Lighting Setup

Introduction

The video based phonomicrosurgery instrument tracking system is used to measure the motion of phonomicrosurgery instruments during a simulated surgery exercise. Two cameras capture the tips of surgical instruments manipulating a paper target during an exercise. Afterwards, an algorithm processes the captured videos. This processing consists of detecting a set of instrument features in each frame. There are two primary features : the position of a marker attached to the rod of the instrument and the boundaries of the rod portion of the instrument. Visibility of these two features in the videos are important for proper detection. This is controlled primarily by the lighting in the setup. This document describes how to setup the lighting for video capture. There are two lighting sources used for a video capture : front lighting and back lighting. This document describes the two sources.

Front Lighting

Front lighting is provided by an LED array flashlight. This light provides a uniform diffuse light. It allows the marker attached to the instrument to be captured with good contrast and visibility. It should be positioned to light the region between the tip of the laryngoscope and the paper target where the instruments are visible. The flashlight is turned on using a switch on its backside. It is held in place by a claw that is attached to the optical breadboard base.

Back Lighting

The instrument is back-lit indirectly. This is done using a plastic background plane and light source. The light source is directed towards the background plane. Light reflected off of the plane provides diffuse instrument back lighting. This is primarily used to provide good contrast at the boundaries of the instrument. This section consists of two subsections related to the setup of the plane and light source.

a) Positioning the Background Plane

The background plane should be positioned behind the volume containing the tips of the instruments imaged by the cameras. A profile view illustration of the surgery station is seen in **Figure 1**. The dotted red rectangle represents the volume imaged by the cameras. The background plane is positioned behind the viewing volume and oriented parallel to the laryngoscope. This angle does not need to be exact (it can be adjusted manually without measurement), but should be close to parallel. The position and orientation of the plane is controlled by a clamp connected to the right vertical pole in the simulated surgery station. A claw that grasps a handle on the background plane is attached to this clamp. It is

easiest to adjust the position of the plane while viewing a live video stream from both cameras using *vidCaptureGUI.* This allows for verification that the background plane is in frame for both cameras. Additionally, the live video stream will be used in the next step related to the positioning of the back-light source.

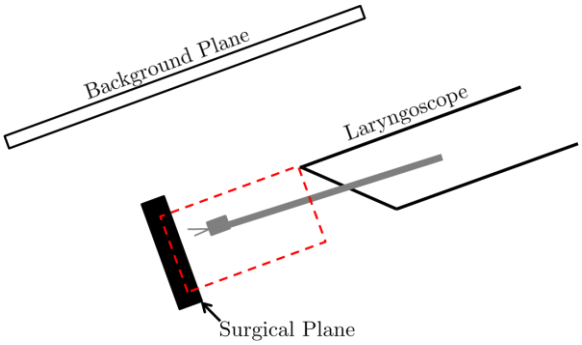

Figure 1 : Plane Position Illustration

b) Positioning the Light Source

As of 12/14/2011 a Scott KL 1500-Z microscope light was used as the background light source. It has a single lamp with two flexible light guides that are directed at the background plane to provide indirect backlighting. Two knobs control the intensity of the light source. The left knob is numbered one to five. Setting number one was used in experiments as of 12/14/2011. The right knob enables the light source and has two settings. During experiments the lower setting was used.

It is very important that this light source is positioned to provide no direct lighting to the surgical instruments. This is done by positioning the two flexible arms towards the background plane and away from the volume containing the instruments. Use the live video stream in *vidCaptureGUI* to verify the back lighting setup. The background in both views should be uniformly white as seen in **Figure 2**. Make adjustments to the arm positions until satisfied. Record a video of the surgical instruments and verify that the appearance of the attached markers and instrument boundaries do not degrade due to lighting that is too dim or too bright.

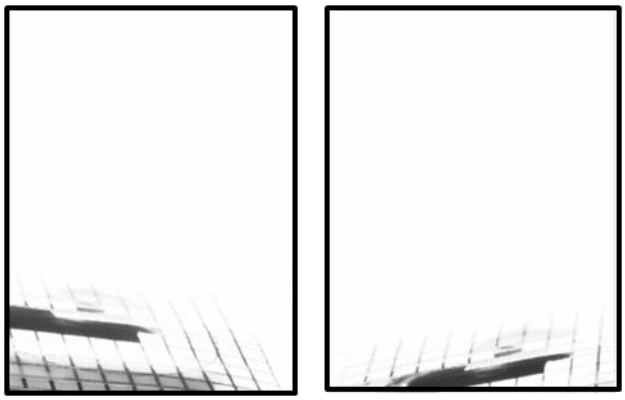

Figure 2 : Example Back Lighting