Student proposed?	*Y/ ~~N~~*	
ID:	**YAG21-04**	
SUPERVISOR:	M. Y. Abdul Gaffar	
TITLE:	PC-based ultrasonic radar demonstrator for sports applications	
DESCRIPTION:	The goal of this project is to develop a well packaged ultrasonic radar demonstrator that can reliably measure moving sporting objects for demonstration and research purposes. The focus is on the hardware design and the initial signal processing of the radar demonstrator. An ultrasonic radar operates by transmitting a pulse of energy at 40 kHz and then listening for the echo return from objects. The time delay of the received echo is used to calculate the range to the targets. Furthermore, the rate of change of phase from pulse-to-pulse of the received echo is used to compute the Doppler frequency of the target, which is proportion to the radial velocity of the target. 	
DELIVERABLES:	The following deliverables are expected: 1. Develop the technical requirements and acceptance test procedures for the ultrasonic radar 2. Identify potential hardware related designs and components 3. Make choices on the design and components of the ultrasonic radar to meet the requirements and constraints of the project (budget, lead time in ordering components). 4. Develop veroboard and PCB versions of the hardware sub-systems 5. Test sub-systems, perform integration and system testing 6. Package system in a presentable and robust enclosure 7. Develop a user interface to process datasets. This may include computing the Spectrogram (CW transmission) and/or Range-Doppler (pulsed transmission) 8. Plan and execute experiments to characterise the performance of the radar for sports applications	
SKILLS/REQUIREMENTS: Include any software requirements	Recommended courses: EEE3090F, EEE3092F, EEE4114F MATLAB programming skills	
GA1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The development of an ultrasonic radar requires refinement of the system and sub-system requirements. It is a high-level development problem that includes sub-problems. For this reason, the work requires a sufficient level of originality and the student is expected to resolve a number of wide-ranging and conflicting issues relating to choosing components to meet the budget and technical requirements of the system.	
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	This project involves: - investigation into appropriate methods to characterise the performance of the ultrasonic radar. This knowledge is available in the open literature for a traditional radar system, and it needs to be adapted for suitable experiments in an indoor/outdoor environment, - design: identification of requirements, identifying feasible hardware building blocks and making choices with reasons, development of test procedures. - experimentation: planning and executing experiments with controlled targets	
EXTRA INFORMATION:	C. Lin, M. Y. Abdul Gaffar, J. Son, S. Winberg, "Dynamic Hand Gesture Recognition using Sonar and Deep Learning", accepted for publication in the International Journal of Electrical and Computer Engineering Research (IJECER), June 2021.	

	Please email me to request a copy of this paper.
BROAD Research Area:	Electronic circuits, Printed Circuit Board design, Digital Signal Processing
Project suitable for ME/ ECE/EE/ All programmes?	ECE, ME, EE

***NOTE: Complex engineering problems** require in-depth fundamental and specialized engineering knowledge and have one or more of the characteristics:

- [✓] are ill-posed, under- or overspecified, or require identification and refinement;
- [✓] are high-level problems including component parts or sub-problems;
- [✓] are unfamiliar or involve infrequently encountered issues;

and their solutions have one or more of the characteristics:

- [✓] are not obvious, require originality or analysis based on fundamentals;
- [✓] are outside the scope of standards and codes;
- [✓] require information from variety of sources that is complex, abstract or incomplete;
  involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

****NOTE: GA 4:** The balance of **investigation and experiment** should be appropriate to the discipline. Research methodology to be applied in research or investigation where the student engages with selected knowledge in the research literature of the discipline. An **investigation differs from a design** in that the objective is to produce knowledge and understanding of a phenomenon and a recommended course of action rather than specifying how an artifact could be produced.