IAF SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Interactive Presentations - IAF SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (IP)

Author: Mr. Zaid Rana
European Space Agency (ESA), Canada

Mr. Martin Unal
European Space Agency (ESA-ESOC), Germany
Mr. Samuel Peterson
Telespazio VEGA Deutschland GmbH c/o ESA-ESOC, Germany, Germany
Mr. Jose Martinez Heras
Solenix GmbH, Germany
Dr. Timothy Finn
Telespazio VEGA Deutschland GmbH c/o ESA-ESOC, Germany, Germany
Ms. Krisztina Annus
European Space Agency (ESA-ESOC), Hungary

RADIO FREQUENCY INTERFERENCE: USING DEEP LEARNING TOOLS TO MITIGATE THE IMPACT TO SPACE OPERATIONS

Abstract

Radio frequency interference (RFI) are a constant source of service interruptions in modern telecommunications systems. Disruptions in the space-to-ground communications can result in telemetry gaps, failed command sequences, and a loss of scientific research data. The worst case scenario is when disruptions due to RFI events trigger a spacecraft safe mode which could take several hours to recover to an operational state. In the coming years, RFI events and the operational impact to a variety of critical missions has the potential to become even more prevalent. Indeed, the space market disruption seen in the past decade has significantly enabled access to Low Earth Orbit (LEO). This paradigm shift has also fostered a growing interest for constellation missions, which complicates further the hazardous impacts to spacecraft from RFI sources. Ingenuity and forethought will be key to the next generation of space mission design. Using the European Space Agency's (ESA) International Gamma-Ray Astrophysics Laboratory (INTEGRAL) as a case study, the integration of machine learning applications into the ground segment architecture have been investigated. This paper highlights the use of deep learning tools to predict and mitigate RFI by developing a training model using observational data from service interruptions caused by other spacecraft which have been collected by the Flight Control Team (FCT) at the European Space Operations Centre (ESOC) since 2014. This solution is designed to be autonomous in predicting, analysing and mitigating operational losses incurred by RFI events by combining Recurrent and Convolutional Neural Networks to reduce such instances. A framework with image processing capabilities is used in conjunction with spectrum traces to differentiate spectral signatures of INTEGRAL from other spacecraft. The objective is to eventually populate a database with information which identifies prospective candidates susceptible of causing additional interferences. This represents a significant step forward in operational methodologies. The current methods are manual requiring the FCT to monitor INTEGRAL's spectrum and to coordinate with other satellite operators to manage conflicts within the framework of the International Telecommunication Union (ITU). The development of a framework leveraging artificial neural networks should streamline this process and enable the FCT to identify the source of harmful RFI signals faster and to a higher degree of accuracy. An additional goal of this project is for the methods to be reusable for future missions.

Keywords: Radio Frequency Interference, INTEGRAL, Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks, Mission Operations, Ground Operations