ME, MY Robot and Artificial Intelligence (AI)

Dr. Faisal Al-Jaber

Assistant Professor of Mechanical Engineering, Department of Mechanical and Industrial Systems Engineering, College of Engineering - Qatar University

Dr. Faisal Al-Jaber, Assistant Professor in the Department of Mechanical and Industrial Systems Engineering at the College of Engineering, is specialized in the design, fabrication, and sensorization of Soft and Bio-inspired Robots. Dr. Al-Jaber's expertise includes the development of soft optical-based sensors that are either pressure-sensitive or pressure-insensitive, enabling **Proprioception (self-internal-state sensing)** for orientation and position, as well as **Exteroception (external-state sensing)** for obstacle avoidance and light intensity detection in inflatable soft robots (Figures 1 and 2).

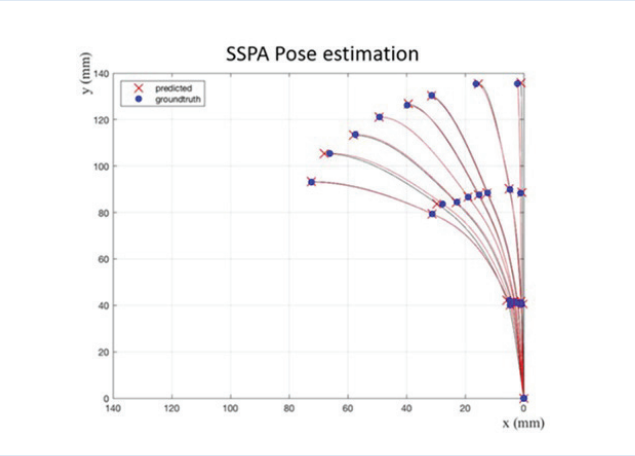

Figure 1: Proprioception sensing which shows the soft robot curvature at different stages of the actuation.

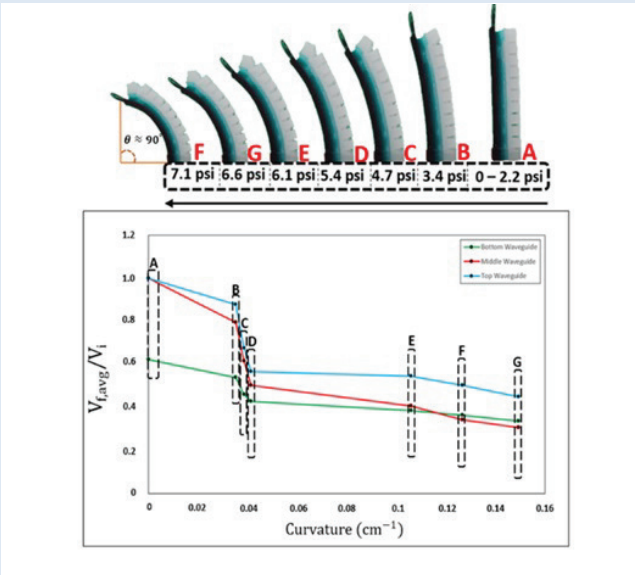

Figure 2: Extereoception voltage vs curvature plot is shown as a result of the pressure input.

To begin, it is essential to define Artificial Intelligence (AI) and its role in the advancing field of Robotics. AI, in simple terms, is the science or the attempt to mimic the human intelligence in the process of decision-making. This involves training machines to identify or classify specific features related to a given task, enabling them to make informed decisions and perform intelligent actions.

There are some AI methods of implementation in robotics, mainly to enable the robotic systems to execute complex tasks. These methods are as follows:

1. **Machine Learning:** AI enables robotic systems to learn from a predetermined set of data to use as a reference and improve their performance over time. This method includes learning from pervious experiences to implement improved decisions and adjust to find new situations.
2. **Computer Vision:** AI allows robots to construe and decode visual information from surrounding environment. This method is essential for core tasks involves objects recognition and classification, navigation, and interaction with humans or other machines.
3. **Natural Language Processing (NLP):** AI helps robots understand and respond to human language, making interactions more intuitive. This method is used in customer service robots and personal assistants.
4. **Autonomous Navigation:** AI enables robots to circumnavigate complex environments and obstacles free of human intervention. This method is essential for applications like self-driving cars and drones and swarm-robots.
5. **Predictive Maintenance:** AI can predict, due to data fed to it, when a robot or its components might fail or requires repair, allowing for timely maintenance and reducing downtime in fully automated production lines.
6. **Robotic Process Automation (RPA):** AI is utilized to automate redundant tasks in various industries, improving efficiency and accuracy.

