Name(s)
Alice Martynova

Project Number
S0819

Project Title
Using Generative Adversarial Networks to Enhance an Affordable Micoscope for Epidemic Prevention in Developing Countries

Abstract

Objectives/Goals
The Foldscope is a microscope made of paper and a removable lense which costs 25 cents to make. In this project Foldscope is used to target Schistosomiasis, a parasitic disease second to Malaria in deaths and economic effect in developing countries. Doctors diagnose it by using microscopes to count the number of Schistosomiasis eggs in urine. If the number is greater than 50, a certain medication is given, and otherwise a different medication is administered. However, developing countries lack not only microscopes but also access to medical professionals.

Methods/Materials
This project uses an algorithm called Generative Adversarial Network (GAN), a Foldscope, and a Raspberry Pi with camera to replace the current expensive diagnostics. First, I used miniscule plastic beads and artificial urine to model Schistosomiasis eggs found in urine. I took 350 images of these samples by attaching a Foldscope to a Raspberry Pi camera, and used them to train the GAN. GAN consists of two components: the generator and the classifier. The generator learns to produce fake images resembling the real ones, while the classifier learns to recognize both the fake and the real images and tell them apart.

Results
Four tests were conducted. In the first the classifier placed images into two categories: with and without eggs. 50% of sample images contained objects other than eggs, for urine often has other visible components especially in areas with dirty water. The accuracy in this test was 95%. The next test used three classes: 0 eggs, < 50 eggs, >= 50 eggs. This test mirrors how the medication is prescribed for Schistosomiasis, and it was 94% accurate. Third test estimated actual egg count for each sample, and measured the average deviation from the true count. By the end of training, the accuracy was 0.25 eggs, less than one egg off. The fourth test was the same as the third, but the network had no generator. This test resulted in an accuracy of 11.5 eggs which demonstrates that GAN algorithm is essential.

Conclusions/Discussion
The trained network is downloaded onto Raspberry Pi, and does not require Internet to operate, making it suitable for remote areas. All together the device costs less than $25, compared to $400 for the cheapest microscope, and replaces the need for a trained diagnostics professional. Finally, while this device was trained to combat Schistosomiasis, it can be re-trained on any parasitic disease.

Summary Statement
I used a novel image processing technique to add a computing component to a paper microscope to build a cheap autonomous device for parasite detection in rural areas.

Help Received
I conducted most of my research by myself, and would sporadically email Kevin Carde, a mentor from one of my past summer camps, giving him updates on my project.