UR-510

Exploring the Impact of Wavelength in Spectroscopy-Based Blood Glucose Monitoring

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Introduction

Background:

Diabetes and metabolic diseases are some of the most crucial health issues of the 21st century. And monitoring blood glucose levels is the leading indicator of these diseases, making it crucial for healthcare. However, current measuring methods involve a constant process of drawing blood or using subcutaneous needles. This process is costly, often painful, and not patient-friendly.

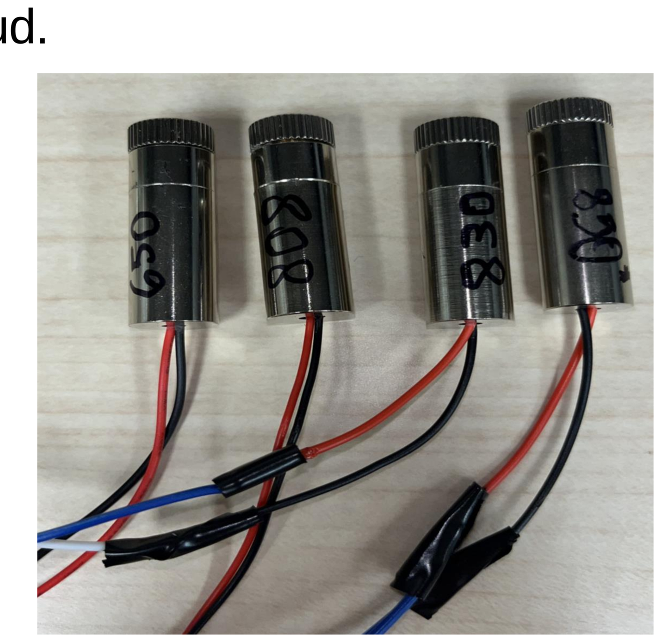
Scope:

An emerging solution is using spectroscopy, which involves the emission of light and capturing patient data with cameras. Having a device that can quickly measure blood glucose values while remaining reusable, cost-effective, and non-invasive is the next step in improving patient-care.

Project Description

One avenue we are exploring for spectroscopy is wavelength, which greatly affects the data collected and used by these devices. Different wavelengths interact with skin in varying ways. This study aims to investigate the impact of wavelength on performance of the team's non-invasive device across different races, genders, and ages of people. The tested model is to use our device with multiple lasers (ranging from 650nm-850nm), an HD camera, and a 3D-printed finger shroud.

Image shows the (From left to right) 650nm, 808nm, 830nm, & 850nm lasers.



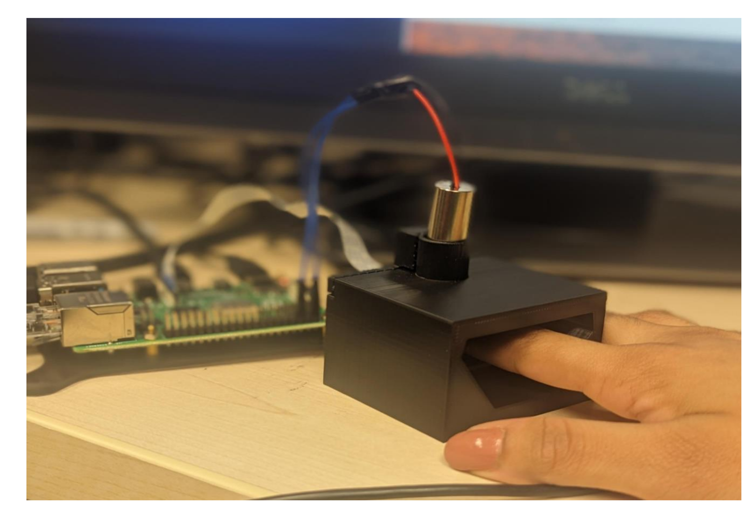
Method Analysis

Data Collection Process:

- First, the patient's blood is drawn from the left index finger, and glucose value is given via glucometer.
- The right index finger is inserted into the box, resting the tip or belly of the finger onto the camera.
- A laser (either 650, 808, 830, or 850) is inserted and the data collection program is started.
- After taking 50 photos per wavelength, the collection model calculates the glucose value based off the pictures.
- Within an excel file, the patient's actual glucose value, our model's value, race, skin color, age, and sex are recorded.

Data Collection Demographics:

- 25 participants with 30 sets collected
- Gender makeup: 11 Females & 14 Males
- Values ranged from 78mg/dl to 165mg/dl

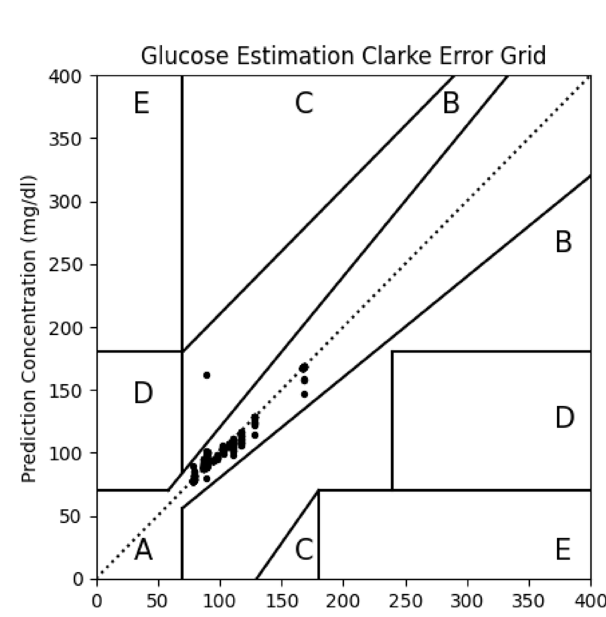


Data collection in progress using the 650nm laser.

