Control of a Surgical Robot Arm

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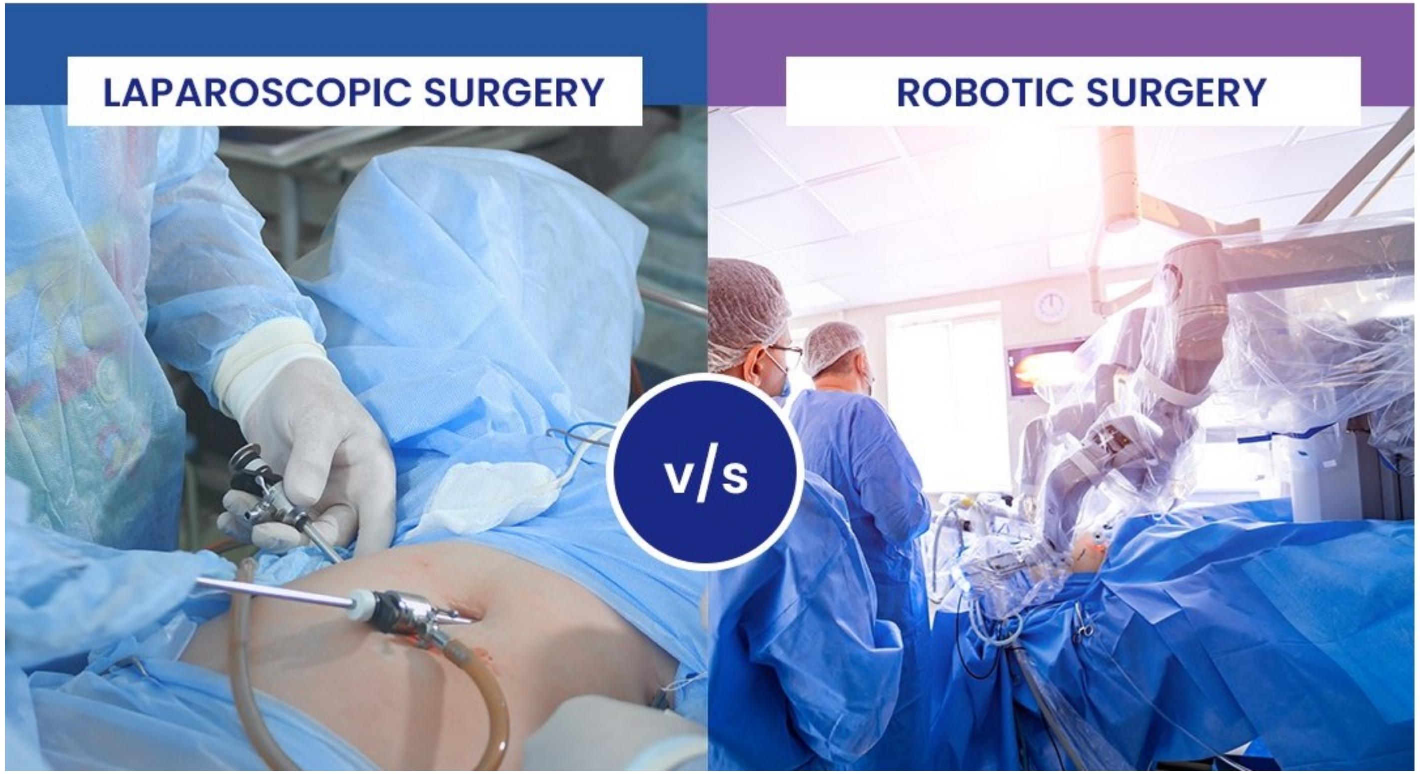
Objective

