Supervisor	Mahmoud Mughavemi
Topic	Automatic registration for Image guided surgery for brain tumor resection
Title	Automated surface-based intraoperative registration for brain tumor resection using machine learning Elements: 1. Automated surface Segmentation: Obtaining Using CNN model that can determine a given feature (e.g. contour of eye)→ outputs feature parameters 2. image processing: Mapping patient face and creating a surface point cloud 3. Registration: of the intraoperative and preoperative point clouds
Synopsis (Background, Problem statement, Objectives)	**Background** With the progress in computer image vision technology, the mapping technique based on optical data has developed specially in the medical imaging field. One of the techniques used in mapping technology is use of stereoscopic cameras for surface-based registration, which is then visualized by overlaying it on 3D preoperative data (MRI, or CT) using either manual or automatic process. It is an interest to have a real-time automatic registration where traditional methods are inadequate. **Problem Statement** Traditional techniques make use of iterations and this manner is very slow where runtime in the tens of minutes are normal for common deformable image registration techniques even with an efficient implementation on the contemporary GPUs; while the practical use in clinical operations is real-time, and such a prolonged wasting time is not appreciated. This paper proposes utilizing deep learning to carry out the registration of face. **Objectives** 1 Evaluate the need for machine learning registration over traditional registration of surfaces. 2 Evaluate a technique for segmentation of face from the rest of head model. 3 Use reliable NN model (CNN or SAE or GAN or RNN or DRL) for registration based on facial features 4 Demo Registration with control model (control is the

	unsegmented model) (Extra) 5 Obtain 3D map of the face 6 Carryout registration based on extracted feature
Expected Outcomes	1 Develop a model that determines the contour of the eye socket 2 Determine an evaluation metric and method for the registration 3 Carryout registration of (pre-segmented) face
Equipment Needed	Personal computer, suitable programming language software (3D slicer-free) (Extra) image acquisition devices .

Complex Engineering Attributes

Assigned PLOs: PLO3 (WK5), PLO4 (WK8), PLO5 (WK6), PLO7 (WK7), PLO9, PLO11, PLO12

Attribute	**Complex Engineering Problems have characteristic WP1 and some or all of WP2 to WP7:**	**PLOs addressed?**	**Comments from FYP supervisor (*give examples / clarifications*)**
Depth of Knowledge Required	**WP1**: Cannot be resolved without in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 which allows a fundamentals-based, first principles analytical approach	PLO3, PLO4, PLO5, PLO7	Required the fundamental knowledge on various field of image processing and artificial intelligence, such as template matching, image enhancement and filtering as well as machine learning. Student needs to basically apply fundamental knowledge in image processing and artificial intelligence to solve a given design problem.
Range of conflicting requirements	**WP2**: Involve wide-ranging or conflicting technical, engineering and other issues	PLO3, PLO4	During the design process, student needs to demonstrate limitations that they encounter during the process, e.g. lighting, image size and acquisition distance.
Depth of analysis required	**WP3**: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models	PLO7	Student need to understand the problem and apply suitable solution which may have been applied in similar problem but in different application
Familiarity of issues	**WP4**: Involve infrequently encountered issues	PLO5	The problem is unique thus requires innovative thinking and adoption of many existing designs which are not directly applicable to the given problem
Extent of applicable codes	**WP5**: Are outside problems encompassed by standards and codes of practice for professional engineering		Need to understand the strict medical imaging standards which can be encompassed for other sectors that use CV (e.g AV).
Extent of stakeholder involvement and conflicting requirements	**WP6**: Involve diverse groups of stakeholders with widely varying needs		Many types of surgery and workflows associated with cranial surgery, which results in wide range of requirements
Interdependence	**WP 7**: Are high level problems including many component parts or sub-problems		Includes both software and hardware design and has sub problems within each.