King Saud University
College of Engineering
Electrical Engineering Department **Semester: 421**

Graduation Design Project Proposal Form

Project # C1

Project Title: A low Complexity RF-based Portable Passive Drone Detection System

Professor(s) Name(s):

1. Saleh Alshebeili 2. Amr Ragheb

Number of Students: Two

Students Qualifications

1- Knowledge of signal processing and communication systems.
2- Aware of programing software tools.
3- Commitment to attend weekly meetings.

Statement of Problem

Unmanned aerial vehicles (UAVs), or drones, are becoming an integral part in modern society, as they have been cheap and affordable. They are finding applications in several areas, including surveillance, search and rescue, package delivery, infrastructure inspection, etc. Drones are increasingly flying in sensitive airspace where their presence may cause a threat to public, private, or government safety, such as flying near airports, large crowded events, secure buildings, and even jails. Therefore, a low-complexity UAV detection system is needed to warn about the presence of drones in such cases.

Brief Description of the Project

This project proposes a system that can use a low-complexity passive RF-based approach to detect a UAV RF link, and determine from which direction a UAV controller is transmitting and the controller's location. The proposed system is intended to combine angle of arrival (AoA) techniques with RF-based signal analysis to determine whether a peak in incoming RF signal strength at a given direction corresponds to a controller and utilizes triangulation or any other techniques to estimate its location. Experiments based on a system consisting of inexpensive software defined radios (SDRs) and antennas will be conducted to show the effectiveness of estimating AoA and location of a drone controller.

Methodology

(1) Conducting literature review about the techniques pertaining to drone detection and localization,
(2) Developing algorithms to detect a UAV link, and estimate the signal AoA and location of UAV controller,
(3) Developing the necessary codes to implement the developed algorithms
(4) Building a low complexity prototype utilizing the developed codes
(5) Evaluating the performance of developed prototype experimentally using different metrics relevant to the problem at hand.

Expected Deliverables

A low complexity prototype to detect a UAV link, and estimate the signal AoA and location of UAV controller.

Project # C2

Project Title: Radar Targets Modeling and Design

Professors: 1. **Professor Majeed Alkanhal**
2. **Dr. Hamsakutty Vettikalladi**

Number of Students: Two Students

Students Qualifications:

Statement of Problem:
A radar system relies on a signal scattering to detect and identify targets. The stronger a target reflects, the greater the returned echo at the radar receiver. This results in a higher signal-to-noise ratio (SNR) and likelier detection. Efficient modelling will facilitate the analysis and design of simple and complex radar targets for the purpose of accurate radar detection and classification. In addition, models that consider the interaction of the multiple scattering centers assist in designing low detectable stealthy radar targets.

Brief Description of the Project:
This project explores how to model objects in the field of view of a radar. It describes ways to model radar targets with increasing levels of fidelity. This includes the concept of radar cross sections (RCS) for simple point targets and extends to more complicated cases of targets with multiple scattering centers. The work will Select and assess the models under different radar environments and for some modern applications. Using the obtained models, design of stealthy and/or special radar targets is anticipated.

Objectives:
(1) Analysis and modeling of simple targets,
(2) Analysis and modeling of compound and complex targets
(3) Analysis and modeling of extended and fluctuating targets
(4) Design of special radar targets.
(5) Assessing and evaluation of detectability of the designed targets under different radar scenarios.

Technical Approach and Expected Deliverables:

The basic technical approaches are: Analytical study, numerical simulations using Matlab toolboxes and CST.

Deliverables:

Accurate RCS prediction models for extended radar targets with multiple scatterers that will facilitate design and valuation of detection and classification of radar targets.

Project # C3

Project Title: Antennas for Internet of Things (IOT Antennas)

Professor(s) Name(s): 1. Hamsakutty Vettikalladi
2. Majeed Alkanhal

Number of Students: Two

Students Qualifications

Knowledge of electromagnetic theory and basic knowledge of antennas

Statement of Problem

The growing market of the Internet of Things (IoT) calls for various types of electronic components and communication technologies for a wide spectrum of applications including smart cities and vehicles, home automation, telemedicine, and industrial applications. Obviously, the successful functionality of these applications is dependent on a reliable wireless component. Among the multitude of attention and discussion that surrounds the Internet of Things (IoT), the subject of antenna performance is not always properly considered. Sometimes, this lack of attention is driven by certain interpretations of IoT, based on which of several low cost devices are close to each other with no need for powerful transceivers. Even in those scenarios, antenna performance remains very important because of issues such as noise, fading and the need for efficiency. Therefore, antennas are an essential element for the IoT.