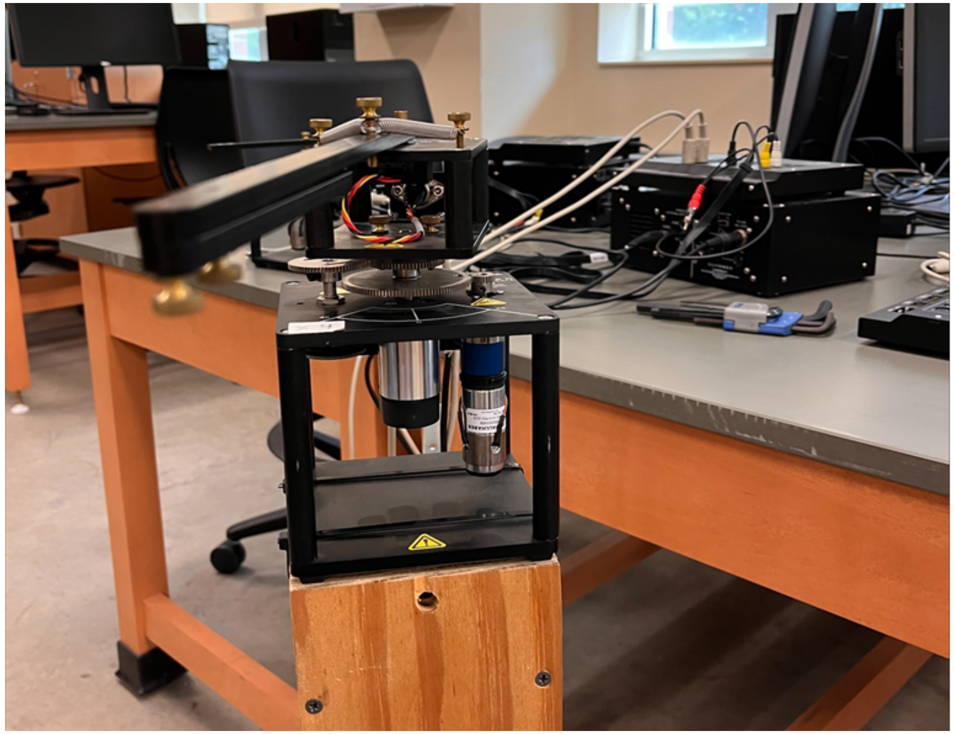
- To make a surgical robot move fast without the flexible joint shaking.

Background



- Since Robotics were first used in surgery in the 1980s, many improvements have been made.
- Surgical robots are now being used in laparoscopic surgery
- Flexible joint shaking is a major issue in using Robotics arm.

Project Description



- Create an algorithm to make the robot arms move fast without oscillation using Fuzzy Control System, QUARC, MATLAB, and Simulink.
- Apply an algorithm into the computer model that controls the robot

Our Task

Learning Phase (first 2 weeks)

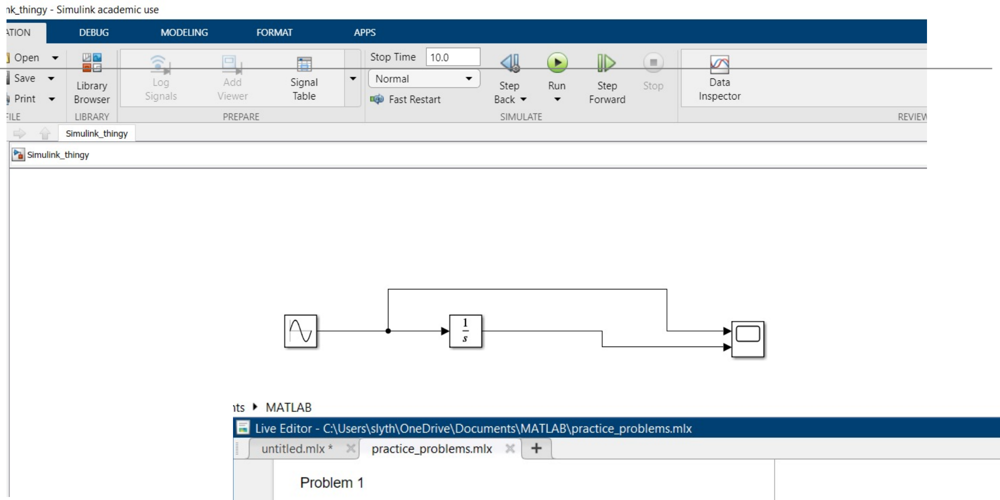
- Learn about the components and functionalities of the robot
- Become familiar with the computer control interface,
- Learn how to use MATLAB, Simulink, and Quanser.
- Learn Fuzzy Control System and other algorithms.

