`EEE4022S/F Topic template

Student proposed?	*N*	
Can this project as described below be completed outside a lab, i.e. done remotely?	*Y*	

ID:	**PA6-20**
SUPERVISOR:	Paul Amayo
TITLE:	Spatial and Temporal Calibration of multi-sensor systems
DESCRIPTION:	With robots coming equipped with more and more sensors there is an increasing need for accurate temporal and spatial calibration, especially as we move from fixed to re-configurable sensor placements. Calibration though usually requires fixed targets or a known environment. In this project we will explore the use of targetless calibration of a rigid sensor platform in motion.
DELIVERABLES:	A comprehensive survey of existing methods related to the problem particularly those that perform the spatial and temporal calibration simultaneously, and the implementation and comprehensive performance evaluation of at least one method of solution on a real-world dataset.
SKILLS/REQUIREMENTS: Include any software requirements	Strong mathematics, computer programming (C++/Matlab or Python), interest in algorithms
GA1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	*The student needs to identify and understand the challenges of multi-sensor calibration and how the lack of a target impacts the results, especially when time offsets between the sensors must be simultaneously obtained.*
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	*The student must then design, implement and evaluate the chosen calibration method on a relevant dataset.*
EXTRA INFORMATION:	Useful background information is in Z. Taylor and J. Nieto, “Motion-Based Calibration of Multimodal Sensor Extrinsics and Timing Offset Estimation,” IEEE Transactions on Robotics
AREA:	Computer Vision, Robotics, Multi-Sensor Fusion
Project suitable for ME/ ECE/EE/ All programmes?	ME

***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 over-specified, 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.

Plan B: If the project above requires lab access, describe how a student who cannot get to campus can complete the project remotely. Keep in mind that all projects still need to meet all of the Graduate Attributes associated with the course, in particular GA 1 & 4: *Identify, formulate, analyse and solve complex engineering problems creatively and innovatively AND Demonstrate competence to design and conduct investigations and experiments.*

1. Describe how you will get hardware to a student who cannot work on campus:

OR

2. Describe how the project will be adapted for a student who has to work remotely

DESCRIPTION:	
DELIVERABLES:	