Brief Description of the Project

Internet of Things means an infinitude of connected devices and small sensors, integrated in a bigger network with a permanent access to the user. One of its major application is in the Smart home concept, allowing more convenience, efficiency (at various aspects) and safety. With more and more devices, it is nowadays mandatory for these devices to be small, low-power and at the same time more capable and efficient. In this project, the students will study the importance of small and effiecient antenna for IOT applications and also design antennas suitable for IoT devices,by developing high bandwidth antennas according to the growing needs of wireless networks. This antenna has a reduced dimensions, ideal to be integrated in most of IoT sensors.

Objectives

Often, the design has two to four specific objectives. You might consider listing them vertically as follows:

(1) Study the concepts of IOT antennas
(2) Design compact IOT antennas: low cost, compact and wide band antennas
(3) Develop the IOT antennas designed based on the manufacturing capacity in KSU

Technical Approach and Expected Deliverables

Phase I: Students will study internet of things and IOT antennas
Phase II: Study the frequency spectrum used for IOT antennas also simulation packages to design antennas.
Phase III: Study the different IOT antenna designing technologies by literature review

Phase IV: Design effiecient antennas suitable for IOT applications.

Project # C4

Project Title: Beam forming Antennas for 5G communications

Professor(s) Name(s): Dr. HamsakuttyVettikalladi and prof. Majeed Alkanhal

Number of Students: Two

Students Qualifications
Knowledge of electromagnetic theory and basic knowledge of antennas

Statement of Problem
Over the last few years, wireless data traffic has drastically increased due to a change in the way today's society creates shares and consumes information. This change has been accompanied by an increasing demand of much higher speed wireless communication anywhere, anytime. In particular, wireless data rates have doubled every eighteen months over the last three decades. Following this trend, wireless Terabit-per-second (Tbps) links are expected to become a reality within the next five to ten years. In this context, Terahertz Band communication is envisioned as a key wireless technology to satisfy this demand, by alleviating the spectrum scarcity and capacity limitations of current wireless systems, and enabling a plethora of long-awaited applications in diverse fields. The THz Band is the spectral band that spans the frequencies between 0.1 THz and 10 THz. The very large bandwidth provided by the THz Band opens the door to a variety of applications in 5G Cellular Network links,WLAN,WPAN etc, which demand ultra-high data rates and allows the development of a plethora of novel applications in classical networking scenarios as well as in new nanoscale communication prototypes. Some of these applications can already be foreseen and others will undoubtedly emerge as technology progresses. Antenna is the fundemental element in all these communication system. Low profile, wideband, high gain , low cost and beam forming antennas are needed for this purpose.

Brief Description of the Project
In the most recent years, wireless communication networks have been facing a rapidly increasing demand for mobile traffic along with the evolvement of applications that require data rates of several 10s of Gbit/s. In order to enable the transmission of such high data rates requires ultra-high bandwidths beyond 20 GHz. Such an amount of unregulated spectrum can be identified only in the sub-THz to THz frequency range of >~ 0.1THz-10THz in general (Sub THz range is 0.1 THz to 1THz). Systems operated at those frequencies are referred to as THz communication systems. The very large bandwidth provided by the THz Band opens the door to a variety of applications which demand ultra-high data rates. Some of the potential applications are in 5G cellular networks, ultra high speed Wireless Local Area Networks (LAN), ultra high speed Wireless Personal Area Network and secure wireless terabit communication. The technology enabling small integrated transceivers with highly directive, steerable antennas becomes the key challenges at THz frequencies in face of the very high path losses. This project plans to study the technology and design compact antennas suitable for mmwave/Sub-THz frequency operation.

Objectives
1) Study the mmwaves/THz waves and technology
2) Finding the best technology to design the antenna at high frequency, because low frequency technology is not applicable at high frequencies.

Technical Approach and Expected Deliverables
Phase I: Students will study mmwave/sub-THz waves and its frequency spectrum
Phase II: Study the Potential Applications ofmmwaves/ sub-THz technology
Phase III: Study the different antenna designing technologies by literature review
Phase IV: Design the beam forming mmwave/sub-THz antenna using CST Microwave studio simulation software.

