DEEP LEARNING FOR ENHANCED SID DETECTION: LEVERAGING CNNS FOR RELIABLE EVENT IDENTIFICATION

Supervisor : Germain PHAM
Email : dpham@telecom-paris.fr
Phone : +33 1 23 45 67 89
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Ref. :
Duration : 6 months
Degree : Master
Fields : (Computer Science, Electrical Engineering) Machine learning, Signal processing
Start date : 2024-04-01

Webpage

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Introduction

Sudden Ionospheric Disturbances (SIDs) are transient events caused by solar activity, such as solar flares, which can disrupt communication signals and affect satellite orbits. Detecting and characterizing these disturbances is crucial for mitigating their impact on communication systems and satellite operations.

An SID (Sudden Ionospheric Disturbance) monitor, consists mainly of three components: an antenna, a preamplifier, and a computer with a sound card. The antenna, designed to pick up VLF (Very Low Frequency) radio signals reflected from the ionosphere, captures very weak signals that are then amplified by the preamplifier. The amplified signals are fed into the computer via the sound card, which converts them from analog to digital form. Software running on the computer tracks the VLF transmission signal strengths and processes the data to monitor changes caused by solar flares, which affect the ionosphere and thus alter the signal strength of VLF transmissions used for the monitoring.

Project description

This project draws inspiration from a previous Stanford University project titled "Classifying Signatures of Sudden Ionospheric Disturbances" [cs332mr4558] to develop an advanced method for detecting and classifying Sudden Ionospheric Disturbances (SIDs). In the previous project, an algorithm was developed to distinguish between noisy and clean Sudden Ionospheric Disturbance (SID) data sets collected by a network of around 500 ground-based SID monitors. The algorithm utilized a set of features derived from time series measurements of low-frequency radio waves, with a focus on differences between daytime and nighttime signal strength. A binary classifier, specifically a support vector machine (SVM), was employed to

automatically assess the quality of the SID data.

While the previous project focused on discriminating noisy data from clean data in SID measurements, our new project aims to enhance SID detection in real-time by leveraging Convolutional Neural Networks (CNNs).

This project aims to develop a deep learning-based approach capable of identifying true SID events as time series data is continuously extended in real-time.

The project will involve the implementation of a CNN architecture optimized for real-time processing of time series measurements from SID monitors. This architecture will be trained on labeled data sets to learn patterns associated with true SID events, allowing it to distinguish between genuine disturbances and noise in the data stream.

The project is done in collaboration with the LESIA (Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique) at the Observatoire de Paris, which provides the data and the expertise in the field of solar physics.

Required skills

This project requires a good knowledge of machine learning concepts, such as neural networks, gradient descent, and backpropagation.

- Mandatory
  - Signal processing
  - Python programming experience
  - Linux OS basics (usage of `terminal` command lines, `ssh`, `make`,...)
- Optional
  - experience with deep learning frameworks (TensorFlow, Keras, PyTorch)
  - practical elements of Latex (writing equations)
  - practical elements of `git`
  - electronics and RF design basics

Workplan (6 months)

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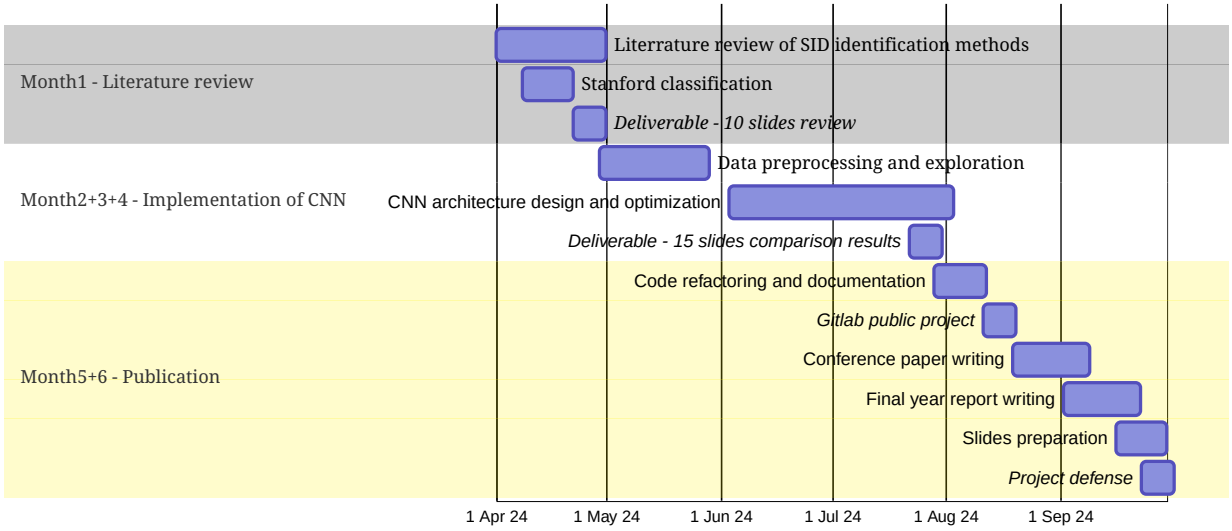
Master Internship: CNN for SID identification



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Application

Please send your application to the internship supervisor (please see headings). Your application should include :

- ▢ a CV,
- ▢ a cover letter,
- ▢ your academic records,
- ▢ a recommendation letter from a professor or a previous internship supervisor.

Deadline for application: 1st March 2024.

Upon reception of your application, we will contact you for an interview. The interview agenda is usually as follows :

Duration	Activity
15 min	Presentation of the candidate's academic (and professional) background to highlight the skills, experiences and any element relevant to the internship
15 min	Presentation of the internship project and the host team by the supervisor
15 min	Open discussion
10 min	Short test on either signal processing or Matlab programming
10 min	Discussion on the short test

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Location

School

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Hosting laboratory

Laboratoire Traitement et Communication de l'Information (LTCI)

Research team

The Circuits et Systèmes de Communication (C2S) team is internationally recognized for its ability to integrate digital intelligence into AMS and RF SoCs such as analog-to-digital converters (ADCs) or RF receivers for cognitive radio. By combining its expertise in the physical realization of the CMOS chip with its experience in signal processing and its knowledge of the other network layers for which LTCI's skills are recognized, the group designs high-performance AMS and RF SoCs. The aim is to develop elements or "building blocks", enabling the system of connected objects to be interfaced on one side with the physical world via sensors, and on the other side with the system core via communications, in particular RF.

Collaboration

The LESIA (Laboratory of Space Studies and Instrumentation in Astrophysics) is one of the five Scientific Departments of the Paris Observatory. It is also a CNRS Laboratory (mixed Research Unit of CNRS – UMR 8109). LESIA is one of the largest French laboratories of research in astrophysics (approximately 12% of the discipline).

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URL: LESIA Website

References

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FAQ

Will I be paid?

You will receive a stipend, the amount is approximately 350€/month.

How to accomodate my stay in France?

There are several student residences in the vicinity of the campus. Further information will be provided upon demand.

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