Internal Mobilization of *in vivo* Glucose Sensing System

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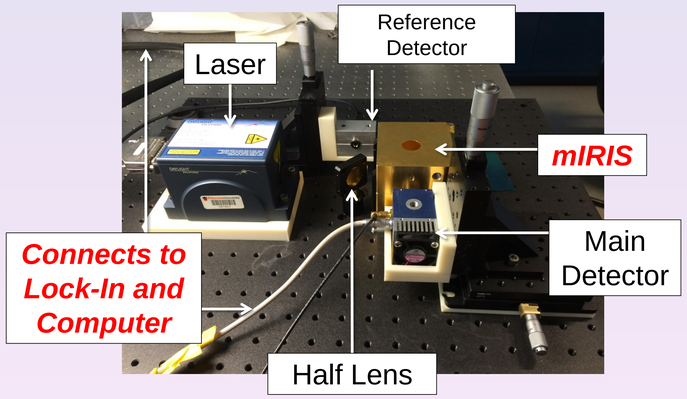
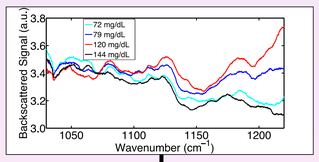
Introduction

- Nearly 10% of the US population is forced to monitor their blood glucose
- Current method is to painfully finger prick several times a day
- Goal is to provide an alternative non-invasive laser device and make it mobile
- Future goal is to reduce system to the size of a smartphone

System Setup





- Current procedure: laser enters mIRIS, bounces off hand on top hole, and reflects outward against main detector
- Calculation takes ~3 min
- Main detector reads in Glucose Absorption Spectra (see figure to left)

Outlier Removal

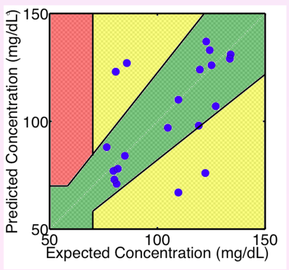
6) Cross-Correlate with Standard

5) Savitzky-Golay Filtering

4) Take First Derivative

3) PLSR

- Following statistical analyses on data (listed left) to produce glucose level reading (below)

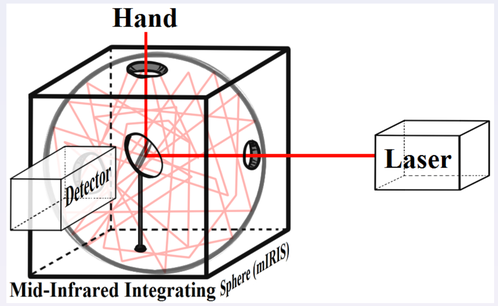


Mid-Infrared Integrating Sphere (mIRIS)

Current size:
Cube: 3.27” x 3.27” x 3.25”
Sphere: 3” diameter
Holes: 2.0 cm diameter

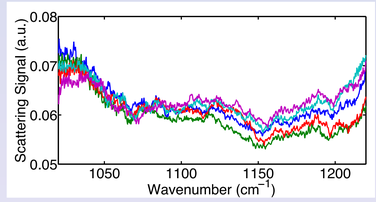
Device Aperture Sizes:
Hand: 1.0mm diameter
Laser: 1.2mm diameter
Detector: 0.50mm x 0.50mm

New Prospective Size:
Cube: 8.3mm^3
Sphere: 7.6mm diameter
Holes: 2.0mm diameter

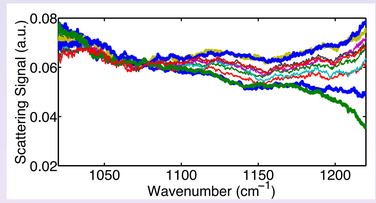


- Laser gets absorbed into hand and reflects back into the sphere where it bounces around until the detector reads absorption spectra.
- The holes in the provided mIRIS are bigger than needed
- The larger top hole interferes with the reading since some of the laser gets reabsorbed by the hand rather than bounce against the walls
- By reducing the size of the sphere until the holes are the minimum size they can be, the sphere will become 10% of its original size.