Project # C5

Project Title: Development of Macro IoT Applications Based on Cognitive Radio WRAN

Professor(s) Name(s): **Dr. Ibrahim Elshafiey & Dr. Abdel Fattah Sheta**

Number of Students: **Two**

Students Qualifications:
Basic knowledge of Communication Engineering

Statement of Problem

Progress in Internet of Things IoT has led to the direction towards 'smart everything': smart cities, smart homes, smart manufacturing, smart agriculture, smart environment, and smart university. With variation in the nature of these applications the network type is shifting from micro IoT that covers a limited region to macro IoT that provides services to wide areas. Macro IoT should thus be attractive in Kingdom with industrial and business activities that cover extended regions. IEEE 802.22 is the first cognitive radio system and is intended for use in wireless regional area standard. It can be adopted in developing the infrastructure of macro IoT systems.

Brief Description of the Project

The project aims at desinining WRAN based on cognvitive radio techniques, making use of white space in the spectrum of TV channels. Software defined radio tools are used in the implementation. The developed WRAN communication system should target applications that serve rural areas in the Kingdom.

Objectives

The objective of this project

(1) Identify an application of massive IoT system in the Kingdom.
(2) Investigate specifications of IEEE 802.22 WRAN standard
(3) Simulate the performance of WRAN system.
(4) Design an implementation of WRAN using SDR modules.
(5) Conduct experimental validation tests.

Technical Approach and Expected Deliverables

The steps to achieve these objectives:

- Phase I: Students will identify related standards and state of art SDR tools.
- Phase II: Students will conduct simulation of WRAN communication.
- Phase III: Students will design WRAN system.
- Phase IV: Students will conduct experimental validation experiments.

Expected Deliverables:

- Analysis and simulation tool of WRAN system.
- Design of WRAN system
- Validation measurement in IoT applications .

Project # C6

Project Title: Intelligent High-Speed Optical Signal Monitoring with Advanced Modulation Formats using Neural Networks.

Professor(s) Name(s): 1. Ahmed Almaiman
2. Saleh Alshebili

Number of Students: TBD

Students Qualifications

EE students with background on digital communications are preferred.

Statement of Problem

Problems that have created the need for the design you are proposing. Examples of those problems are pollution, cost, energy losses, etc.

The goal of the project is to demonstrate a device that can monitor the quality of optical signals that is *cheaper* than using a full optical coherent receiver.

Brief Description of the Project

The purpose of this paragraph is to give an overview of what the design need is and what design is being proposed to fill that need. (This section can be combined with the previous section)

Dynamic optical networking requires knowledge about the health of the optical paths. Currently, the network health is either characterized manually by 'human' technicians who conduct the test thousands of miles apart using actual transmitters and receivers. There have been several reports on approaches to monitoring the signal quality using simpler devices, but these reports are mostly considering basic signal modulation formats. In this project, we will propose a signal monitoring system that can characterize the quality of optical links for high-speed optical communications with advanced modulation formats using simpler-and-cheaper devices with assistance from neural networks.

Objectives

Often, the design has two to four specific objectives. You might consider listing them vertically as follows:

(1) Simulate several scholarly reported optical performance monitoring technique.
(2) Study the performance of the monitoring technique in the presence of changing modulation format and when implementing probabilistic shaping.
(3) Adding a neural network processing layer to the monitor.
(4) Build a prototype for the optical monitoring system in the lab.

Technical Approach and Expected Deliverables

This section discusses how to achieve the objectives mentioned above and the expected end product (if any), etc.

(1) Simulate an optical performance monitoring technique:
Using VPIPhotonics, the students will be asked to build a high-speed optical communication system for >100 Gb/s data transmission. The students will tap the signal at the receiver and implement one/ many of the previously reported monitoring approaches in literature to measure the OSNR(such as using interferometers or using asynchronous sampling).

(2) Study the performance of the monitoring technique in the presence of changing signal conditions:
The students will vary the characteristics of the transmitted signal by adding: (i) cascaded filters, (ii) optical nonlinearity, (iii) higher-order modulation formats, (iv) chromatic dispersion, and (v) probabilistic shaping. Upon the addition of these parameters, the quality of the monitor will be assessed by measuring the error (difference between actual and measured OSNR).

