

# Magnetic Induction Wand Design for Novel Penile Prosthesis

## Engineering Science Capstone Design Project

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### Abstract

Uronext LLC designed a novel penile prosthesis made of the shape change alloy nitinol for men who suffer from erectile dysfunction. The optimal way to induce the shape change in the prosthesis is by applying heat through induction heating. Existing induction heaters are too heavy and too powerful to safely and effectively heat the Uronext implanted penile prosthesis. An induction heating wand was made to combat this issue and provide a more appropriate induction heating device. A test bench was designed to test the effectiveness of the wand on the prosthesis.

### Introduction

An induction heating wand sends an alternating current across a metal coil to create a changing electromagnetic field around the penile prosthesis. The field creates eddy currents in a metal prosthesis, causing only the metal to heat up, and the increase in temperature induces a shape change in the prosthesis. Normally, induction heating wands use intense amounts of power to heat metals until they are red-hot. To keep the temperature at an appropriate level, the induction heating wand described herein was designed. To determine the effectiveness of the design, a test bench was designed which utilizes LabVIEW to analyze and display collected data.

### Design Requirements

To fully complete this project, the following objectives must be completed:

#### 1. To redesign the induction heating system to

- decrease its size such to be portable
- make it battery powered
- take care of possible hazard issues such as skin contact and excessive power
- Implement a simple safety mechanism to avoid excessive heat.

#### 2. Create a test bed to test the induction heating system, that will

- Use thermocouples or other sensors to measure temperature changes
- Measure the prosthesis shape changes
- Measure induction heating effect for different angles and distances
- Measure induction heating effect for two magnetic field shapes

