An Intraocular Robotic Interventional Surgical System – IRISS: Evaluating Automation Components

Marios Christofides working in the lab of Professor Tsao

The Intraocular Robotic Interventional Surgical System (IRISS) is capable of performing surgery on an eye without the need of human intervention. The IRISS machine has 3 limbs as well as a computer for real-time feedback control and a lens for 3-D (three-dimensional) imaging. The IRISS machine has a real-time computer for servo level feedback control, a customized master manipulation tool for performing the surgery and a camera mounted binocular microscope for 3 dimensional visualization as well as image based tracking of the surgical field. The problem with IRISS is that only one of its limbs has an identifiable zero position. Assuming that the tip of the limb in which the camera is mounted on is at the zero position (the camera is placed on the tip), the objective is to use position sensors to find the location of the tips of the other two limbs. While this may not be a major fundamental problem in the scientific community, it needs to be studied to make the IRISS machine operate properly. A possible solution is to use position sensors to find out the position of the two limbs and calibrate the device. There are two components: a sensor and an actuator that are going to be used by the lab. Specifically, photo interrupter sensors and limit switches are being used. The photo interrupter sensor is composed of an infrared emitter on one upright and a shielded infrared detector on the other. By emitting a beam of infrared light from one upright to the other, the sensor can detect when an object passes between the uprights, because the object is breaking the beam. The gap width between the two upright is about 10mm. A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection (circuit). In this way, the limit switch does not allow an object to move beyond a pre-determined point. However, we do not know if the sensors will give the same measurements when hit in the same place numerous times (precision of the sensor) as well as how accurate the measurements are in the sense of being close to known values. The datasheets (manual of the sensors) do not have this information which is why we need to evaluate the sensors and the actuators. To test the reliability of the sensors, we will set up experiments to measure positions of objects. A touch probe sensor will be attached to the device and it will move and hit the sensor/actuator. As long as the results are consistent the sensors and actuators are good. We will also evaluate limit switches in a similar way. First, I did a survey of commercially available sensors and actuators. I evaluated nine photo interrupter sensors and seven limit switches. I evaluated them based on specific criteria such as response time, sensing distance and price. The lab plans to buy some of these sensors and actuators and we will evaluate them.