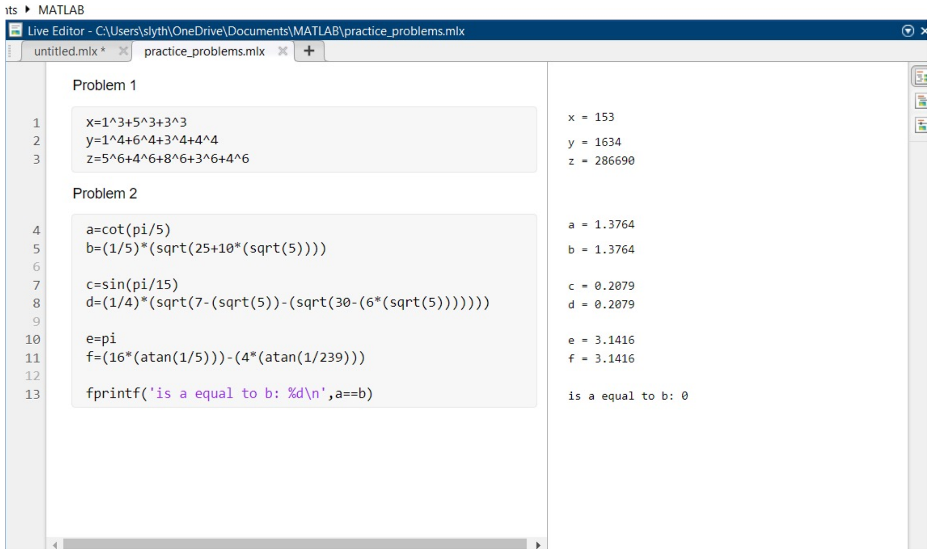
Development Phase (last 2 weeks)

- Create and apply an algorithm to make the robot move fast without oscillation.
- Write a research paper detailing the findings during the project

MATLAB

- MATLAB = Matrix Laboratory
- Programing language we are using
  - Mainly used for math functions
- Simulink function
  - Mainly used for simulating and as a control system



