Low Cost Near-Infrared (NIR) System for Parathyroid (PT) Visualization

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Problem

- The parathyroid gland is composed of four tiny glands located behind the thyroid gland.
- Incidental parathyroid (PT) damage during thyroidectomy occurs in 5.2-21.6% of cases [1].
- Postoperative vocal cord paresis is common after thyroid and parathyroid surgery as a result of exploratory dissection.
- Indocyanine green costs ~$77 per 25-mg vial and can induce toxic effects [2].

Figure 1. Poor visualization of parathyroid tissue in ambient light. Thyroid gland indicated by thick arrow. Parathyroid gland indicated by thin arrow [3].

Our project aims to develop a surgical tool for endocrine surgeons that enables for intraoperative visualization of parathyroid tissue to increase clinical outcomes and reduce the need for reoperative surgery.

Design Criteria

Live Surgical Imaging Tool	Design Requirement
Sensitive PT detection without tracer	100% detection
High PT/background ratio	>1.5
Reduce cost of PT visualization	<$5000
Safe for use above the airway	Max temp 43°C
Deep tissue penetration	~1.5 cm

Standards

ASTM F2560-06

ASTM E1770 - 04(2016)e1

Prototype

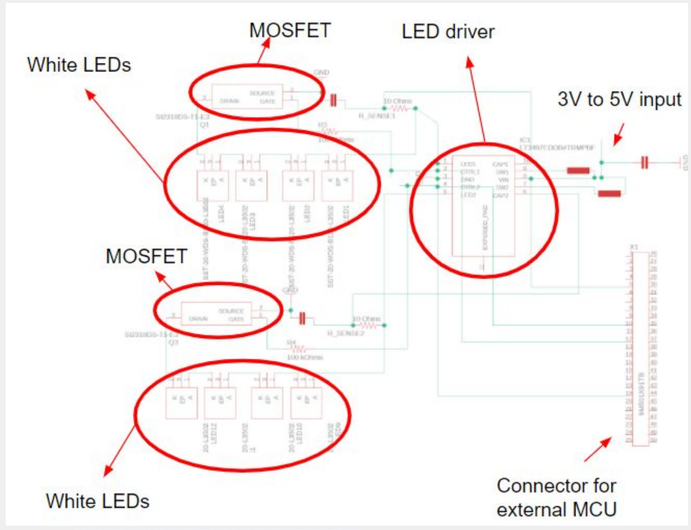

Figure 2. Printed circuit board (PCB) schematic of LED driver.

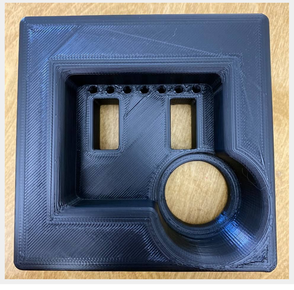

Figure 3. PCB holder with integrated slots for the excitation filter, visible LEDs, and air-cooling.

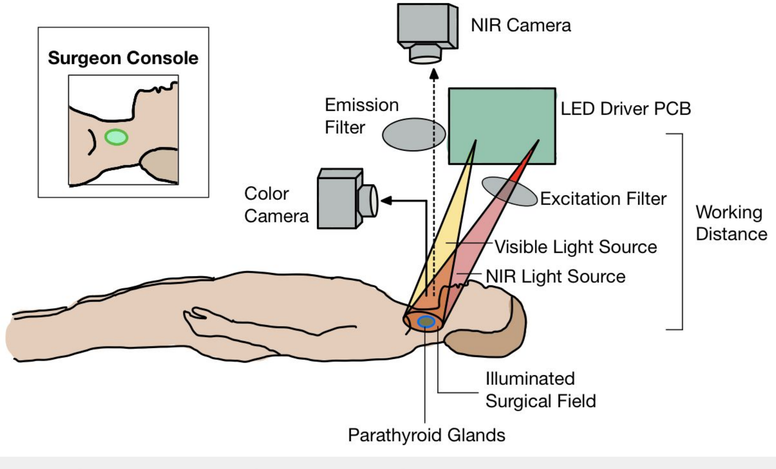

Figure 4. Surgical workflow with PCB illuminating parathyroid tissue.

Testing

- Power Transmission and Filter Validation — ***Phase I*** Laboratory Testing
- Temperature and Penetration; Parathyroid Fluorescence — ***Phase II*** Porcine Model Testing
- Surgical Workflow and Parathyroid Fluorescence — ***Phase III*** Human Testing

Future Directions

- **Device Characterization**
  - Measure power emission of LED and heat generation
  - Measure depth of tissue penetration
- **Animal Testing**
  - Signal excitation and measurement on porcine cadaver and live porcine models
- **Device Optimization**
  - Design smaller and more compact PCB
  - Optimize surgical illumination field
- **Additional Application** Test calcium levels based on the intensity of the signal

Acknowledgements

References