Developing a Novel, Accurate, and Rapid Computer Vision and Machine Learning Based Skin Disease Diagnosis Pipeline, Hardware Apparatus, and Mobile Application

Ganesh, Raghav (School: Lynbrook High School)

One in three cancer diagnoses is a skin cancer. While early diagnosis can saves lives, the required number of biopsies reported by medical professionals for an accurate diagnosis varies widely from 5 to 500, with physician diagnosis accuracy at 80.2%. Through my research, I developed a novel, automated, end-to-end skin cancer diagnosis pipeline. The first component of the pipeline is a cross platform mobile application for dermoscopic lesion imaging. Through grayscaling, a Gaussian filter, and Otsu Binarization, the skin lesion is extracted. Using these segmented images, I developed a set of classifiers to diagnose the lesion as benign or malignant. I trained and tested each algorithm with a dataset of over 10,000 skin lesion images. I created one and three layer convolutional neural networks, while also testing transfer learning models. I then created a custom image classifier using a K Nearest Neighbors (KNN) model, 9 computer vision (CV) features, feature filtering, and PCA to achieve 93% accuracy. The next step in the pipeline is diagnosing the specific class of the cancerous lesion. I used deep CNNs, CV features, and OpenCL accelerated algorithms to achieve an accuracy of 92%. In addition, I also created a ML boosted algorithm to determine whether a follow up diagnosis is required, with an accuracy of 82%. Further, to analyze the skin lesions needing a biopsy, I developed a frugal, automated cell staining and imaging device. The entire pipeline averages 30 seconds for a diagnosis and uses cloud computing. At the 2.5% significance level, my algorithms outperformed the corresponding data published from dermatologists with all levels of experience. A dermatologist also tested my application and found it useful.

Awards Won:

Second Award of $1,500

National Aeronautics and Space Administration: First Award of $2500