Course: Computer-Aided Surgery and Medical Robotics
Project Title: Dental Assistant Robot: Enhancing Precision and Efficiency in Dental Surgery

Team Members: Muhammad Kabir Hamzah, Diptan Regmi, Faisal Farhan

Advances in robotic systems have transformed various fields of surgery, enhancing precision, control, and efficiency. In dentistry, there is a growing interest in applying robotics to assist dental practitioners in tasks that require high precision and coordination. This project proposes the design and development of a robotic dental assistant capable of assisting dentists during oral surgery by handling routine tasks, such as delivering/injecting anesthesia, suctioning of fluids and/or instrument passing, light adjustment, and performing certain emergency procedures.

The main objective of our project is to design a robotic dental assistant that can support dentists during oral surgery by automating specific manual tasks.

Proposed Robot: The robot that will be used for the project is Staubli Robot TX-60.

Explaining of the real procedure performed in surgery room:

Oral surgery refers to any mouth operation. It includes procedures done on our teeth, gums, tongue or any other area inside your oral cavity. A general oral surgery follows the following steps:

- The dental surgeon will give the patient a local anesthesia to numb the mouth for oral surgery. They may also give sedative medications to help the patient relax or sleep through the procedure.
- They'll make an incision inside the patient's mouth. The location of the incision depends on the affected area(s).
- The oral surgeon will do the surgery using small, specialized instruments. Depending on the patient's needs, this step might include removing teeth, placing implants or reshaping bone or tissue. The patient shouldn't feel any pain due to the anesthesia.
- Once the oral surgeon completes the procedure, they'll close the incision with stitches.

Simple tooth extraction procedure can be found in the following video:

[Oral Surgery | Simple Extraction | INBDE, ADAT (youtube.com)](youtube.com)

Project Objectives

The main objective of this project is to design a robotic dental assistant that can support dentists by automating specific manual tasks during oral surgery. The following are the specific objectives of the project:

- **Performing Local Anesthesia:** The robot will inject local anesthesia to the tooth gums required during the surgery.
- **Suctioning:** The robot will have the ability to clean the mouth by suctioning excess fluid.

The overall goal is to improve the efficiency of dental procedures, reduce surgery time, and provide consistent assistance to minimize dentist fatigue.

Explanation of the setup that will be used.
The setup for the project will consist of the Staubli TX-60 robot, equipped with various attachments suitable for dental surgery assistance. The robot environment will include a chair, some lighting, and a few surgical instruments. The robot will be positioned in such a way that it can easily access the patient's oral cavity without obstructing the dentist's workspace. The control system for the robot will be a laptop to write the code and the robot's control device.

What tool and how you plan on fixing it to the robot.
The tools to be fixed to the Staubli TX-60 robot include:
- **Anesthetic Delivery tool:** This tool will be a syringe for precise injections of local anesthesia. It will be mounted on the robot's tcp.
- **A Suction Tool:** A dental suction tool (a bigger syringe) will be attached to the robot's tcp.

What mock-up will be used to simulate the patient.
To simulate the patient for testing and demonstration of the Dental Assistant Robot, we will use a dental manikin like the skull in the lab that has some realistic teeth and gum, and the mouth is able to realistically open and close. We will use some fluid to mimic the saliva during the dental procedures.

A 10-session plan
Session 1: Project Kickoff and Initial Planning
- **Objective:** Establish project goals, timelines, and roles.
- **Activities:** Team introductions, discussion of the project scope, setting milestones, and distribution of responsibilities.

Session 2: Technical Requirements and Design Specifications
- **Objective:** Finalize the technical requirements and detailed design of the robot.
- **Activities:** Define specifications for robotic tools, control systems, and safety mechanisms.

Session 3: Development of Control Algorithms
- **Objective:** Develop and write initial control algorithms for robotic operation.
- **Activities:** Coding of basic control structures for tool handling, movement precision, and task sequencing.

Session 4: Development of Control Algorithms cont'd
- **Objective:** Develop and write initial control algorithms for robotic operation.
- **Activities:** Coding of basic control structures for tool handling, movement precision, and task sequencing.

Session 5: Prototype Tool Development

- **Objective:** Develop prototypes for each robotic tool (anesthesia module, suction tool).
- **Activities:** A session to acquire the tools.

Session 6: Assembly and Initial Testing
- **Objective:** Assemble the robot and conduct initial functionality tests.
- **Activities:** Integrate tools with the Staubli TX-60 robot, perform basic operation tests, and adjust for mechanical precision and efficiency.

Session 7: Comprehensive System Testing
- **Objective:** Perform comprehensive testing using the dental manikin.
- **Activities:** Test all functionalities. Document any errors or issues for troubleshooting.

Session 8: Troubleshooting and Optimization
- **Objective:** Refine the system based on test results.
- **Activities:** Optimize the control algorithms, and repeat testing as needed to meet all specifications.

Session 9: Troubleshooting and Optimization cont'd
- **Objective:** Refine the system based on test results.
- **Activities:** Optimize the control algorithms, and repeat testing as needed to meet all specifications.

Session 10: Final Review and Demonstration
- **Objective:** Conduct a final review of the project and prepare for demonstration.
- **Activities:** Final adjustments and testing, prepare a demonstration session, and review project documentation for submission.