Micro-Q: A Low-Cost, Portable, IoT-Based Fluorometer

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In biotechnology, fluorescence is a commonly used optical reporter for signaling the presence of specific substances. However, the use of fluorescence is limited by the high cost of traditional fluorometers ($10,000+), making them inaccessible to many researchers. To address this, we have developed Micro-Q, a low-cost and portable fluorometer that costs less than $20 to build yet maintains high accuracy. Micro-Q utilizes a 405nm laser to excite fluorescence samples in a PCR tube, and a photoresistor and emission filter to sense light intensity. An ESP-32 microcontroller in Micro-Q transmits the raw light intensity values to a Google Firestore database. On the cloud, these signals are processed through a series of regression algorithms. The processed value is then accessed from a mobile application, allowing for convenient, real-time analysis and display of results. To test the accuracy of our device, we measured the fluorescence of multiple concentrations of fluorescein. Through our algorithm, which we designed and tweaked over several months, we developed a relationship to model the output from the photoresistor to a Relative Fluorescence Unit (RFU) value. Our data yields a 98.058% accuracy when compared to a commercial plate reader, with statistically significant results. In addition, Micro-Q was tested with BL21 and DH5-alpha strains of E. coli biosensors which produce green fluorescent protein (GFP). When compared to a commercial plate reader, Micro-Q outputted similar fluorescence values, indicating that Micro-Q is able to quantify fluorescence with high accuracy yet at an affordable price. With these findings, we hope to increase participation in research, and promote biotechnology and fluorescence education in more classrooms worldwide.

Awards Won:
Fourth Award of $500