CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
35829

Project Title
DermatoScan: Machine Vision, Analysis, Learning & Natural Computing Optimizations for the Early Detection of Skin Cancer

Abstract

Objectives/Goals
A dermatoscope is a handheld device used by doctors to view skin tumors. Very few dermatoscopes provide any form of intelligent analysis or diagnostic support. Machine vision, image processing, machine learning and artificial intelligence could be combined to develop and train a fuzzy-logic neuro-network to identify pathological high-risk skin condition. Such a system could be embedded in an intelligent device, creating an easy to use and inexpensive dermatoscope that could be sent home with patients to assist them in tracking their own skin conditions. This software could also be integrated into and distributed in the form of an app for a computer, tablet or smartphone.

Methods/Materials
Developed a C++ program using the OpenCV library to capture and isolate images of skin lesions. Created numerical methods to extract and quantify visual features, including brightness, contrast, symmetry, concavity and color variability. Collected a library of sample images, and implemented a simple fuzzy-logic neuro-network simulation function, which analyzes the measured features to assess the risk of malignancy. I applied this function as a fitness test to implement a genetic learning algorithm, which tested and adjusted the weighting parameters applied to each feature. I tested, adjusted, optimized and repeatedly re-tested these algorithms.

Results
I tested the genetic training algorithm many times. Even after a series of 950 generations, the success rate never surpassed 89% Adding images to the training set produced a consistently higher success rate of 92%, but changing the internal transfer/fitness function to expand the sensitivity of some variables and then tightening the cutoff criteria for determining fitness, produced a very significant improvement, consistently achieving 100% accuracy rates within the known sample set.

Conclusions/Discussion
The results support the hypothesis. The evolutionary genetic learning process quickly and effectively adapts its weights and parameters to achieve a very high sensitivity and specificity in the recognition and classification of skin cancer lesions. Given a broader sample set or a wider range of analyzed visual features the effectiveness and efficiency might further improve. These algorithms could be embedded into a variety of real-time micro-controllers and mobile devices.

Summary Statement
Computer vision, image analysis, feature extraction and a genetic machine learning process can evolve and determine an effective set of weights and parameters for a fuzzy-logic neuro-network to recognize and evaluate skin cancer.

Help Received
I#d like to thank Harry Evry for introducing me to OpenCV and for suggesting I learn about fuzzy-logic and natural computing. Thanks also to Dr. Malhotra for helping edit, organize and improve my research report and project documentation.