Simulation of Drone detection and identification using Phased Array Radar

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Contents

Motivation

- Drones are used for terrorism, unlawful activities, which have to be detected and neutralized.
- Nowadays,unmanned aerial vehicles(UAVs) are rapidly expanding to commercial or public sector.
- These vehicles, called drones, should be very dangerous, in case of collision with planes.
- Typical primary surveillance radars are not able to detect because radar cross section (RCS) of UAVs is out of resolution of the radar.
- It is necessary to develop new type of radar to detect and localize these small UAVs.
- Our project is focused on development of the new type of radar able to detect these UAVs.

Objective

- To design a RADAR system that uses an Active Electronically Scanned Array(AESA) which is an Electronically Steered Phased Array Antenna for detecting drones/UAVs using beamforming technique.

Introduction to Phased Array Radar

- For some applications single element antennas are unable to meet the gain or radiation pattern requirements.
- Active radar systems can contain one antenna unit where each radiation element contains a receiver and transmitter or two antenna units with a separate transmitting and receiving antenna.
- Mechanically rotating the antenna for tracking the UAV using motors based on azimuth and elevation angles are difficult and is a more expensive and consumes more space due to its bigger setup.
- To overcome this, we electronically rotate the beam using AESA to track the drone which can give better accuracy depending on the beamwidth of the beam formed.
- The expected requirements for the antenna array design are low weight, compact dimensions and simple construction.

Literature survey

REF NO:	TITLE	LITERATURE	UAV Type	Drone Type
1.	” Detection and Localization of Unmanned Aircraft Systems Using Millimeter-Wave Automotive Radar Sensors ” Peter Joseph Basil Morris∗ and K. V. S. Hari	IEEE 2021	DJI Matrice100	FMCW RADAR SENSOR 40m 76–81 GHz
2.	” Modeling Small UAV Micro-Doppler Signature Using Millimeter-Wave FMCW Radar ” Marco Passafiume 1 , Neda Rojhani 2,* , Giovanni Collodi 1 and Alessandro Cidronali 1	MDPI 2021	QUADCOPTER	MIMO RADAR NA 77GHz
3.	Vivek, R., Piramasubramanian , S., Madhan, M. G., Roopchand , J. (2016, April). Simulation and performance prediction of an UWB radar for active protection system applications. In 2016 international conference on communication and signal processing (ICCSP) (pp. 0351-0355). IEEE September 1, 2022 MIT campus 12	IEEE 2016	ROCKET PROPELLED GRENADE	Multi band OFDM Type UWB Radar 75m 10GHz

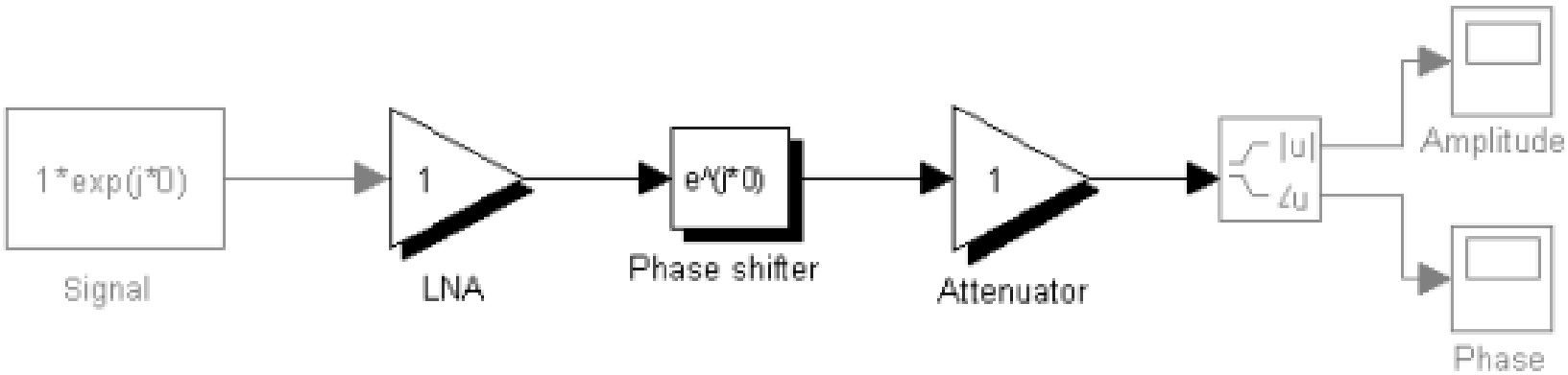
Methodology

- Identifying desired Target drone and its specifications
- Getting RCS data for desired target using CST
- Identifying Optimal RADAR parameters
- Phased array design for the identified frequency, pulse width
- Radar system simulation using Matlab
- Optimisation in Matlab
- Evaluation of Radar in matlab under single and multiple drone scenario
- Tracking simulation

Significance of AESA - Active Elecronically Scanned Phased Array Radar

- PESAs took a signal from a single source, split it into hundreds of paths, selectively delayed some of them, and sent them to individual antennas.
- The AESA is a more advanced, sophisticated, second-generation of the original PESA phased array technology
- The AESA can radiate multiple beams of radio waves at multiple frequencies simultaneously
- Low probability of Intercept
- Hybrid AESA are cost efficient than Pure AESA

Design of Active Electronically scanned Array



- Design and Simulation of AESA begins with a single Transceiver module being repeated in two dimensions
- Each Transceiver contains own low noise amplifier and phase shifter

Applications of Phased Array Radar

- Broadcasting - AM Broadcast radio stations
- Weather research usage
- Satellite broadband internet transceivers
- Human Machine Interface - airborne ultrasound tactile display

Work Plan

WEEK1	WEEK2	WEEK3	WEEK4	WEEK5	WEEK6	WEEK7	WEEK8	WEEK9	WEEK10	WEEK11	WEEK12
Read Base Paper.											
Choose the drone & get its specification.											
Get RCS data of chosen Drone using CST simulation.											
RADAR specifications preparation											
Phased array design for the identified frequency, pulse width.											
RADAR system simulation and optimisation using MATLAB											
Post processing of RADAR data by MATLAB.											
Evaluation of Radar in MATLAB under single and multiple drone scenario											
Finding the velocity and position . PPI display, or A-Scope											
Tracking simulation											
Final Demo											
Thesis Submission											

References

- Zhang Wei, Shi Jun and Tian Zhong,," System simulation for a multifunction phased array radar", Proc. IET International conference on Radar systems 2007, Edinburgh,pp.1-4.
- Jaroš, Ondřej, and Ladislav Beran. "Design of an electronically steered antenna array in the X band." 2019 Conference on Microwave Techniques (COMITE). IEEE, 2019.
- Vivek, R., Piramasubramanian, S., Madhan, M. G., Roopchand, J. (2016, April). Simulation and performance prediction of an UWB radar for active protection system applications. In 2016 international conference on communication and signal processing (ICCSP) (pp. 0351-0355). IEEE