# MULTISENSORY TISSUE CLASSIFICATION USING "SMART" GRASPER ROBOT 2.0

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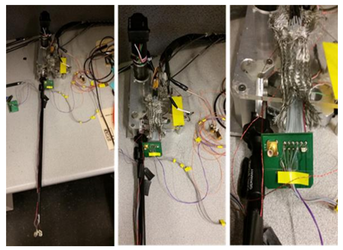
GLOBAL INNOVATION EXCHANGE

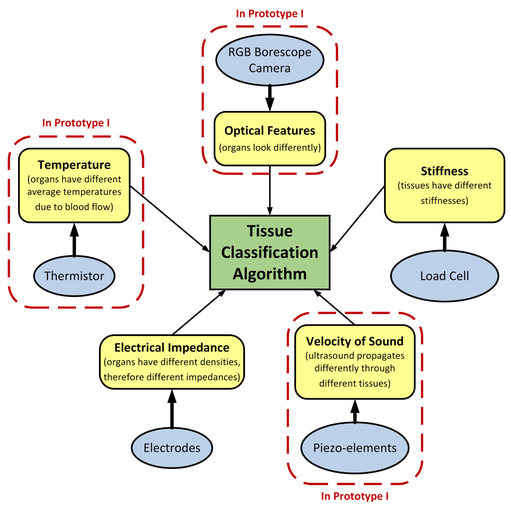
## Introduction

- The main objective of this work is to re-design existing motorized surgical robot "Smart" Grasper to perform tissue classification based on multi-sensory fusion approach.
- Original "Smart" Grasper was developed by Philip R. Roan, and had optical, electrical impedance and temperature sensors on the grasper's jaws. [1]
- However, over the time of traveling and storage, wiring of the sensors was damaged and data acquisition became impossible.



Original "Smart" Grasper design developed by Philip R. Roan. A lot of wires were broken and sensors were shorted due to transportation and storage of the "Smart" Grasper robot.

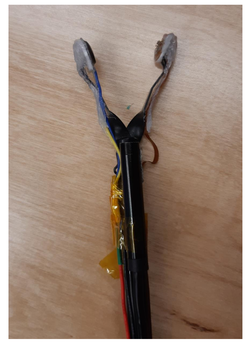
## Sensor Fusion Diagram



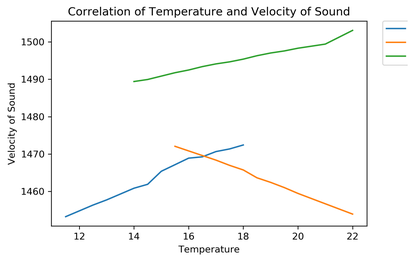

- Sensor Fusion Algorithm (SVM based) for tissue classification via "Smart" Grasper is based on the correlation of sensory measurements with physical, acoustical, optical, electrical and thermal properties of tissue.

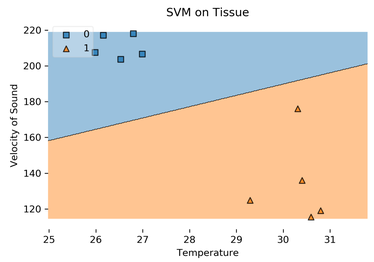
## Prototype I : Manual Surgical Grasper

- The sensor set (ultrasonic transducer, thermistor and RGB borescope camera) was set up on the manual surgical grasper in order to collect the data from tissue.



## Ultrasonic Preliminary Results

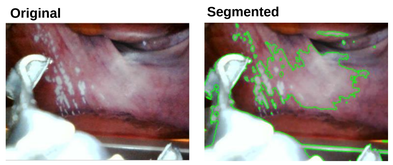



- The left plot shows the correlation between temperature and the ultrasonic Time of Flight, and its non-linear behavior for different liquid mediums (water, oil and soap).
- The Velocity of Sound on right plot is likely off, due to signal processing error. A clear difference between tissue (finger and muscle) is still observed, which supports the hypothesis that the ultrasound time of flight is a predictive parameter for tissue classification.

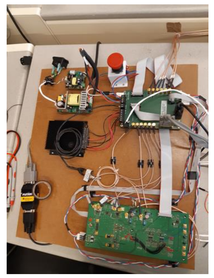
## Computer Vision Preprocessing

- Segment surgical grasper from its background:
- Added filters to reduce noise, increase contrast, and sharpen the image.
- Translated to binary and added contours to perform image segmentation.

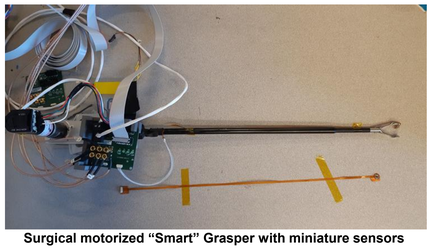



## Prototype II : Motorized Surgical Grasper

- The motorized surgical grasper based on original "Smart" Grasper will be used as final design of the project. It will include the following sensors: load cell, ultrasonic transducer, RGB borescope camera, pulse-oximetry, thermistor and bioimpedance.



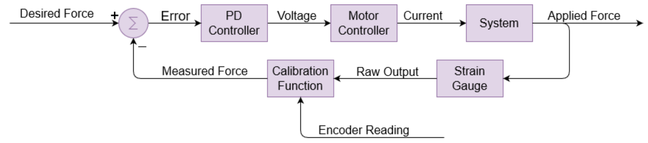
Data acquisition electronics



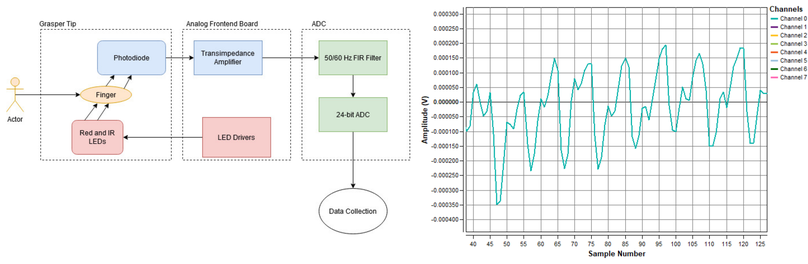
Surgical motorized "Smart" Grasper with miniature sensors

Miniature sensor set

## Force-Control Diagram




## Pulse-Oxymetry Circuit Development




## Future Work. References.

- Collect data using manual grasper from organs: liver, kidneys, bones, and muscle.
- Process the data with pre-processing and classifier machine learning algorithms.
- Finish development of Prototype II: Motorized "Smart" Grasper.

1.Philip R. Roan, "An instrumented Surgical Tool for Local Ischemia Detection," Ph.D. Thesis, University of Washington, 2011.
2.Astrini Sie, "Online Identification of Abdominal Tissues During Grasping Using an Instrumented Laparoscopic Grasper", M.S. Thesis, University of Minnesota, 2013.
3. M. Daoud et al, "Tissue Classification Using Ultrasonic-Induced Variations in Acoustic Backscattering Features", IEEE transactions " Biomedical Engineering, February 2013.

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