(3) Adding a neural network processing layer to the monitor:
The students will export the resulting data from VPIphotonics to machine learning processors. The students will feed the processor with the training pattern by measuring the actual OSNR (using the on/off technique in VPIphotonics) along with the raw data from the monitor itself. The goal is to optimize the NN processor to provide an optimal OSNR measurement with low error.

(4) Build a prototype of the optical system in the lab
The students will experimentally build a testbed for monitoring the signal quality in the lab. The students will input high-speed data channels (>100 Gb/s) with different modulation formats and different probabilistic shaping characteristics. The experimental data will be processed using the neural network and the results will be compared to simulation.

Project # C7

Project Title: Smart Motion Sensor Using Reflections in Optical Fibers and Artificial Intelligence

Professor(s) Name(s): 1. Ahmed Almaiman
2. Saleh Alshebili

Number of Students: TBD

Students Qualifications

EE students with background on optical fibers and signal processing are preferred.

Statement of Problem

Problems that have created the need for the design you are proposing. Examples of those problems are pollution, cost, energy losses, etc.

The goal of the project is to develop *an intelligent motion* sensor over kilometers of distance by processing the reflections from an optical fiber using a neural network.

Brief Description of the Project

The purpose of this paragraph is to give an overview of what the design need is and what design is being proposed to fill that need. (This section can be combined with the previous section)

An interesting application of optical fibers is using them as sensors by recording and processing the light reflections happening during light propagations. These reflections can be either induced due to acoustic waves as in Brillouin scattering or due to Bragg reflectors that are written on the fiber. The points of reflections are wavelength-specific and depend on the geometry of the fiber and thus are a function of stress and strain (i.e, the moving object itself). In this project, we will use the fiber as a sensor and analyze the reflections associated with specific moving objects and feed the reflections information to a neural network for processing to identify to type and location of object with high accuracy.

Objectives

Often, the design has two to four specific objectives. You might consider listing them vertically as follows:

(1) Simulate using the fiber as sensor.
(2) Study the limitations of the fiber-based sensor under different conditions.
(3) Train a neural network processor to identify the location of moving objects.
(4) build a prototype of the optical fiber sensor and identify the type of moving object using the information of reflected light.

Technical Approach and Expected Deliverables

This section discusses how to achieve the objectives mentioned above and the expected end product (if any), etc.

(1) Simulate using the fiber as a sensor:
Using VPIphotonics, the students will be asked to build a simulation software to use the fiber as a sensor. The students will be asked to analyze the scattering happening due to Brillouin interaction and to identify the point of reflection using a sequence of pulses.

(2) Study the limitations of the fiber-based sensor under different conditions:

The students will vary different parameters in the setup and characterize the dependence of reflection quality on them. For example, students will be asked to vary: (i) the length of the fiber, (ii) the pulse duration, (iii) the amplification level, (iv) the polarization, (v) the wavelength spacing. Also, the students will be asked to provide an assessment on the sensing dependence on (i) spatial resolution, (ii) speed of scanning, and (iii) noise.

(3) Train a neural network processor to identify the location of moving objects:
The students will export the resulting data from VPIphotonics to machine learning processors. The students will train the processor with the reflection data and the priorly reflection location. Afterward, the students will randomly change the location of reflection and its characteristics (i.e., change the moving object properties) and use the NN processor to identify the location of reflection.

(4) Build a prototype of the optical fiber sensor and identify the type of moving object using the information of reflected light.
The students will experimentally build an experimental testbed for sensing the moving objects using an optical fiber. The testbed will be optimized using the simulation information. The moving objects will be varied (such as using walking humans, bikes, cars) and the NN will be used to identify the object type and its location.

Project # C8

Project Title: Dynamic Spectrum Sensing under Unknown Noise Level

Professor(s) Name(s): 1. Dr. Majid Altamimi
2. Prof. Saleh Alshebeili

Number of Students: Two to three

Students Qualifications

Complete EE422 and EE420. Very Good background in Matlab coding.

Statement of Problem

In the era of the dramatic growth of wireless technologies, the RF spectrum becomes fully occupied and cannot accommodate the demand for the RF bands by new wireless technologies. Therefore, the dynamic spectrum access is invented to overcome this problem by allowing more than one wireless network to share the RF bands. However, sharing the bands introduces a new problem, which is how to enable the sharing with minimum interference and transmission collision. One of the crucial issues is the spectrum sensing for unknow environment.

