Screening for Multiple Gastrointestinal Cancers With CanDELA: Low-Cost, Automated Gastrointestinal Cancer Detection Utilizing Magnetic Bead miRNA Extraction, Peristaltic Pump-Based Liquid Handling, miRNA Amplification and Fluorescence Spectroscopy With Support Vector Networks

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Annually, Gastrointestinal (GI) cancer affects 4.8 million people worldwide, and has 5-year survival rates as low as 8%. However, the survival rate increases to 70% if GI cancers are detected in their early stages prior to metastasis. Modern diagnostic measures for GI cancer, such as Endoscopy Ultrasound, CT Scans, MRI, and biopsies have not significantly improved in accuracy for 60 years and are invasive and expensive, making them unjustifiable for seemingly moderate symptoms like itchy skin. This project aims to improve early GI cancer detection through the analysis of serum miRNAs with a custom built, automated, end-to-end system: CanDELA. CanDELA uses a magnetic bead based miRNA extraction apparatus to extract miRNAs from patient whole blood samples, and an automated peristaltic pump based liquid handling robot to synthesize an appropriate solution for cDNA synthesis. The solution is then passed into CanDELA's rt-qPCR device that uses a custom low-cost thermal cycling system and novel-optical design to compute cT values from emitted fluorescence in the sample. A user interface is used to view live results and enable easy usage, diagnostics, and customization. CanDELA simultaneously analyzes a panel of 12 miRNAs and passes their concentrations into an SVM machine learning algorithm to classify patients with healthy, pancreatic, colorectal, and hepatic cancers with 100% Sensitivity, 94% Specificity, 96% Accuracy, and 0.98 AUC; results are available within three hours upon sample insertion. In a comparison with lab-grade qPCR devices for 64 samples, CanDELA yielded near-identical results. At a cost of $300, CanDELA has the potential to revolutionize GI cancer diagnostics by serving as a blood-based standard of care to reference high-risk patients for further testing.

Awards Won:
First Award of $5,000
Robert Horvitz Prize for Fundamental Research