Instrument Preparation : Markers

Introduction

The video based phonomicrosurgery instrument tracking system is used to measure the motion of phonomicrosurgery instruments during a simulated surgery exercise. Prior to an exercise, two paper markers are attached to the instruments. These markers have a distinct appearance which allows a computer algorithm to track and differentiate the instruments. This document describes how to prepare an instrument for tracking by attaching a marker to it. First the marker patterns are described. Next instructions are given on how to generate images of them and how to print sheets of labels containing them. Finally, information is given on how to attach them to an instrument.

Marker Patterns

The two marker patterns are seen in **Figure 1**. Both consist of a set of black and white stripes. The patterns differ in the number of stripes and stripe width. Different patterns are used to differentiate the two instruments used for a phonomicrosurgery exercise.

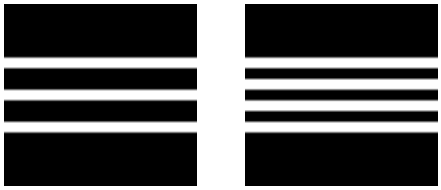

Figure 1. Marker patterns

Both marker patterns are (17 row pixels x 18 column pixels) binary images. A black (5 X 18) border exists at the top and bottom of both patterns. A set of black and white stripes are sandwiched between the borders. The left pattern consists of three (1 X 18) white stripes and two (2 X 18) black stripes. The right pattern has four (1 X 18) white stripes and three (1 X 18) black stripes. The width of the pattern is given by the number of column pixels. This width was selected so that a pattern wraps around the circumference of an instrument's rod with minimal overlap. The rod of a phonomicrosurgery instrument has a ~1.96 mm diameter. If a marker is printed at 72 PPI (pixels per inch) the following equation is used to choose the #column pixels that correspond to the circumference of the rod

$$\#columns = ceil(72(\frac{0.196\pi}{2.54})) \ .$$

Generating Marker Images

A Matlab function exists to generate an image of each marker pattern. The functions can be found in the directory

C:\Simulated_Surgery_Software\Matlab\MarkerGeneration .

They are named *markerPatternGen_1* and *markerPatternGen_2*. Both functions can be used to write a '.tif' image. When either function is called without an input argument, a file save dialog is opened. This dialog is used to set the image file name and location.

Figure 2 : Instrument Position Prior to Attaching Marker

Printing Markers on Labels

As of 12/05/2011 the markers were being printed on 3M 3100-Q (80 labels per sheet) permanent adhesive return address labels. These labels are sized 0.5" X 1.75" and designed to be used with a laser printer. A document named "MarkerSheet.doc" is saved in

"C:\Simulated_Surgery_Software_Matlab\MarkerGeneration .

This document is formatted to print on the 3100-Q labels and split into pattern 1 and pattern 2 labels. It can be used to print additional markers. If another label type is used, images of the patterns should be generated using the functions described in the previous section. These images can be imported into a template for the label sheet type being printed to. NOTE : The marker pattern images are generated assuming a print resolution of 72 PPI (pixels per inch).

Attaching the Marker

The methodology used to attach a marker to a surgical instrument (as of 12/06/2011) is described in this section.

1) Securely Position the Instrument

Prior to attaching a marker to an instrument, it is helpful to position the instrument on the end of a table with the rod and tip extending off of the table. In this position the handle of the instrument should extend vertically away from the table. An illustration of this position is seen in **Figure 2**. The instrument should be securely placed in this position so it does not move when the label with the marker is attached. This can be done by sandwiching the instrument's handle between two boxes. A piece of tape can be used to secure the rod to the table. **Figure 3** is an image of this.

2) Pre-Cut the Label

Figure 4 is an image of a sheet of labels. Dotted red lines in the image show how to cut the label out of the sheet. The horizontal cuts should lie along the horizontal boundaries of the marker an extend beyond the vertical boundaries of the label. This makes it easy to peel the label from its backing. The label will not need any additional trimming until after being attached to the instrument.

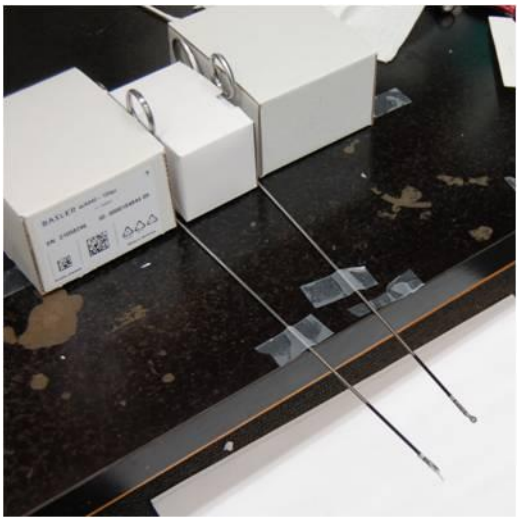

Figure 3 : Boxes and tape used to stabilize instruments prior to marker attachment

