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Title

Collaborative Localization Assisted RFI Detection Using Low-Cost COTS GNSS Receivers

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Abstract

Radiofrequency interference (RFI) can disrupt the normal functioning of navigation devices. Depending on the characteristics of RFI signals, the ultimate impact on a GNSS receiver can be anywhere from minimal, where it can slightly impact the signal strength of the received signals - to severe, where it can cause the receiver to output an invalid or incorrect position, velocity and time (PVT). Therefore, it must be ensured that a navigation dependent infrastructure is fully aware of its environment and should be able to detect any possible interference signal that could possibly impact its adequate functioning. Typically, the RFI is detected by sensing the variations in various receiver observables such as received signal strength (RSS), carrier to noise density ratio (C/N_0), automatic gain control (AGC) etc. The degree of variation in these observables represents the severity of the RFI observed by the receiver.

In this paper, we present and evaluate the interference detection approaches leveraging continuous RFI localization [1] that estimates position of an interference source. A Minimum to Second Minimum Error (MSME) ratio metric is introduced that quantifies that variability of the localization results. It is calculated as a ratio of minimum error to second minimum error between the true and estimated position of the RFI source. It has been shown that the proposed metric is sensitive to variation in the localization results prompting the presence of an interference source.

Another technique presented in the paper is based on the major voting mechanism. It has been proposed for the situations where more than one node is part of a network and fully or partially impacted by the RFI. A tolerable threshold is defined for the receiver using the observed data and the impact of the receiver.

The detection techniques are compared using a reference detection scheme. The reference detector works in a non-position domain making it independent of the localization results. In our case, it is based on studying the receiver's inherent capability of interference detection. As per the protocol followed by the uBlox receivers, that are used in the current study, there are certain receiver messages that contain information that is potentially suitable for the interference detection.

The interference detection schemes introduced above have been tested using a UAV based scenario. In the scenario, six identical UAVs are simulated to follow a predefined trajectory. The UAVs are made to fly in an open sky condition, and no secondary effects impacting the GNSS signal quality and reception, except the interference, is modeled. The scenario is implemented on a Spirent HW GNSS simulator and the interference signals are emulated using the Spirent Interference Signal Generator. The GNSS signals generated by the simulator and the interference signals are combined using an RF combiner and connected to the antenna input of the uBlox NEO-M8T receivers.

The results show the potential of the presented techniques to detect strong and weak interference in the environment. The results also reveal that the performance of majority voting based detection method is prone to threshold selection and toleration level of the receivers in presence of interference.

References

[1] N. Ahmed, A. Winter and N. Sokolova, "Low Cost Collaborative Jammer Localization Using a Network of UAVs," *2021 IEEE Aerospace Conference (50100)*, Big Sky, MT, USA, 2021, pp. 1-8, doi: 10.1109/AERO50100.2021.9438441.