Measuring Blood Glucose Without Finger Stick: NIR Spectroscopy

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Optimal management of diabetes requires frequent blood glucose testing that necessitates phlebotomy or finger stick with a lancet, a painful procedure that reduces patient compliance. This creates a need for the development of non-invasive glucose monitors. My engineering goal was to design a proof-of-concept instrument to measure glucose concentration in a solution of saline and gelatin (a stand-in for biological tissue with Na and Protein) using NIR spectroscopy. Glucose has an absorption band in the Near-Infra-Red(NIR) region around 940 nm that is not absorbed to a significant extent by other components of tissue. Using low-cost electronic components, I built a NIR spectroscope utilizing this absorption band to find glucose concentration by the Beer-Lambert Law. Then, I used test glucose solutions to create a calibration curve, correlating the transmittance counts from the machine to their respective known glucose concentrations using a linear regression model, and coded this into the processor using embedded C. Next, I tested samples and compared the instrument's output to both the actual concentration and the concentration as measured by a commercial glucometer (Bayer's Contour-Next). The Mean-Absolute-Error of my device compared to the actual concentration was 2.08 mg/dL, and the Root-Mean-Square-Error was 2.76 mg/dL, whereas those for commercial glucometer were 5.83mg/dL and 7.70 mg/dL, indicating the higher accuracy of my instrument. My next steps entail modifying this device into a pulse-oximeter-like device, and because tissues are virtually transparent to NIR, we will similarly be able to measure blood glucose in-vivo by replacing the sample in the test tube with a well-vascularised tissue like the finger, thus revolutionizing diabetes management.