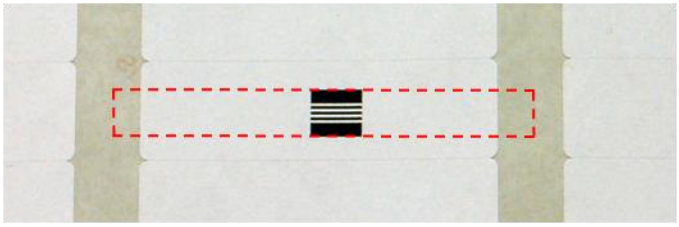

Figure 4: Label Sheet with Single Marker Cutting Boundaries

3) Attach the label

Remove the backing from the label. The label will be wrapped around the end of the instrument's rod at the point identified in **Figure 2**. **Figure 5** is an illustration of the procedure for attaching the label. This figure is a cross-sectional view of the instrument's rod. The dotted horizontal line in the figure represents the table that the instrument is sitting on. Attach the label to the instrument's rod from above. Attach it so that the marker is centered on the top of the rod. Wrap the ends of the label around the instrument's rod so that it tightly follows the boundaries of the instrument. (a) of the figure shows this configuration. On the bottom side of the rod bring the two sides of the label together (indicated by red arrows in (a)). This configuration is seen in (b) of the figure. The label should tightly hug the instrument. The marker should be visible at all points except at the excess label. Leave the label in this configuration for a couple of minutes so it can adhere. Finally, trim the excess label. Make sure to not completely remove the excess when trimming. This helps to keep the marker attached to the rod. Otherwise the label tends to disconnect at the point where the two sides of the label meet. This configuration is seen in (c). You should fold over the excess label so that it does not stand up. Make sure to not touch the portion of the label that will be visible to the cameras when folding over the excess.

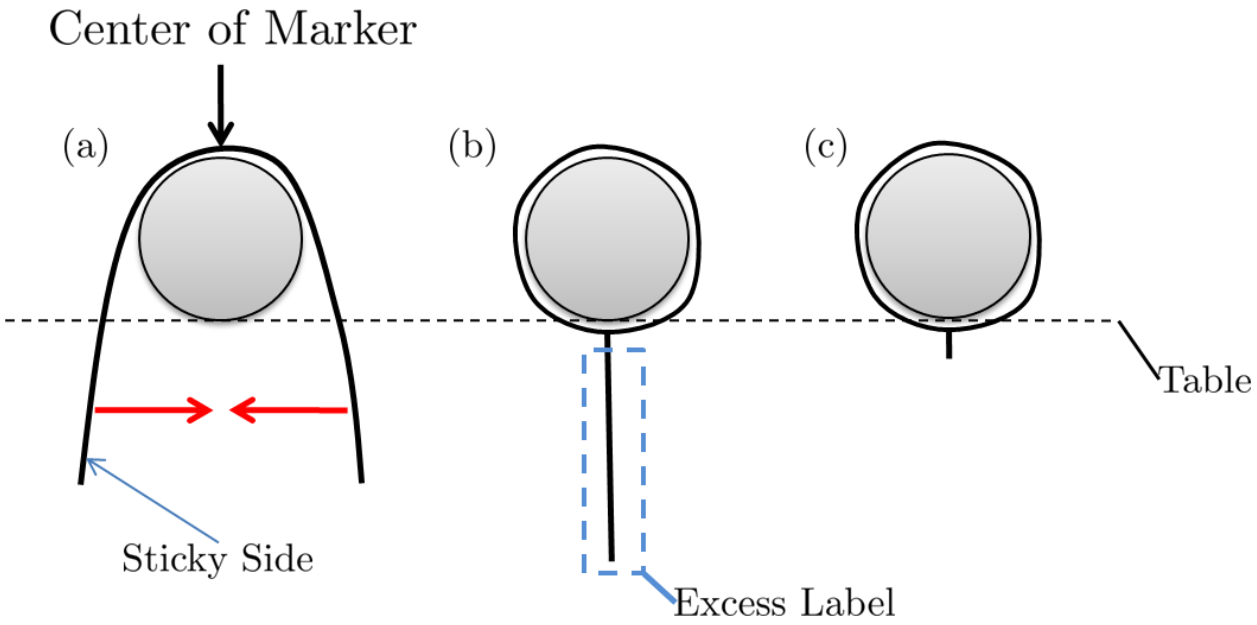

Figure 5 : Label attachment Illustration

4) Paint above marker label

The rod region of the instrument above the marker black (towards the handle) needs to be painted black. As of 12/06/2011 this was done using a black sharpie marker. It would be better to permanently paint the rod portion of the instrument black as the sharpie can rub off or rub onto a marker.