In eastern medicine, particularly acupuncture, the appearance of the tongue is used as a diagnostic tool. Characteristics that are considered are the shape, color (both of the tongue proper and of any plaque), and any cracks, including the placement and orientation.

**Mobile App**

The mobile app was created on android studio and uses firebase as a data base.

When a new visit is created, the user is allowed to enter information into the fields of the patient name, visit date, a diagnosis, acupuncture treatment points, and any other important notes. This screen also allows the user to capture a photo. The photo is taken using the devices built in camera. When a new patient is chosen, the same screen as for a new visit is displayed.

**Image Processing**

First an image is read into the program. The image is then broken up into the different color spectrums, red, green, and blue. Those images are then turned into a binary image. That binary image is used to identify the tongue.

Once the tongue is identified it is zoomed in on. For later use, the image’s color spectrum is stretched before zooming.

To analyze color, the image with the color spectrum stretched is used and the tongue is again zoomed in on. The tongue is broken up into 9 segments and the average color of each segment is taken.

**GUI**

The GUI allows the user to browse for images on their computer. Once one is chosen it is run through the program and is displayed next to a panel that shows the diagnosis.

A special thanks to Professor Peter Yoon, Professor Madalene Speziali and the entire Trinity College Computer Science Department

**Technologies**

The GUI and the image processing program were created using MATLAB.

**Problem and Solution**

The problem is that every diagnostician may describe or interpret the same tongue differently.

For example, all the colors above can be described as pink, but they are clearly distinct. The solutions is easy, take a picture.

The question is then what to do with that picture? In the first part of my project I created a mobile app for image storage. The app allows tongue images to be categorized by patients and for each patient’s images to be separated by visit or time that the tongue is used for a diagnosis.

In the second part of my project I attempted to eliminate the need to get a diagnosis from an acupuncturist or diagnostician. For this a desktop GUI was created that takes an image as an input. The image is then displayed and a diagnosis is shown in a panel next to the image. For the GUI, an image processing program was created that extracts important features and translates that to a diagnosis.

**Future Work**

Future work is to connect the image processing program to the mobile application. That would allow analysis to happen instantaneously on the device that took the photo and eliminate the hassle of transferring the image to a computer. Other future work includes creating a program that can isolate the tongue in a wider variety of images, including images taken without the flash on. This could hopefully be done using more advanced image processing techniques.

An app could be created that would prompt the user to take a photo with the tongue shown in a certain range on the screen. Important future work is to look into HIPAA regulations and patient confidentiality and ensure all privacy is protected.

**Results**

21 images were used to test the program. Only 4 of the images were able to completely isolate the tongue for further analysis. 11 other images were able to isolate part of the tongue. The 4 images that could isolate the tongue were the only 4 images taken with the camera flash on. All 4 of these images did give a correct diagnosis.