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Research Problems for DIA-CoEs

Directorate of Futuristic Technology Management


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DRDO

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Introduction

DRDO is funding multi-institutional and multi-disciplinary directed research projects to Academia and National Research Institutes to develop cutting edge defence technologies. The funding is focused on translational research for developing the crucial and futuristic technologies in defined research domains through a network of DRDO Industry Academia – Centre of Excellences (DIA-CoEs) at premier and capable academic institutes and universities in the country.

To foster the research in academia, DFTM invites project proposals on problem statements in multiple areas, that will be taken up through DIA-CoEs for directed research. Received proposals will be scrutinized by DFTM and forwarded to respective DIA-CoEs as per research verticals for further evaluation.

Forms for submission are provided at ***https://www.drdo.gov.in/drdo/en/offerings/schemes-and-services/dia-coes***

Fully furnished project proposals shall be submitted to DFTM through ***techforesight.drdo@gov.in***

1. Development of FPGA IP Core for Eigen Vector Decomposition and Singular Value Decomposition

DLRL

Technology Area
Electronic Warfare

Technology Category
Single Processing

Brief of the Research Problem
Super resolution algorithms for DOA Estimation like MUSIC , ESPRIT or their variants require Eigen Vector and Singular Value Decomposition of Data Covariance Matrix estimated using signal samples acquired from multiple antennas. In EW, each channel has to be processed in parallel and therefore there is a need for efficient FPGA IP Core for EVD and SVD. Number of Antennas could be 2, 5, 6 or 7. It is also expected that number of sources to be estimated in the IP Core using the computed Eigen Values making use of Information Theoretic Criteria like AIC and MDL.

Major Objectives
Development of FPGA IP Core for Eigen Vector Decomposition and Singular Value Decomposition capable of Real Time Performance.

Expected Deliverables
FPGA IP Core along with Profiling Results, Test Results, Technical Report and Computational Requirements for Xilinx Kintex Ultrascale, Intel Stratix 10 or Xilinx Versal Computation Engines.

Figures of Merit
Parameter: Time taken for Eigen Value Eigen Vector Decomposition.

DLRL

2. Single Station Location Algorithm for HF DF using Azimuth Bearing, Elevation Bearing and Ionospheric Model Software

Technology Area
Electronic Warfare

Technology Category
COMINT

Brief of the Research Problem
In High Frequency Direction Finding (HF DF) Stations, geolocation of distant HF transmitters need to be carried out using estimated Azimuth and Elevation bearings. The mode of propagation assumed is Ionospheric or Sky Wave. The Virtual Height of Ionospheric Layer that caused total internal reflection of Sky Wave signal is dependent on Location, Time of the Day, Season of the Year, Sun Spot Number, Frequency of Signal etc. Scope of Work is to identify and procure Ionospheric Model Software. Further use information like Frequency of Signal, Azimuth Bearing, Elevation Bearing and Virtual Height obtained using Ionospheric Model Software for estimating the geolocation of HF Transmitter.

Major Objectives
Development of Single Station Location Algorithm for HF DF using Azimuth Bearing, Elevation Bearing and Ionospheric Model Software.

Expected Deliverables
Ionospheric Model Software, Simulation Results with Profiling of Execution Time, Tool for test signal generation, Technical Report and Geolocation Algorithm Description along with Computational Requirements and Code.

Figures of Merit
Parameter: Accuracy of Single Station Location of HF Emitter

3. Classification of LPI Signals into Burst and FH with Hop Rate Estimation in Direction Finder System using Deep Learning/Machine Learning

