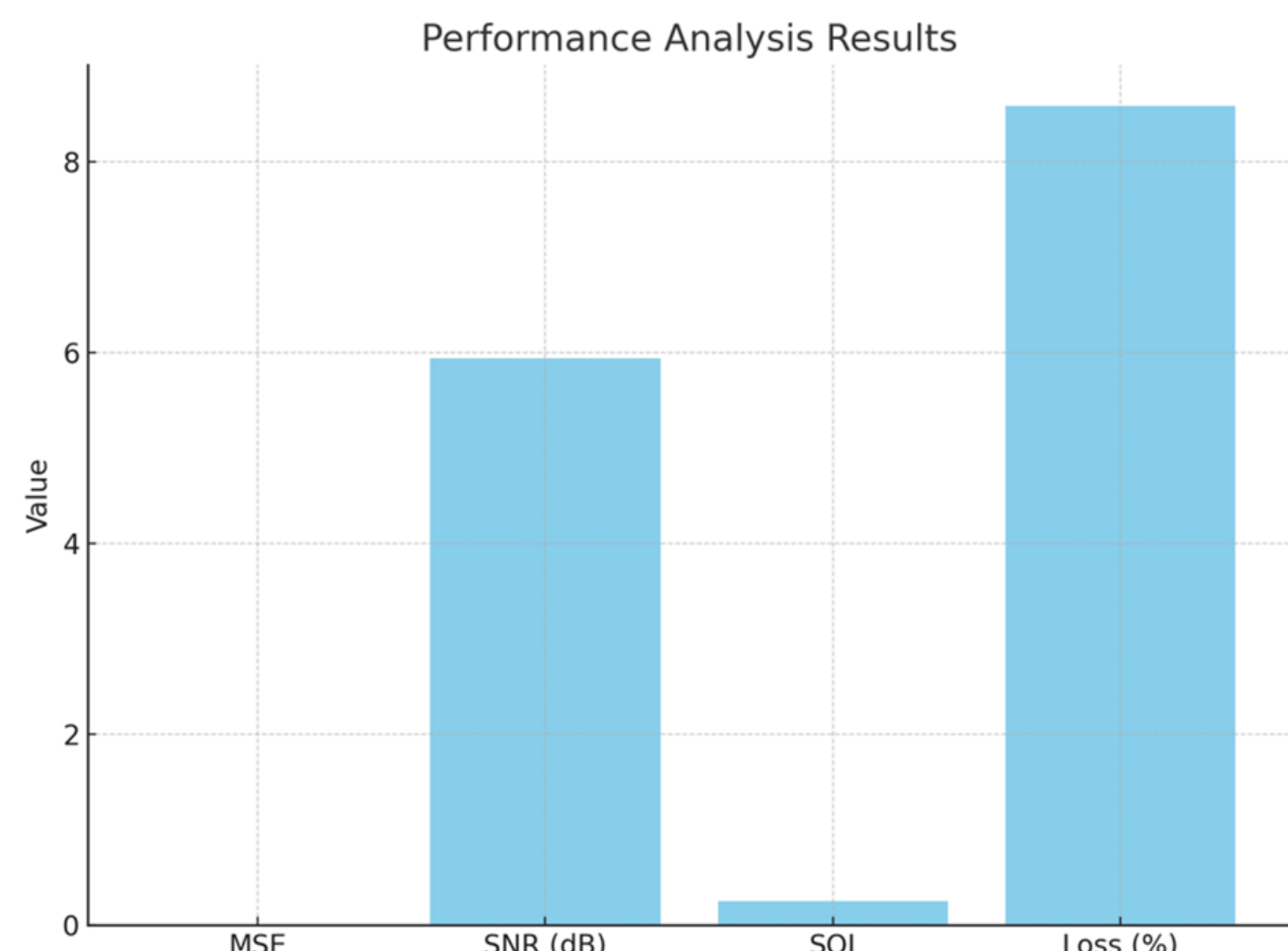


Chart 1. The result MSE ,SNR ,SQI, Data Losses.

Results / Simulation / Discussion

We successfully synchronized signals between university-based radio telescopes with high time accuracy. By using SDR and GPSDR technologies, we saw a clear improvement in data quality and a reduction in signal loss caused by satellite interference. When we analyzed the signals using Fast Fourier Transform (FFT), we were able to recover missing parts of the signal, which helped produce clearer and more accurate astronomical readings.