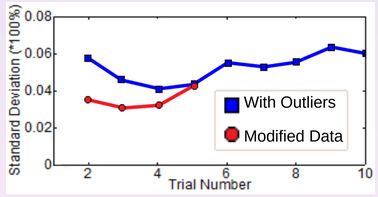
Outlier Removal Algorithm



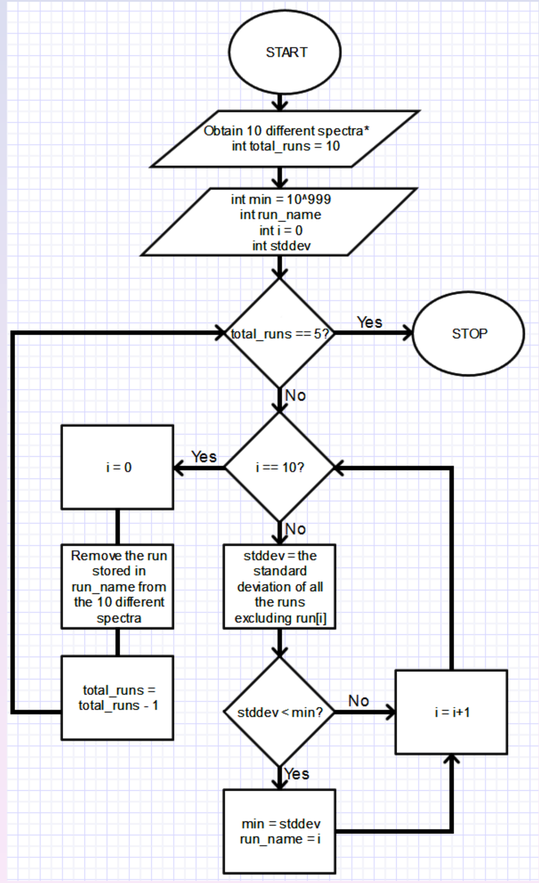
- Original 10 spectra of glucose scans with outliers (bold) before algorithm



- Depiction of 5 most consistent spectra after algorithm

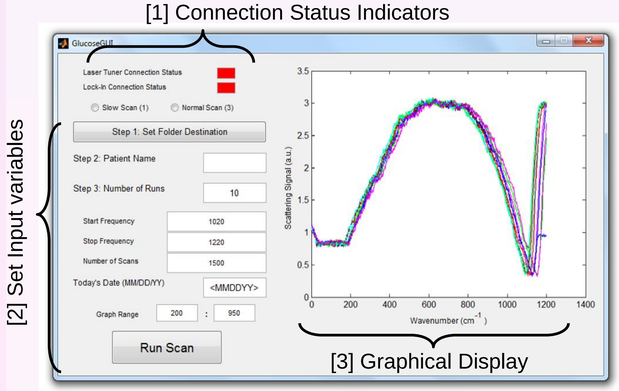


- Standard deviations of the data per each trial with and without outliers



Flowchart for the new shifting algorithm that removes outliers by leaving only the five most consistent spectra are left in order to make the average std. dev. decrease from 0.060 to 0.032, a 47% increase in accuracy

Graphical User Interface (GUI)



[1] ➢ The red dialog boxes change to green once the GUI detects that they are connected via USB

[2] ➢ Top radio buttons determine whether reference scan or normal scans are being recorded

➢ Edit buttons allow for easy manipulation of data ranges and iterations

[3] ➢ Current display depicts raw graphical output prior to cropping and statistical analyses

Future Work

- ❑ Incorporate statistical analyses into GUI algorithm
- ❑ Produce a physical version of the modified IRIS
- ❑ Reduce the sizes of the laser and detectors along with the mIRIS

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