Briefing for
Third Year Students on

Radar Programme

List of projects and supervisors:
Slides 13 to 23

Coordinator: Ng Boon Poh

15 March 2013 (Friday)

What is a Radar ?

Radar =
Radio Detection and Ranging

Applications

- **Military** - used in Electronic Warfare
- **Air traffic control** – used in the airports
- **Sea traffic control** – used in the seaports and on board of the ships
- **Road traffic control** – used by the police to monitor car speeds
- **Weather forecasting and monitoring** - http://app2.nea.gov.sg/rain_animation.aspx

What's next after DIP?

- We have put in place a series of programmes for interested students !

EE4190 Introduction To Modern Radar

Objective:

To give students an understanding of the practical aspects of modern radars at system-level.

DESIRED OUTCOME

At the end of the course, the students are able to understand the working principles and operations of a typical radar system so as to be able to participate in the design, installation and management of some typical radar systems.

Teaching Team Members

- Tan Shen Hsiao
  - Senior Research Scientist, TL@NTU
- Ang Wee Peng / Leonard Tan
  - Distinguished Member Member of Technical Staff, DSO National Lab
- Sylvain Azarian
  - Supelec, France
- Ng Boon Poh
  - Course Coordinator & Tutor, NTU

Course Awards

- TL@NTU Radar Award
- Award:
  - S$500 for top student in the class
  - S$500 for top Singaporean student in the class. (if overall top student is a Singaporean, he/she will receive S$1,000.)

What's next after B.Eng? -- **PhD Programme**

- TDP PhD scholarships / sposorship from School of EEE and TL@NTU
- Up to S$3200++ per month

- Mindef/DSO (several scholarships for Singaporeans)

Careers in Radar

There is demand from industries

- Homeland securities

- Defense industries

- Healthcare industries / Biomedical engineering

- Aerospace industries

Careers in Radar (con't)

Job Opportunities in homeland securities, defense industries, biomedical engg …

- TL@NTU
- DSO National Lab
- Research teams in School of EEE
- Mindef
- Singapore Technology
- Thales Solutions Asia
- CAAS (*Civil Aviation Authority of Singapore*)
- PSA Singapore
- Companies in aerospace industries …..

Careers in Radar (con't)

Some development out there …

- Thales Solutions Asia has just set up a Radar Centre of Excellence on 25 Jan 2013.

- Seletar Airport (Seletar Aerospace Park) expanded to be Business Aviation Hub

- Air traffic management research centre to open by the start of 2014.

Available Radar Projects

1. Implementation of a radar prototype on a Unmanned Arial Vehicle (hardware) (Zheng Yuanjin, Tan Shen Hsiao, Ng Boon Poh) (Number of students: 8)

    ◦ To construct part of a radar hardware and install the radar in the UAV. Finally, to test the radar on the fly.

2. Implementation of a radar prototype on a Unmanned Arial Vehicle (software) (Zheng Yuanjin, Tan Shen Hsiao, Ng Boon Poh) (Number of students: 8)

    ◦ To construct part of a radar software system and install the radar in the UAV. Finally, to measure the data from the radar on the fly.

3. Construction of an ultrasound pulse radar on the Labview Elvis platform (Ng Boon Poh and Ling Keck Voon) (Number of students: 8)

    ◦ To construct a radar hardware model using ultrasound sensors on the Elvis platform and to program in Labview to process the radar signals obtained from the Elvis platform.

Available Radar Projects (Con't)

4. A phased array radar system simulator (Teh Kah Chan, Li Kwok Hung) (Number of students: 8)

   ◦ This project provides better understanding of phased array radar via constructing a simulated program. The system contains all the important modules of phased array radar, such as, antenna, transmitter, receiver, signal processing, data processing, scheduling and interface. Detailed requirements are as follows:

     • The signal types include chirp signal and frequency modulated continuous wave (FMCW) will be considered.

     • The simulator will have the ability to search and track multiple targets, e.g., aircrafts with constant velocity or high maneuverability.

