

**TISSUE CHARACTERIZATION WITH SMART GRASPER ROBOT**

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**Introduction**

- Minimally-Invasive Surgeries (MIS) has advantages for patients (faster recovery time, less blood loss, less trauma to tissue), however MIS also has a disadvantage - lacking tactile feedback for the surgeons. Multi-sensory laparoscopic grasper can help with this problem.

- Original “Smart” Grasper was developed by Philip R. Roan, and had optical, electrical impedance and temperature sensors on the grasper’s jaws. (1)

- Modified by Astrini Sie in work (2).

- Multi-modal surgical instrument has the following advantages:
  - Providing real-time feedback to surgeons in MIS;
  - Modeling the tissue for surgical robotics simulators;
  - The study of tissue behavior in response to surgical manipulators;
  - In vivo and in-vitro tissue classification;
  - The diagnosis of tissue abnormalities in early stages;

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**Hardware Prototype: Motorized Surgical Grasper**

- The developed motorized surgical grasper based on original “Smart” Grasper has miniaturized sensors set: load cell, 3MHz ultrasonic transducer, RGB borescope camera, pulse-oximetry, thermistor and multi-frequency 2-point bioimpedance.

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**Sensor Fusion Algorithm (DL based) for tissue characterization via “Smart” Grasper is based on the correlation of sensory measurements with physical, acoustical, optical, electrical and thermal properties of tissue.**

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**Future Work. References.**

- Integrate all subsystems together;
- Collect data using Smart Grasper from organs: liver, kidneys, muscle, soft tissue;
- Process the data with pre-processing and deep learning algorithms to characterize the tissue.

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**Electrical Impedance Calibration**

- Average Impedance through Frequency Sweep
- Average Phase through Frequency Sweep

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**Pulse-Oximetry**

- *Part of the work is presented at SWR-21 Conference (4)*

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**Ultrasound Sensor Calibration & Artifact Removal**

- Noise Artifact Removal Methods
  - Bandpass Filter
  - Adaptive LMS Filter
  - Spectrum Suppression
  - DES
  - LSTM
  - IIR

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**Electrical Impedance Calibration**

- Average Impedance through Frequency Sweep
- Average Phase through Frequency Sweep

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**Future Work. References.**