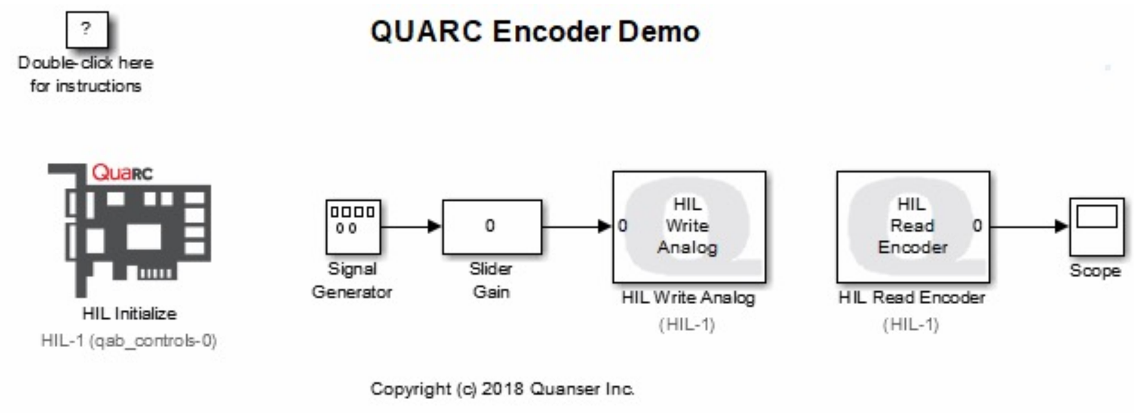


QUARC

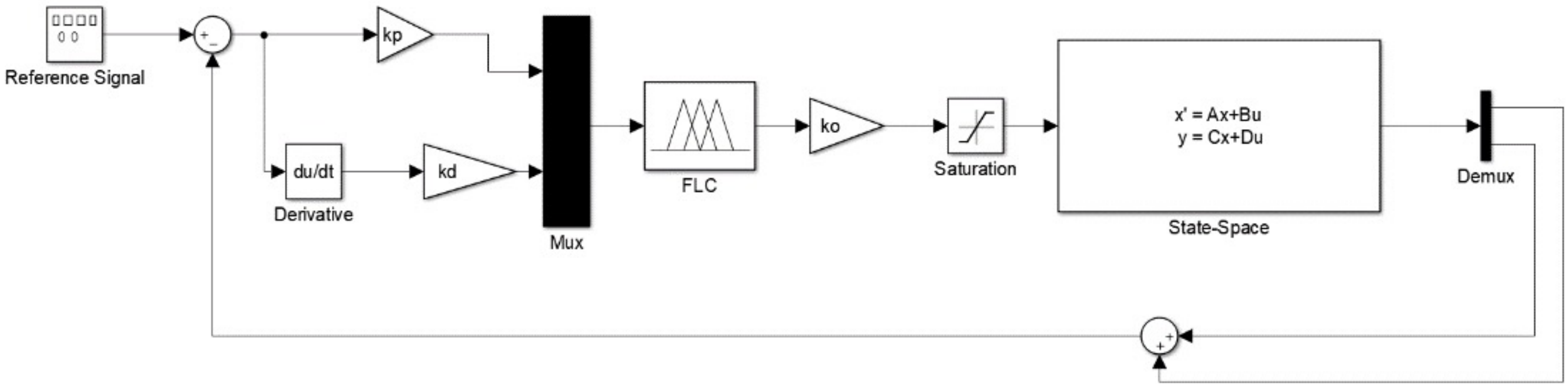
- QUARC = Quanser Real-Time Controller

- HIL Read = sends data from encoders to computer

- HIL Write = sends commands from computer to motors

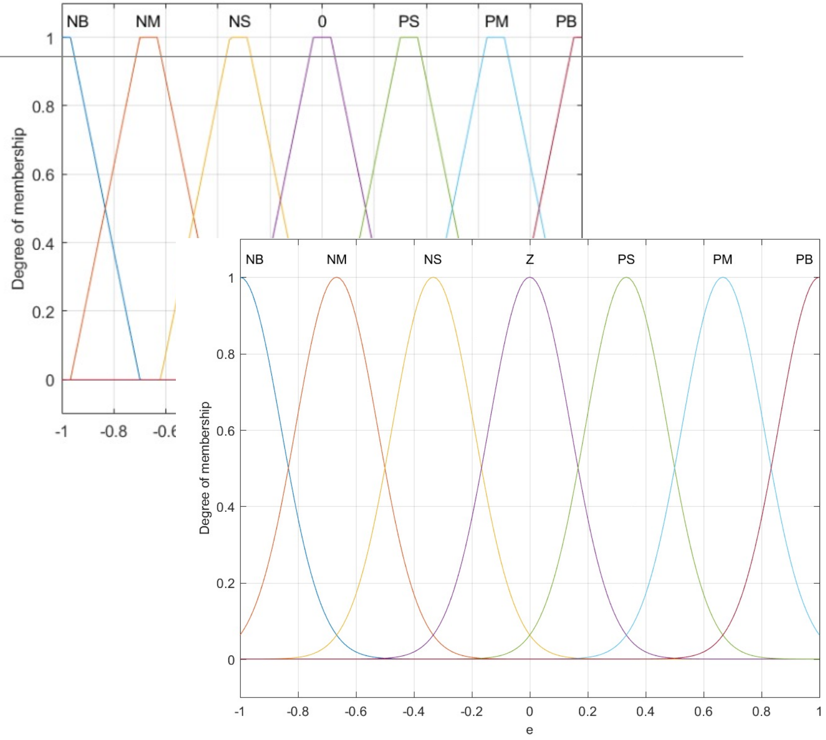


Fuzzy Logic Controller



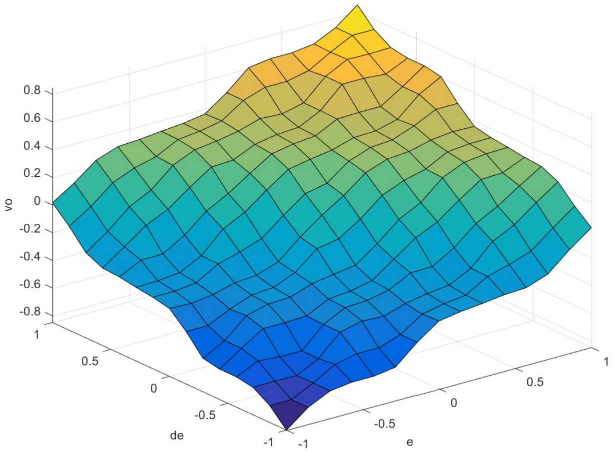