     • Active jamming and corresponding anti-jamming technique will be considered (if applicable).

     • The simulator will have an input interface to set up the variable parameters, e.g., signal type, power, wavelength, beam width, pulse recurrence frequency, pulse width, bandwidth, etc.

     • The simulator will have an output interface to show the simulated results, e.g., radar beam scanning position, search and tracking results, etc.

     • Matlab programming will be adopted.

Available Radar Projects (con't)

5. Radar imaging: concept and experimentation (Lu Yilong, Jiang Xudong, Liu Weixian and Sun Hongbo) (Number of students: 8)

  ◦ Students can learn the principles of synthetic aperture radar imaging and conduct some simple radar imaging measurements using vector network analyzer.

6. Target detection using illuminator-of-opportunity (Jiang Xudong, Liu Weixian and Sun Hongbo) (Number of students: 8)

  ◦ Students can learn the basic concept of passive radar and conduct the target detection measurements using GSM or DTV signals.
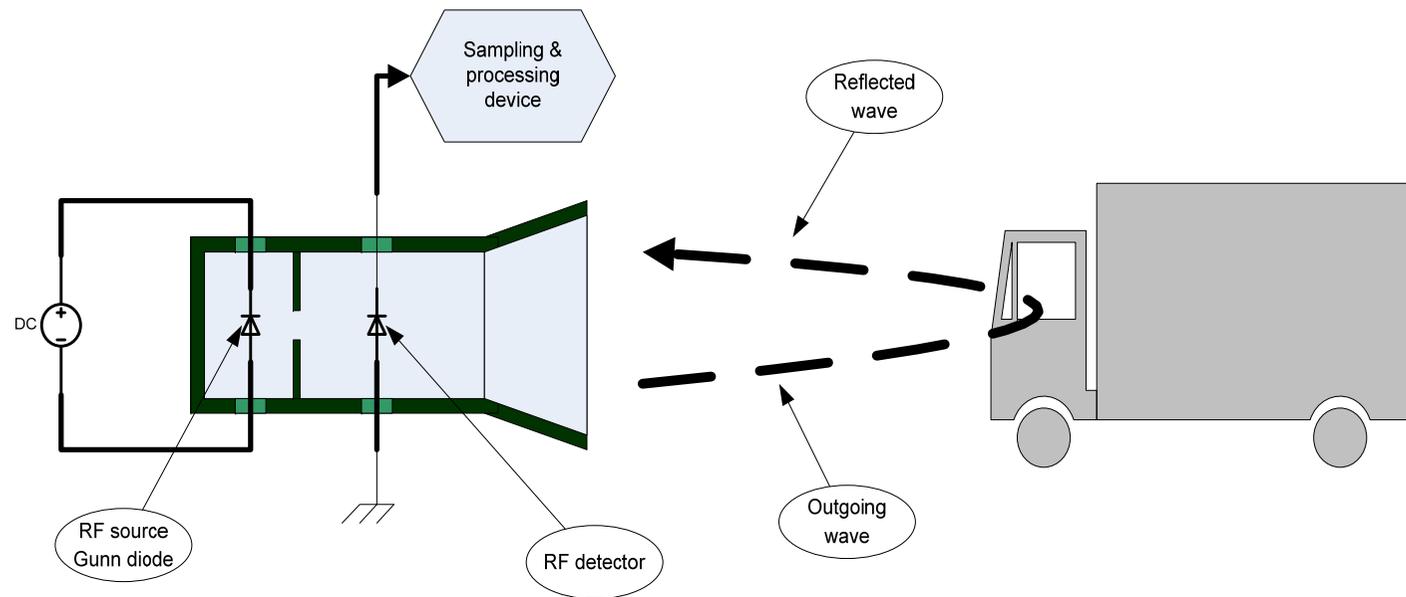
Available Radar Projects (con't)

7. Development of a software defined radar (SDR) (Ng Boon Poh, Sylvain Azarian, Liu Weixian and Sun Hongbo) (Number of students: 8)

- Students can develop a simple SDR system using arbitrary waveform generator and test it for short range target detection.

