

Title:

Comparative Analysis of Near-Infrared Light Absorption in Glucose and Simulated Blood Component Solutions with and without Ultrasound Enhancement

Abstract:

Diabetes is a major global health issue, with approximately 537 million adults affected in 2021—a figure projected to reach 783 million by 2045. Early diagnosis and continuous monitoring are essential for effective management. However, current tools such as glucometers and sensor patches are either invasive or minimally invasive, causing discomfort, especially in children and the elderly. Recent advances in non-invasive monitoring using near-infrared (NIR) light show promise, but challenges remain, including interference from ambient light, water absorption, and reducing substances. Studies suggest that integrating ultrasound with NIR can improve measurement contrast and sensitivity. This study aims to enhance the correlation between glucose concentration and NIR absorption by incorporating 1 MHz ultrasound. A NIR transmitter and silicon photodiode circuit were developed, and measurements were conducted on glucose solutions (0–300 mg/dL) with and without 30 mg/dL ascorbic acid to evaluate selectivity. Results showed that ultrasound improved sensitivity from $72.24 \mu\text{V}/\text{mg}\cdot\text{dL}^{-1}$ to $77.56 \mu\text{V}/\text{mg}\cdot\text{dL}^{-1}$ in glucose-only samples and from $105.6 \mu\text{V}/\text{mg}\cdot\text{dL}^{-1}$ to $126.3 \mu\text{V}/\text{mg}\cdot\text{dL}^{-1}$ in glucose + acid samples, corresponding to 7.4% and 19.6% improvements, respectively. Linearity (R^2) also improved, especially in glucose + acid samples (from 0.7859 to 0.9634), indicating higher measurement reliability. Selectivity remained consistently high across all concentrations (>98%), with minor variations, confirming the system's ability to distinguish glucose from interfering substances. In conclusion, the NIR prototype integrated with ultrasound demonstrated improved sensitivity, stronger linear correlation, and high selectivity, supporting its potential as a non-invasive glucose monitoring solution.

Author:

Puteri Eyriena Maysara Binti Yazit

Corresponding author:

Dr Muhamad Amin Bin Abd Wahab

Co-author:

Dr. Mohamad Ikhwan Bin Jamaludin

Dr. Mohamad Ikhwan Bin Kori

Dr. Muhammad Faiz Bin Md Shakhiah

Prof. Madya Ir. Dr. Azli Bin Yahya

Prof. Madya Ir. Ts. Dr. Nasrul Humaimi Bin Mahmood

Track:

Electronic, Optical, and Magnetic Properties