Input Membership Functions (MSF)

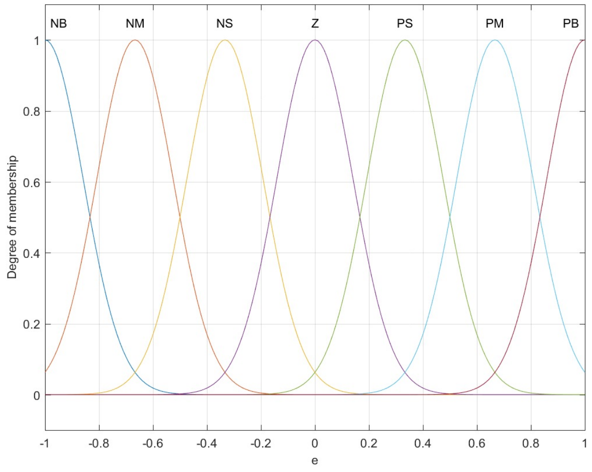
- Uses degrees of truth rather than absolute truth
  - All the numbers between 0 and 1
- Membership functions take fuzzy data and turns it into crisp data
- Different types of membership functions



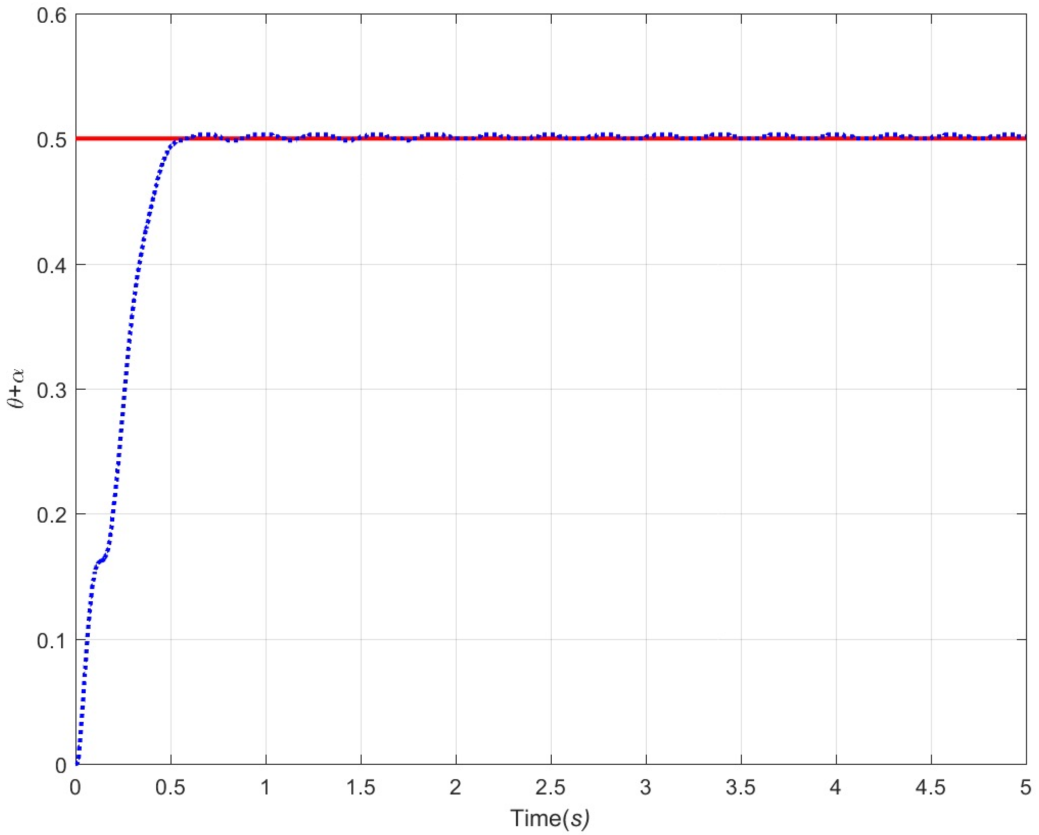
Output MSF, Fuzzy Rules, Control Surface