DLRL

Technology Area
Communication

Technology Category
Electronic Warfare

Brief of the Research Problem
DLRL Direction Finder (DF) System currently uses azimuth bearings for identifying Frequency Hopper Signals and also classify detected signals among three categories viz., Fixed Frequency (FF), Frequency Hopper (FH) and Burst. The DF System scans in frequency domain and performs DF of all detected signals. Since signal processing is frame/batch based and performed in frequency domain, in parallel for each of the channels, the accuracy of time duration estimation for bursts and individual hops is limited due to which Hop Rate estimates are inaccurate for fast hoppers. It is required to develop an algorithm based on Deep Learning/Machine Learning using time domain IQ data from each of the two or five DF antennas to classify the received signals into FF, FH and Burst. Training data needs to be generated by appropriate mathematical models that should allow to introduce Noise and Fading. Signal generated should allow for multiple signals present simultaneously at different frequencies within the instantaneous bandwidth. It is expected to be able to estimate Hop and Burst durations of the order of 200 micro seconds. The performance of the proposed approach need to be validated using Simulations and also test on Workstation/Laptop or PC using data that is generated or captured using commercial phase coherent signal acquisition hardware with minimum 2 channels. DLRL seeks solutions with Academic Institutions to develop and implement the Complex Statistical Digital Signal Processing Algorithms.

Major Objectives
Classification of LPI Signals into Burst and FH with Hop Rate Estimation in Direction Finder System using Deep Learning/Machine Learning

Expected Deliverables
Deep Learning Model with Parameters, Simulation Results with Profiling of Execution Time, Tool for training and test signal generation, Technical Report and Algorithm Description along with Computational Requirements and Code

Figures of Merit
Parameter: Percentage of correct classification and Accuracy of Hop Rate Estimation

4. Geolocation of Terrestrial Radio Emitters from RF Payloads on LEO Satellites

DLRL

Technology Area
Space Technologies

Technology Category
Electronic Warfare

Brief of the Research Problem
3D Hawk Eye from USA, is a “Data as a Service” Product, that is made recently available to subscribers for Situational Awareness through Space Based EW. It consists of constellations of satellites in Formation Flying in LEO & it is projected that with multiple constellations in multiple orbits, revisit time for surveillance of a given area of interest would be close to 15 minutes in the foreseeable future. Targets include AIS, ADS-B, Military Radio/Radars. Performance data with respect to geo location accuracies is not publically available in the open domain. Similar systems (Kleos etc.) are being commissioned by some other countries in Europe. Difference is number and geometry of satellites in Formation Flying. Some use three Satellites in Triangular Geometry whereas, others use four satellites in Rectangular Geometry. These systems work on the principle of Joint TDOA and FDOA and require precise Time/Frequency Synchronization across multiple satellites and multiple constellations. The spacecraft move at a speed of approximately 50 Kms/s. Knowledge of precise location of spacecraft’s that carries these payloads with respect to a common frame of reference is mandatory apart from synchronization requirements listed above. The digitized IQ data of the signals received would have to be recorded when spacecraft is moving with area of interest in the field of view. The recorded data would have to be relayed back to Ground Control Station (GCS) when it is in field of view of the spacecraft’s. All the signal detection and parameter estimation would have to be done on the ground to perform geolocation of the potential emitters. DLRL seeks solutions with Academic Institutions to develop and implement the Algorithms.

Major Objectives
Development of Practically Implementable Algorithms for Geolocation of Terrestrial Radio Emitters from RF Payloads on LEO Satellites that will be enabling technology for future Projects

Expected Deliverables
System Design Document specifying Satellite Geometry, Trajectory, Data Link Throughput, RF Payload Capabilities, Signal Processing Algorithms for Payload, Ground Station for Geolocation Computation along with Profiling of Execution Time, Simulation Results for Statistical Performance Evaluation, Tool for signal generation, Technical Report, Algorithm Description and Computational Requirements.

Figures of Merit
Parameter: Accuracy of Geolocation, Minimum number of Satellites

5. Quality Function Deployment (QFD) Model for the Small Turbojet Engine for the Missile Application

GTRE

Technology Area
Aero Structures

Technology Category
Processing/Fabrication

Brief of the Research Problem
Develop a QFD model for the design and development of a turbojet engine for the missile application.

Major Objectives
- Develop a QFD matrix
- Prepare a full House of Quality
- Carry out competitive analysis
- Prepare a correlation matrix

Expected Deliverables
A full QFD report and Chart with House of Quality.

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