Executive Summary:

Soft robotics offers significant potential in the field of surgical robotics. Soft materials, due to their high adaptability, deformability, and number of degrees of freedom, often mimic the mechanical properties of biological tissues. This makes them ideal for use with delicate tissue and in several different surgical applications, but often due to their inherent properties, it becomes challenging to receive feedback on soft tools being used in the surgical field. This project aims to develop a smart touch system for surgical robots that enhances real-time feedback by sensing force and torque during minimally invasive procedures. Addressing the limitations of current robotic systems in detecting nuanced tissue properties, the proposed design incorporates hybrid soft robotics and deep learning to classify tissue type, texture, and applied force. By integrating force sensors, piezoelectric sensors, soft actuators, and feedback loops, the system will provide surgeons with precise tactile insights. To achieve this, a proof of concept was developed, integrating a load cell into an end-effector CADed using Onshape. Expected outcomes include a functional prototype demonstrating accurate force and texture detection, evaluated using benchmark tissue models. The design will feature two end-effectors equipped with force sensors and soft, flexible materials to mimic human touch sensitivity. Success will be assessed by comparing the system's feedback accuracy and reliability to standard surgical tools. Simulations and iterative testing will ensure robustness before moving to physical validation. This research addresses critical gaps in surgical robotics by improving dexterity and sensory feedback, potentially reducing complications during surgery.