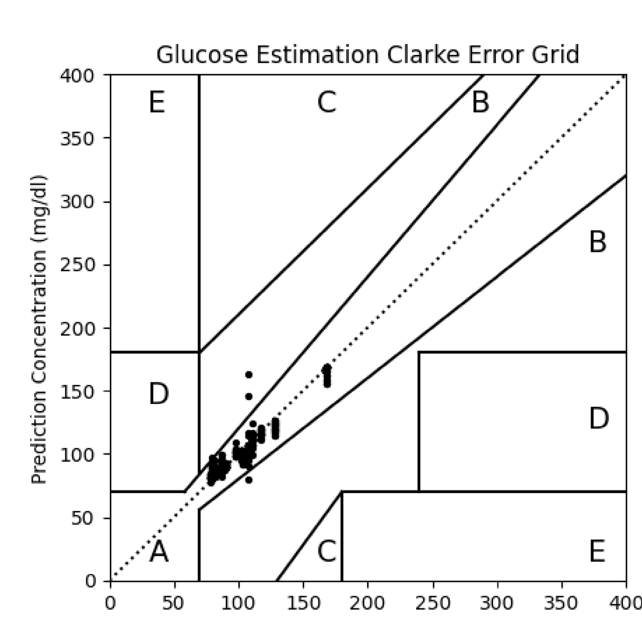
Results

The wavelengths' models are compared through their performance in regression with Mean Absolute Error and their clinical accuracy with the Clarke Error Grid. The MAE and CEG metrics found for each wavelength were: 2.31mg/dl and 99.72% clinically accurate for 650nm, 3.66mg/dl and 98.89% for the 808nm, 1.75mg/dl and 99.12% for the 830nm, and 2.05mg/dl and 98.89% for the 850nm. The standard deviation in the MAE is 0.84mg/dl and 0.39% for CEG. The correlations coefficient for MAE and wavelength is 0.33 and 0.12 for CEG and wavelength.

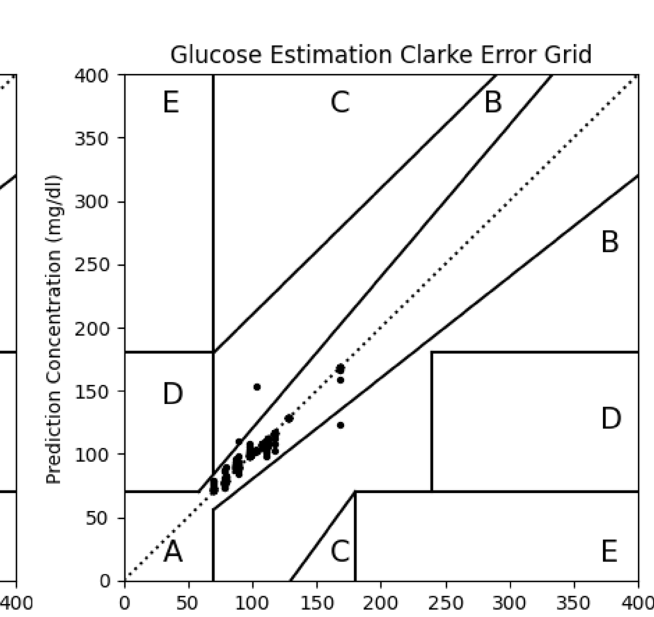
650nm



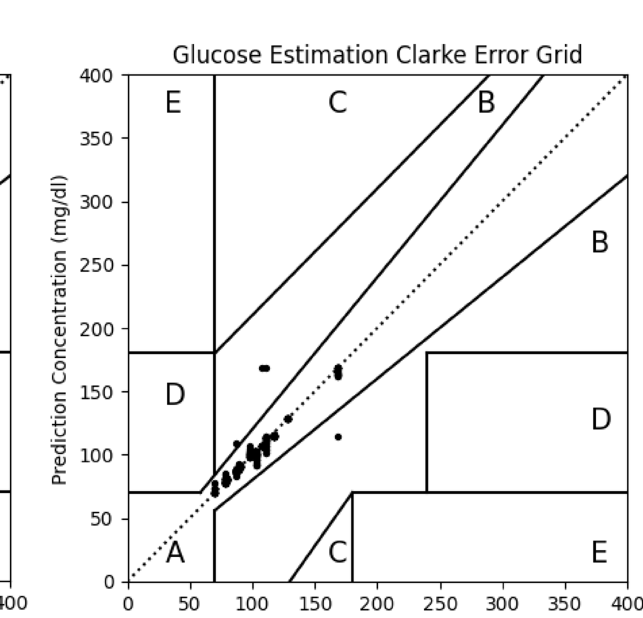
808nm



830nm



850nm



Research Question(s)

How does laser wavelength impact the performance of non-invasive glucose monitors?

Conclusion

From reviewing previous literature, we expected a negative relationship between wavelength and error. However, our results show a slightly weak but positive relationship between MAE and wavelength. Moreover, they show a positive relationship with CEG, but it is much weaker than that with the MAE. Furthermore, the variability in error and accuracy is low. Due to the variability and contradictory correlations in our results, we can draw no concrete conclusion on the relationship between wavelength and accuracy. However, in a future study, we still wish to investigate this issue and explore the impact of an even larger range of wavelengths on the performance of our device. The range used in this study, 650nm-850nm, is not a large enough wavelength range to make clear conclusions.

Acknowledgments

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