Brief Description of the Project

This project is designed to give the students an overview on the cutting-edge technologies in the wireless communications. The students need to understand the current regulation for the RF spectrum and the anticipated future regulation. In addition, they are expected to design and implement dynamic spectrum sensing that works under uncertainty of the noise level, then develop spectrum sensing based on that result.

Objectives

This project is intended to:

1) design and implement dynamic spectrum sensing,
2) examine the performance of this algorithms, and
3) develop their own algorithm or improve its performance.

Technical Approach and Expected Deliverables

The project is expected to deliver the above objectives by conducting an academic research and write a short survey on the proposed algorithms for dynamic spectrum sensing. Then, the students have to design their experiment using their programming skills to examine some attractive spectrum sensing from the literature. Finally, the students will be encouraged to deploy their full real-time system to sense and access the spectrum.

Project # C9

Project Title: Communication Base Station Powered by Renewable Energy

Professor(s) Name(s): 1. Dr. Majid Altamimi
2. Dr. Majed Alotaibi

Number of Students: Two to three

Students Qualifications

It is recommended a group of students one from the communication track and one from the power track completing the core course such as EE320 and EE340. A good background in statistic and Matlab coding is required.

Statement of Problem

Remote communication base station is an off-grid system and usually is powered by Diesel generator, which is not reliable and increase the CO_2 generated by the communication system in addition to their high operating cost. Therefore, the renewable energy (RE) sources are potential candidates to replace the diesel generator and are expected to play a key role to overcome the aforementioned limitations and impact of current energy sources for base stations.

Brief Description of the Project

In this project, it is expected to design a base station that is powered by renewable energy (RE) sources (e.g., PV, Wind Turbine, …, etc). The design includes a study of a real base station energy consumption, build an expectation for its behavior, then design the required RE sources for the base station under study.

Objectives

Students are expected to achieve the following:

(1) Study a real base station system,
(2) Extract and infer a useful data from experiments or from the field, and
(3) Design and implement a prototype.

Technical Approach and Expected Deliverables

The result of this project is expected to end by a fully function prototype of base station powered by RE sources.

Project # C10

Project Title: Wideband Microwave Detection Utilizing Electrically-Small Resonators

Professor(s) Name(s): 1. Ali Albishi
2. Abdullah Alsuwailem

Number of Students: Two to three

Students Qualifications

1- Highly motivated, adaptable, quick, and eager learner of new materials and subject matters.
2- Responsible and Serious, ready to give the time to learn something new
3- Microwave circuit design (reading Pozar's book can help to catch up)
4- Knowledge of simulation tools such as Matlab and Numerical simulation (HFSS, CST, etc.)
5- Having skills in report writing and presentation.
6- Hard working students and can collaborate and work in a team

Statement of Problem

Nowadays new technologies need cheap, small, selective, and sensitive sensors. Among wide applications of such devices, detecting changes in dielectric materials is very important in different areas, including food industry, agriculture, medicine, healthcare, and military and defense. Since many microwave technologies is calling for advance materials, the materials can be a composition of different other materials. Thus, detecting the changes in the materials under test using a narrow band sensor is not sufficient to meet the need for detecting multiple materials simultaneously. This is where this project come. In this project, the resonance frequency of a complementary split-ring resonator (CSRR) will be tuned by tuning electronically the microstrip line that is used to excite the resonator.

Brief Description of the Project

Microwave complementary split-ring resonators can bring to sensing field many advantages such as higher sensitivity since the resonators are electrically-small compared to the excitation wavelength. Thus, resonator is so sensitive to the perturbation of the electromagnetic field in the near proximity. In this project, the resonators are excited using the microstrip line technology. The sensing mechanism is based on recording the shifts in the resonance frequency due to the interaction with the materials under test (MUTs). Thus, after we develop the microwave sensor, it will be used to detect the presence of dielectric materials. The sensor will be fabricated using relatively cheap technology PCB. All the measurements will be conducted using vector network analyzers (VNAs).

Objectives

1) Conduct a comprehensive literature review of microwave resonators based sensors for sensing and particularly for material characterization
2) Choose a well-cited paper and duplicate the results to build confidence with the simulation tools .
3) Try to come up with new ideas for material characterization
4) Implement the new ideas using the numerical simulation (HFSS)
5) Finally, being able to describe in details the steps to how one can be able to implement the idea experimentally

Technical Approach and Expected Deliverables

1) Conduct a comprehensive literature review on the topic using the university electronic library and international engineering journals such as IEEE. 2- Modeling using simulations tools such as HFSS and analyzing the result using MatLab .
2) Show the real confidence in understanding the problem where the student able to explain the main problem, show what others have done, and provide novel solution. The experiments will be in the second parts of the graduation project (EE497).