We ran a detailed simulation to understand how satellite interference affects telescope data. The results showed that the system could recover missing signals by using information from nearby telescopes. By calculating the differences in timing and angles between telescopes, we were able to reconstruct cleaner and more accurate signals, which helped a lot during analysis.

The experiments clearly showed that synchronizing the telescopes reduced data loss and improved accuracy, especially during times of satellite interference. Adding a satellite tracking system made a big difference — it allowed us to predict when interference would happen so we could either avoid it or correct the data afterward. This gives researchers more reliable data to work with in their studies.

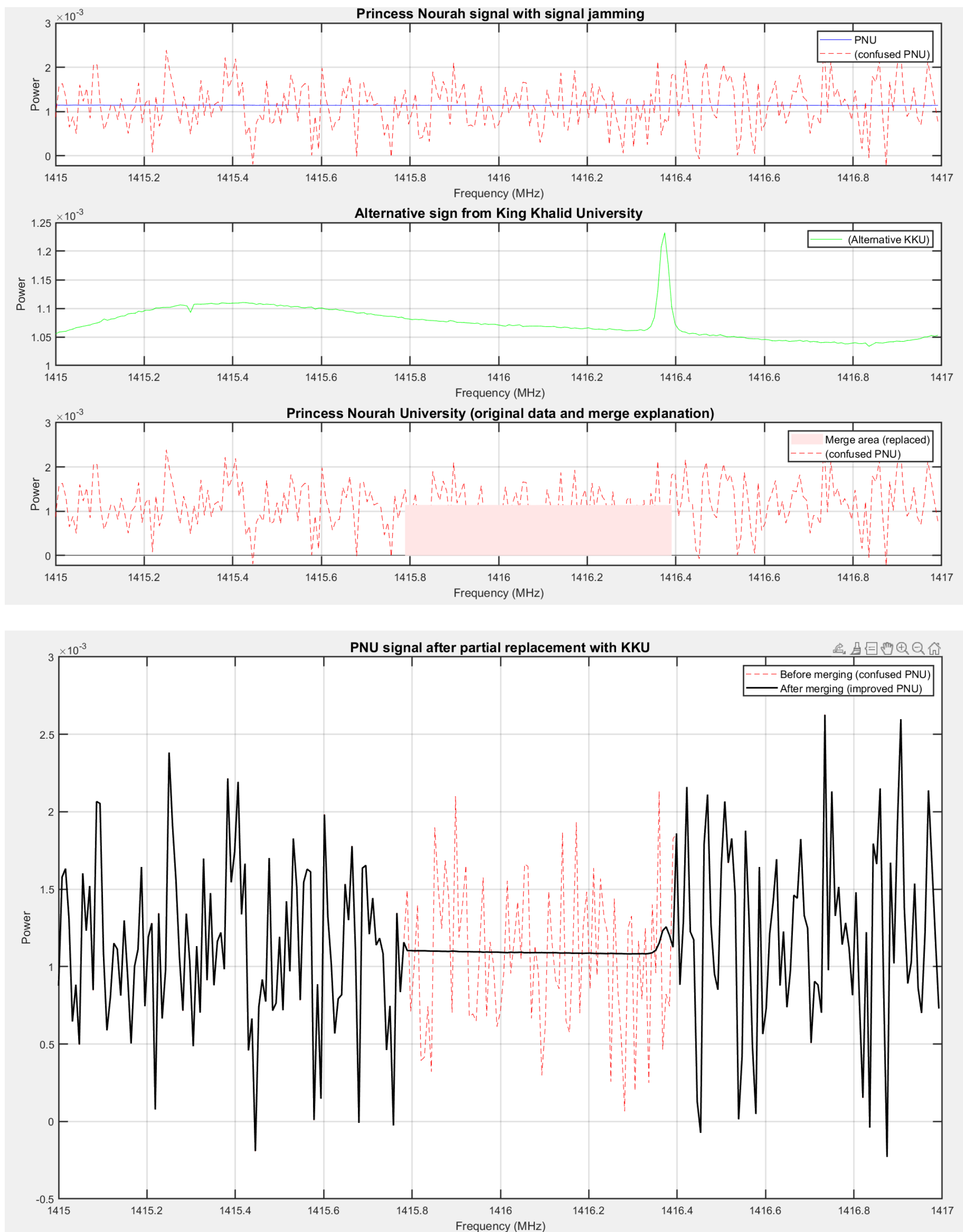


Figure 1. Partial Replacement Figure

References:

