Internship Description

1. Title: DESIGN OF OPTIMAL COUPLING BETWEEN TEMPORAL BLANKER AND ADC/AGC BLOCK FOR AN AIRBORNE DFMC RECEIVER

2. Supervisors:

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3. Description

3.1. Context

In the context of civil aviation, it is important to characterize the Radio Frequency Interference (RFI) relevant to the airborne GNSS receivers processing signals in the L1/E1 and L5/E5a bands to guarantee Safety-of-Life (SoL) service. Focusing on GNSS L5/E5a band, the RFI environment is dominated by pulsed interferences such as DME/TACAN and JTIDS/MIDS signals [1]. Airborne Dual-Frequency Multi-Constellation (DFMC) GNSS receivers must implement a temporal blanker to mitigate these type of pulsed signals. The temporal blanker role is setting to zero received signal samples having its instantaneous power envelope higher than a certain threshold (interference detection/mitigation).

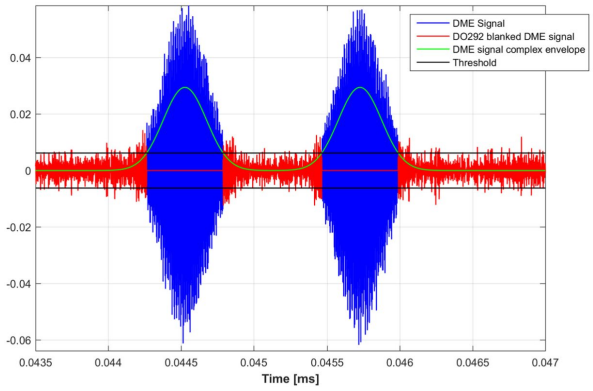

Fig: Example of DO-292 instantaneous blanker behavior over the DME signal complex envelope

The temporal blanker is implemented in the Radio-Frequency Front-End (RFFE) block of the GNSS receiver and must be coupled with the ADC (Analog-to-Digital-Converter) / AGC (Automatic gain Control). An optimal coupling should lead to a minimum degradation of the link budget effective C/N_0, $C/N_{0,eff}$, where $C/N_{0,eff}$ is compared to different C/N_0 thresholds to guarantee the minimum performance of acquisition, carrier phase tracking and demodulation (fundamental GNSS signal processing operations).

However, the temporal blanker implementation and its coupling with the ADC/AGC are not defined in any civil aviation standard, and thus the achievement of its optimal behavior must still be demonstrated. Moreover, mathematical models assuming an optimal and linear behavior of the ADC/AGC coupled with the temporal blanker are also assumed in the standards to define $C/N_{0,eff}$

mathematical models [1][2]. Indeed, proposed mathematical models assume an optimal ADC/AGC behavior without considering that no-blanked interference (below threshold interference) may distort the nominal functioning conditions of the ADC/AGC block.

3.2. Objectives

The main objective of this internship is twofold, first to analyze potential temporal blanker implementations and coupling configurations with the ADC/AGC and second, to identify the most performing implementation/promising solution in terms of $C/N_{0,eff}$ degradation.

If the time allows it, the identified solution will be implemented and introduced to the GNSS L5/E5a receiver in presence of pulsed RFI simulator of the SIGNAV research group.

3.3. Work plan

The following tasks are planned for the internship:

- State-of-the-art on ADC/AGC, temporal blanker and $C/N_{0,eff}$ mathematical models
- Analysis and testing of temporal blanker implementations
- Analysis and testing of ADC/AGC implementations
- Analysis, mathematical design and testing of coupled temporal blanker and ADC/AGC blocks
- Mathematical modelling of $C/N_{0,eff}$ degradation for the identified temporal blanker/ADC/AGC coupling configurations and selection of the most promising one.
- (Optional) Implementation of the overall scheme on the GNSS L5/E5a receiver in presence of pulsed RFI simulator of the SIGNAV research group
- Report redaction
- Defense preparation

3.4. References

[1] DO-292 - Assessment of RF interference relevant to the GNSS L5-E5a band, RTCA, July 29, 2004

[2] A. Garcia-Pena, O. Julien, C. Macabiau et al., "GNSS C/N0 degradation model in presence of continuous wave and pulsed interference", Navigation vol 68, pp.75-91, January 2021, doi: 10.1002/navi.405

4. Period

- Starting date: 1st March 2024 (flexible)
- Duration: 6 Months (flexible)

5. Department

SINA/TELECOM/SIGNAV

The internship is proposed by the SIGNAV (SIGnals for NAVigation) research group. SIGNAV is one of three research groups of the TELECOM team in the SINA (Sciences et Ingenierie de la Navigation Aerienne) department at ENAC (Ecole Nationale de l'Aviation Civile).

6. Location

The internship will take place at main campus of ENAC in Toulouse, France. Adress: 7, avenue Edouard Belin BP 31055 Toulouse Cedex 4, building F.

7. Candidate's profile

Master student in electrical/telecommunications/electronic engineering with background in signal processing. Knowledge in GNSS will be appreciated.