Project # C11

Project Title: Tunable Split-Ring Resonators for Material Detection

Professor(s) Name(s): 1. Ali Albishi
2. Abdullah Alsuwailem

Number of Students: Two to three

Students Qualifications

7- Highly motivated, adaptable, quick, and eager learner of new materials and subject matters.
8- Responsible and Serious, ready to give the time to learn something new
9- Microwave circuit design (reading Pozar's book can help to catch up)
10- Knowledge of simulation tools such as Matlab and Numerical simulation (HFSS, CST, etc.)
11- Having skills in report writing and presentation.
12- Hard working students and can collaborate and work in a team

Statement of Problem

In industrial and bio-medical sensing applications, it is required to have sensitive sensors that can detect changes in the materials under test (MUTs). Since the materials can be a composition of different materials, microwave sensors that utilize a single resonator based detection is not sufficient. Such resonators include split-ring resonators. In the same time, multiple resonators will solve the difficulties where multiple resonance frequency can be generated, yet for the compact size, it is preferable to have a single resonator. Thus, in this project, we propose a novel idea of tuning the excitation microstrip line that utilized to excite the SRR, where the resonance frequency can be tuned over large range of frequency. The tuning is based by on the utilization of varactor diodes.

Brief Description of the Project

Microwave resonators such as split-ring resonators provide many advantages including higher penetration, resolution, and sensitivity. Since the resonators are electrically-small compared to the excitation wavelength, the resonator is so sensitive to the perturbation of the electromagnetic field in the near proximity. The excitation mechanism is based on the use of the microstrip line technology where the sensing mechanism is based on observing the shifts in the resonance frequency due to the interaction with the materials under test (MUTs). Thus, after the development of tuned sensors, it will be used to detect the presence of dielectric materials. The sensor will be fabricated using relatively cheap technology PCB. All the measurements will be conducted using vector network analyzers (VNAs).

Objectives

6) Conduct a comprehensive literature review of microwave resonators based sensors for sensing and particularly for material characterization
7) Choose a well-cited paper and duplicate the results to build confidence with the simulation tools .
8) Try to come up with new ideas for material characterization
9) Implement the new ideas using the numerical simulation (HFSS)
10) Finally, being able to describe in details the steps to how one can be able to implement the idea experimentally

Technical Approach and Expected Deliverables

3) Conduct a comprehensive literature review on the topic using the university electronic library and international engineering journals such as IEEE. 2- Modeling using simulations tools such as HFSS and analyzing the result using MatLab .
4) Show the real confidence in understanding the problem where the student able to explain the main problem, show what others have done, and provide novel solution. The experiments will be in the second parts of the graduation project (EE497).

Project # C12

Project Title: Deep Learning based Classification/Detection for Small Cross-Section Targets in Radar Applications

Professor(s) Name(s):
1. Dr. Mubashir Alam
2. Dr. Irfan Ahmed

Number of Students: Two to three

Students Qualifications: Students should be from the radar, signal processing, communication area, strong willingness to learn, and then model, simulate the data model and analysis for different radar configuration.

Statement of Problem

The project covers the small cross-section targets like micro drone detection and classification using different signatures. The project deal with mathematical data modeling for different radar configuration, and then used the modelled data to classify/detection common types of targets using deep learning or neural nets.

Brief Description of the Project

The use of small cross section devices such as micro drones for different application are increasing and hence there is need for their automatic detection and classification. The radar provides an attractive tool, however the small size of these drones and consequently the signature they generate is a challenge for the classification. Micro-Doppler signature does provide a feature, which can be utilized for effective detection and classification of these drones.

Objectives

(1) Mathematical modeling for drones micro-Doppler signature generation using bi-static or multi-static radar configuration
(2) Features extraction from Micro-Doppler signature
(3) Detection/Classification using Deep learning from features extracted in (2)

Technical Approach and Expected Deliverables

This project will cover Data modeling and implementation of micro-Doppler signature in Matlab/LabView environment. Then feature extraction and classification/detection using Deep learning or neural nets in Matlab environmnet.