CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

S1402

Project Title

Aegis: A Biosensor for Hydration Status

Abstract

Objectives/Goals

75 percent of Americans are dehydrated, leading to an influx of general health problems, such as obesity and heart disease. The reason for this is the unavailability of low-cost, user friendly hydration measurement systems. The purpose of this engineering study is to develop a biosensor for hydration that uses salivary osmolality as a biomarker, is available via smartphone, provides near real-time measurements, and exhibits at least 80 percent accuracy.

Methods/Materials

After some preliminary observations, a multidisciplinary approach was taken that combined biological theory with image processing and machine-learning techniques to create the sensor. 112 samples of saliva were collected from different individuals at different times of the day over 2 weeks. The optimal position for performing tests was determined and a case was printed to make tests rigorous for the user. Features were extracted from each vector and the Random Forest model was iterated five different times to reduce noise, and each engineered with a separate set of features. After feature selection and training the model and the system were evaluated in three different ways: OOB Error, 2-fold Cross Validation, and Cohen's Kappa (to eliminate randomness).

Results

The final model exhibited a cross validation accuracy of 87.5% and a Cohen's Kappa of 80%. It considered the average luminance of the ambient room compared to the luminance of an image of saliva, as well as the subjects's BMR. The other four iterations were substantially less accurate due to the amount of noise from external features. The final algorithm takes less than 90 seconds of processing time and requires only 4 images and basic user data.

Conclusions/Discussion

Firstly, the project verifies the usability of salivary osmolality to correspond with hydration with a larger sample set than current literature. More importantly, this technology has major implications in the field of personal healthcare, revolutionizing the ability to track a vital characteristic of health without a professional analysis. With the ability to track hydration in real time, patients will be able to maintain their general health more conveniently. An iOS application has been developed using the algorithm is accessible to everyone who owns a smartphone.

Summary Statement

This project engineered a point of care, iOS application-based biosensor with the ability to categorize an individual's hydration using personal data and images of saliva, making non-diagnostic hydration testing more accessible for patients

Help Received

None. I designed, built, and performed the experiments myself. I designed and programmed the algorithm myself after an internet search on techniques. I was simply supervised in the laboratory.