e ė	NB	N M	NS	Z	PS	P M	PB
NB	NB	N M	N M	NS	NS	NZ	Z
NM	N M	N M	NS	NS	NS	Z	PS
NS	N M	NS	NS	NS	Z	PS	PS
Z	NS	NS	NS	Z	PS	PS	PS
PS	NS	NS	Z	PS	PS	PS	P M
PM	NS	Z	PS	PS	PS	P M	P M
PB	Z	PS	PS	PS	P M	P M	PB





Controlled System Response



Performance Index	Its value	Performance Index	Its value
t_r	0.316	M_p	0.314%
t_s	0.468	α_{rms}	0.0083

Demo

Project Scope and Schedule

Tasks	Week 1	Week 2	Week 3	Week 4
Task 1: Get to Know the Surgical Robot Components				
Task 2: Get to know the Computer Control Interface				
Task 3: Test Code				
Task 4: Modifying Test Code for Flexible Joint				
Task 5: Testing Flexible Joint Code				

Completed:

In Progress:

Not Started:

Research Paper

INTELLIGENT CONTROL OF A SURGICAL ROBOTIC ARM

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Abstract

This study presents an intelligent control algorithm for a surgical robotic arm. A fuzzy control is used to control the motion of the robot arm while reducing vibration and increasing the system response time.

Introduction

Advancements in robotics and computers have been impacting many sectors, especially medical fields where accuracy and dexterity could be improved by using robots and robust computer algorithms. In the last few years, several surgical robots have been introduced in literature. The feasibility and practical application of surgical robotic arms as substitutes for surgical assistants in laparoscopic surgeries were investigated in [1]. Seventeen laparoscopic procedures were performed by one surgeon controlling the surgical robot arm, and the performance of the procedures were compared to past human-assisted procedures. The results showed that the surgical robot performed as adequately as a human assistant, and there was no increase in operation time. That is, surgical robots are feasible and may be a more cost-effective solution than traditional human surgical assistants. Similarly, the performance of the da Vinci™ operating robot in general surgery was analyzed in [2]. 128 procedures were performed on 78 females and 50 males, of which 122 (95%) were successfully completed using the da Vinci™; 4 patients had surgical complications, and there were technical issues in two other procedures. The use of the da Vinci™ is feasible and safe, and has been proven especially useful in tiny, hard to reach areas, along with dissecting delicate anatomical structures. However, the robot was considerably more expensive to maintain than conventional minimally invasive surgery. In [3], a comparison between the manual single incision laparoscopic cholecystectomy (SILC) and Single-site robotic cholecystectomy (SSRC) using the da Vinci platform was conducted. Eight variables including age, sex, body mass index, indications, pain scale, length of stay, and complications were analyzed using data collected from 114 patients who received SSRC or SILC from February 2014 to September 2015. The study found that the SSRC was better than SILC in terms of surgical complications.

Questions?