

A Novel Optical Diagnostic Method for Non-Invasive Detection of Blood Glucose Using Reverse Iontophoresis Modulation and Personalized Neural Networks

Ahluwalia, Rohan (School: Westview High School)

Diabetes is a chronic condition that requires constant monitoring of blood glucose and external administration of insulin. People with diabetes monitor their blood glucose by an invasive method of point-stick finger measurements with blood draws which is painful, expensive and inconvenient. This is a big deterrent as diabetics avoid multiple checks per day leading to poor management of their diabetes. This can lead to devastating long-term complications of hypoglycemia which cause seizures and in severe cases death or hyperglycemia which leads to diabetic retinopathy, nephropathy, and neuropathy, and in severe cases amputations. The goal of this project was to develop a low-cost, portable near-infrared device that will detect blood glucose in a non-invasive manner. This device uses near-infrared light for detection of glucose concentration, reverse iontophoresis for glucose modulation, and neural networks for a personalized algorithm. Due to the NIR wavelengths, 940 nm, being absorbed by different compounds in the blood, the glucose modulation will increase the accuracy of the detection system. This system was developed and tested in multiple phases starting with glucose concentration in distilled water, then in tissue samples and finally in human testing. Based on this, an artificial neural network was created to accurately correlate light intensity with blood glucose. Based upon Clarke's error grid, the device was able to predict all glucose values within the clinically accurate range and had a RMSE of 23.3 mg/dL. In conclusion, the system is a novel non-invasive method of detecting blood glucose in people with diabetes, eliminating the pain, expense, and inconvenience associated with current glucose measurement techniques.

Awards Won:

Second Award of \$1,500

Serving Society Through Science: Second Award of \$500

SPIE, the international society for optics and photonics: Third Award of \$1,000