The aforementioned methods are used as part of fused-AI system in surgical and medical Robotics, especially those systems that use soft robotics manipulators. Machine learning and image processing modalities can be fused and used to identify certain features in patient's scans for full form of Augmented Reality (AR) projection on a patient to locate the operational targeted

area. Figures 3 and 4 show a part of the pervious project of Dr. Al-Jaber along with his team from the Imperial College London, who were able to project a volumetric CT-Scan slice on a brain-phantom by processing the image and creating an algorithm that can predict the position of the LED in 3D-space

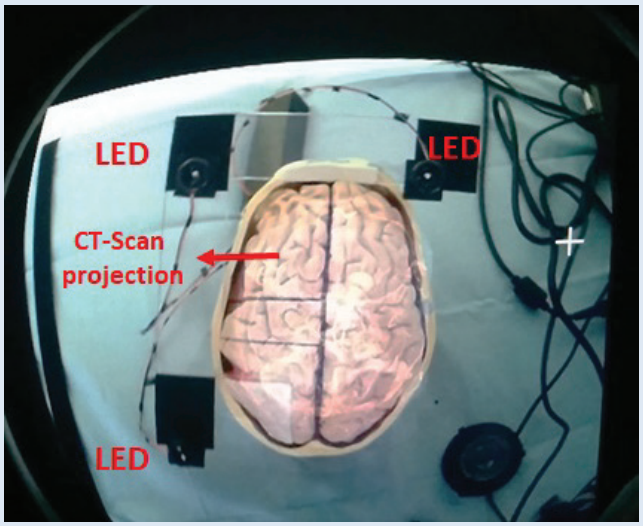

Figure 3: FPS perspective via the oculus added cameras showing the projection of the scan over the brain model.

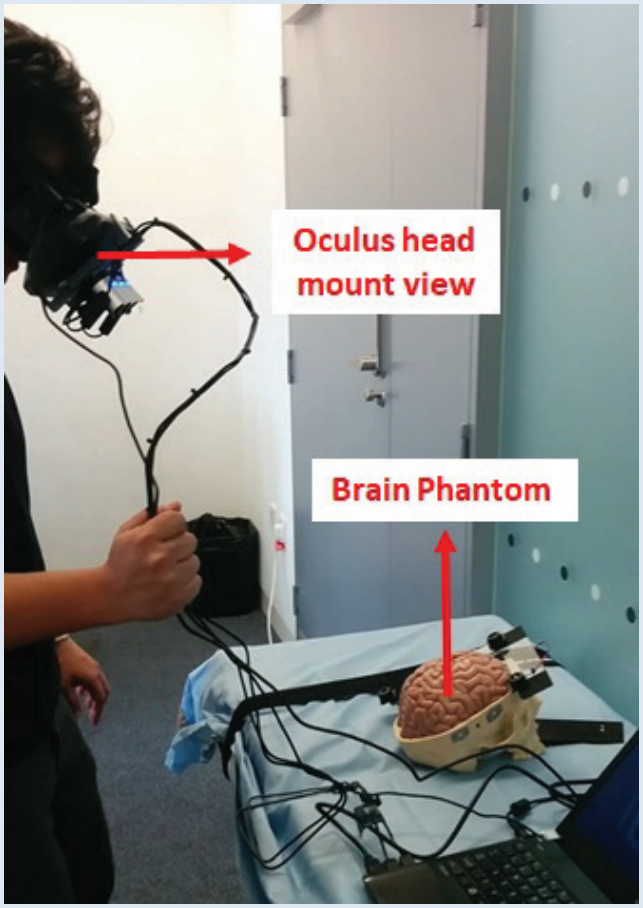

Figure 4: System setup.

and then scale each frame of the patient scans on the brain-phantom using the DEVKIT of Oculus.1 rift.

Additionally, another project involved using machine learning and image-processing tools to teach an algorithm to identify the hyper-redundant soft robot bending shape by learning to link the shape to the light-intensity of the optical sensors by extracting frames and run it against a pre-determined reference images as shown in Figures 5 and 6.

AI as a tool in robotics and medical robotics, particularly, is meant to enhance the performance of clinicians and improve outcomes. However, as a tool that is being adopted cautiously in applications that might affect the health, or compromise human privacy and rights, the advancement of ethical conduct has to improve to keep up with advancement of technology.

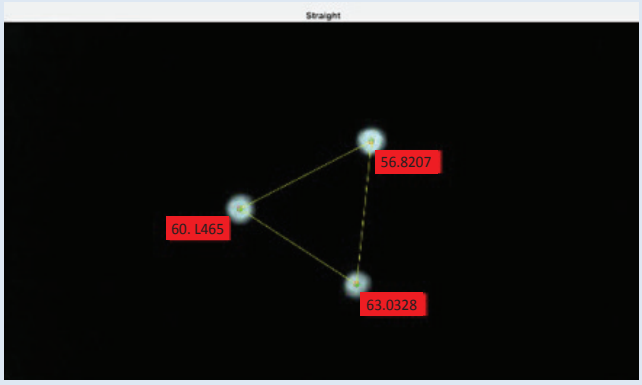

Figure 5: The algorithm is learning using the reference images and machine learning tools to compare the live-streamed images to the reference ones.

Figure 6: Graphical user interface showing the three light intensity circles are divided and compared individually to project the right shape predication.

For any inquiries regarding the article, do not hesitate to contact the Robotics team at Kindi Center of Research.