Available Radar Projects (con't)

8. Autonomous UGV (unmanned ground vehicle) with radar-aided navigation for search-and-rescue missions (Guan Yong Liang, Cheah Chien Chern and Dmitriy S Garmatyuk) (Number of students: 10)

   ◦ In this project the students will integrate a radar sensor with an unmanned ground vehicle (UGV) so that the UGV could make use of the radar image to autonomously navigate itself in an environment with low visibility or many obstacles to find an object/person of interest in a search-and-rescue mission. The advantages of using a radar sensor versus an optical sensor (camera) is that RF waves have better penetrating capability to enable the system to operate in low-light, foggy, dusty, obstructed environment with debris and rubble. The project will focus on the integration of three major components: a) a UGV with motor and wheel controls; b) a radar sensor based on the USRP wireless card; c) a small laptop to process the radar image and control the UGV movement. The students will research and design algorithms to process the radar data (e.g. to locate a doorway or a human) and generate decisions about the UGV's future movements.

Available Radar Projects (con't)

9. Police Radar Speed control system (Huang Guangbin, Soon Ing Yann, Sylvain Azarian, Leonard Tan) (Number of students: 8)

   ◦ To implement a speed-measurement device, typically used to check vehicle speed on the roads.

Available Radar Projects (con't)

10. Compressive sensing comparison of reconstruction algorithms for CS radar (Justin Dauwels, Anamitra Makur) (Number of students: 8)

   ◦ Compressed sensing (CS) is about sensing a signal from a reduced set of measurements compared to the Nyquist rate; sensing is followed by signal recovery algorithms to reconstruct the original signal from the reduced set of measurements, based on the properties of the signal and how the measurement is made. In CS Radar, the low SNR (or high noise) of the Radar returns has to be surmounted by the signal recovery algorithms to produce a reliable output. In this project, we are going to analyze and compare various signal recovery algorithms based on greedy pursuit, convex relaxation, and Bayesian framework. In the second step, we try to modify the algorithms to better suit the field requirements.

Available Radar Projects (con't)

11. Compressive sensing for radar imaging (Justin Dauwels, Huang Guangbin, Leonard Tan) (Number of students: 8)
    ◦ The students will gain a deep understanding of the relevance of compressive sensing in solving radar problem and modelling of the radar problem.

Available Radar Projects (con't)

12.

Project title	**3-Dimensional Ground Penetration Imaging with UWB Radar**
Supervisor	Professor LU Yilong http://www.ntu.edu.sg/home/eylu
Brief Description	Ultra Wideband (UWB) radar systems transmit signals across a much wider frequency than conventional radar systems. UWB radar systems can be used to achieve high resolution radar imaging with many applications in non-destructive inspection, homeland security, and medical diagnosis. In this DIP project, students will learn UWB radar technology through theoretical study, computer simulation, UWB radar ground penetration measurement, and UWB radar data processing. Students are also expected to make innovative contributions on UWB radar data processing and 3-dimentional data visualization which are very important for extracting useful information and understanding what beneath the ground.
Number of students required	10

Available Radar Projects (con't)

13.

Project title	**Design of a Novel Low Cost Phased Array Antenna**
Supervisor	Professor LU Yilong http://www.ntu.edu.sg/home/eylu
Brief Description	Phased array is a critical technology traditionally used for military radar. There are increasing interests in using phased array concept in civil radar and wireless communication systems for better system performance. In this DIP project, students will first learn radar and wireless communication concepts, basic design techniques for microwave circuits and antenna. Then students are expected to make innovation design of a low cost phased array antenna system and design/build necessary array antenna, phase shifter, and control circuits, finally to integrate and test the phased array system. Through the theoretical study, computer simulation, hardware fabrication, use of many state-of-the-art measurement equipment, students will get a valuable comprehensive training
Number of students required	10

- This list was updated on 25 March 2013 (Monday).

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Wish you a fruitful DIP

Thank you