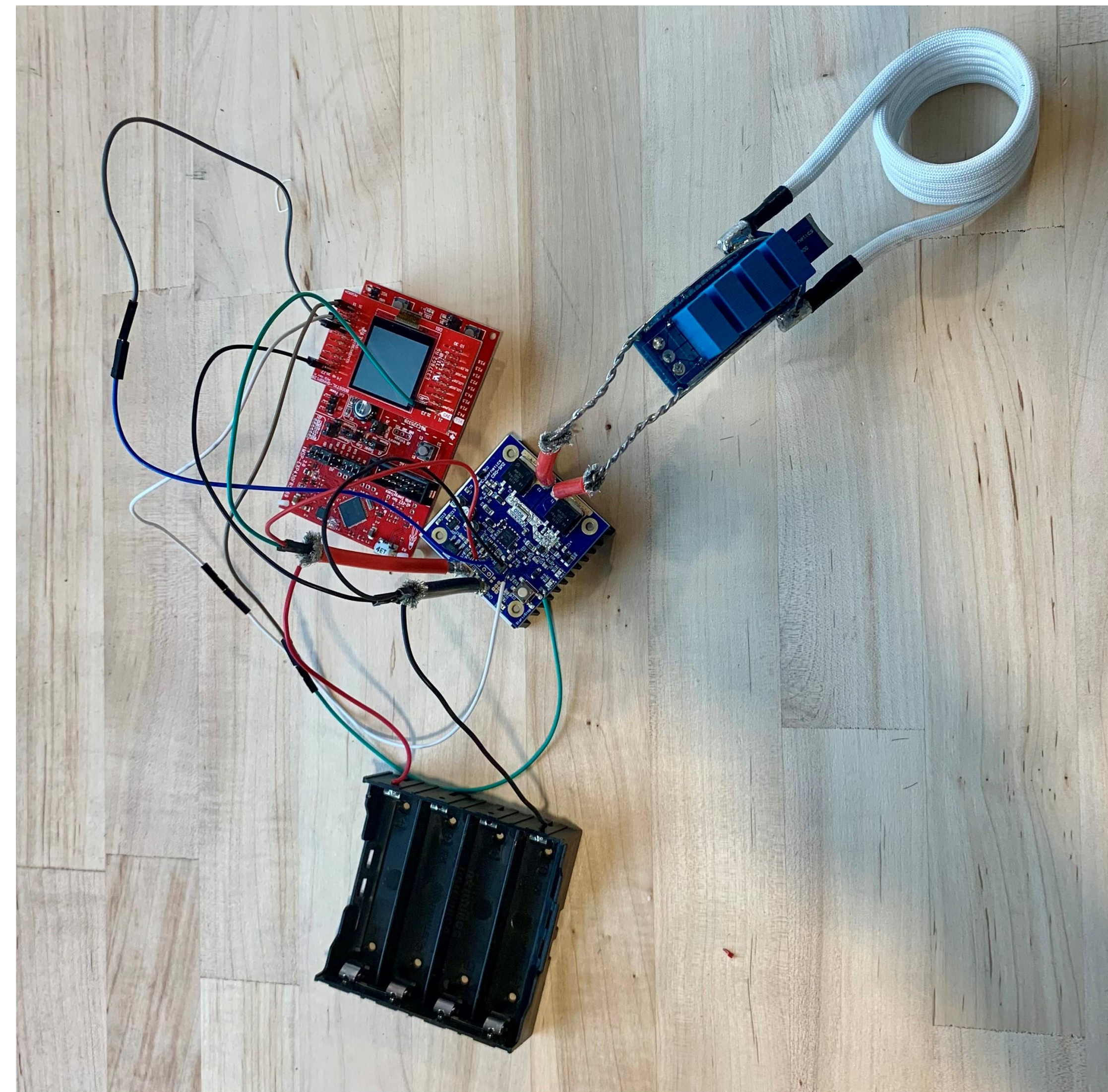


Figure 2. Induction Heating Wand

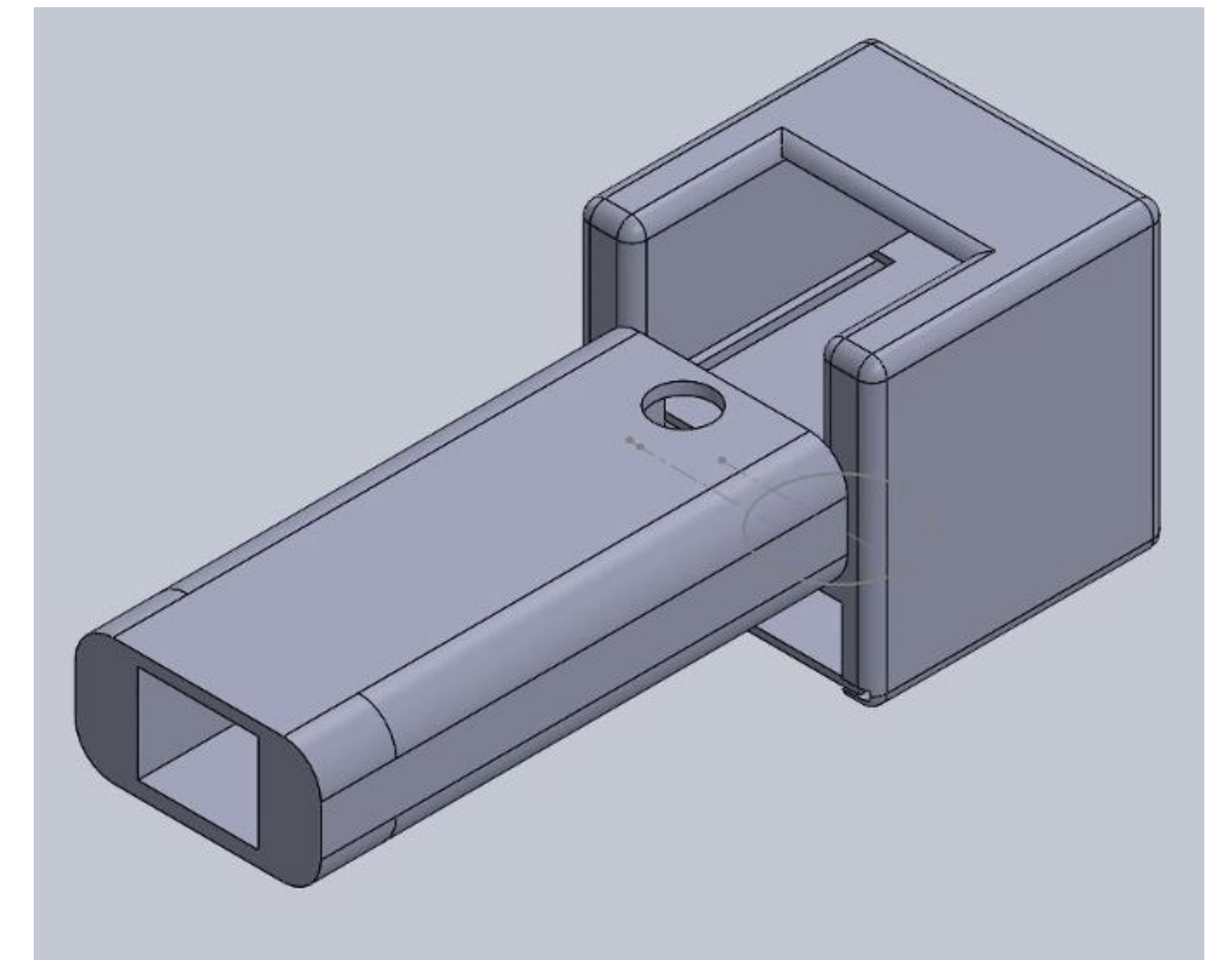


Figure 4. Induction Wand Case

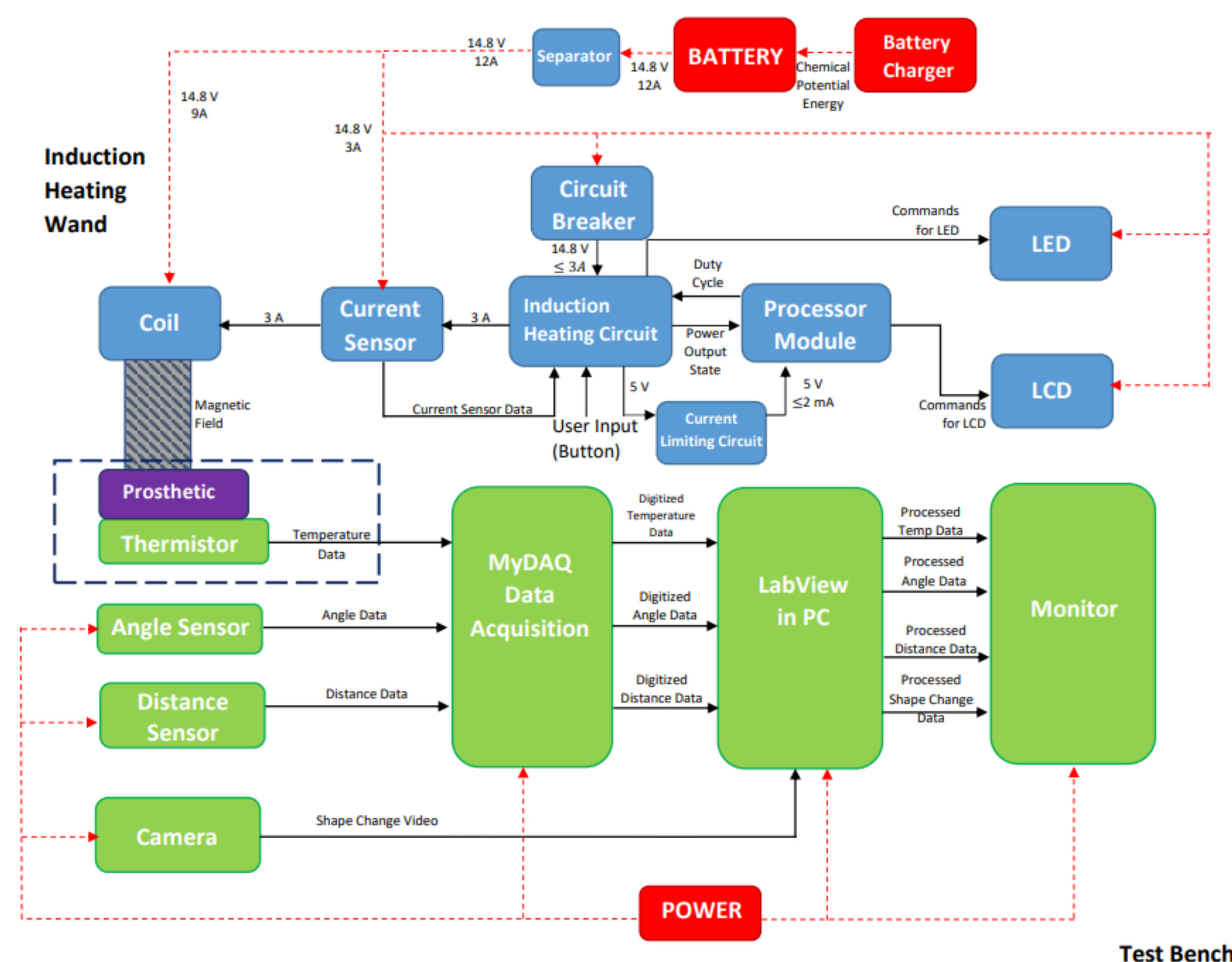


Figure 1. System Diagram

### Induction Heating Wand

The induction heating wand utilizes a ZVS Power Resonator circuit by RMCybernetics to create an alternating current across a custom induction coil. Two induction coil shapes were tested and implemented: a helical coil and a pancake coil. A TI MSP430 microcontroller controls the induction heating circuit as well as an LCD screen. The system is powered by 4 rechargeable lithium-ion batteries which make the system portable. Using SolidWorks, a 3D printed case was created to house the system in one portable, handheld unit.

### Test Bench

The testbench measures 4 aspects of the system: the distance between the coil and prosthesis, the angle between the coil and prosthesis, the temperature of the prosthesis, and the amount of shape change of the prosthesis. The testbench includes sensors for distance, angle, and temperature which are secured on lab stands to keep continuity between tests. The distance, angle, and temperature sensors all send collected data to NI MyDAQ which sends collected data to test software in LabVIEW where data is analyzed and stored. LabVIEW also collects video from a camera to determine the amount of shape change in the prosthesis.

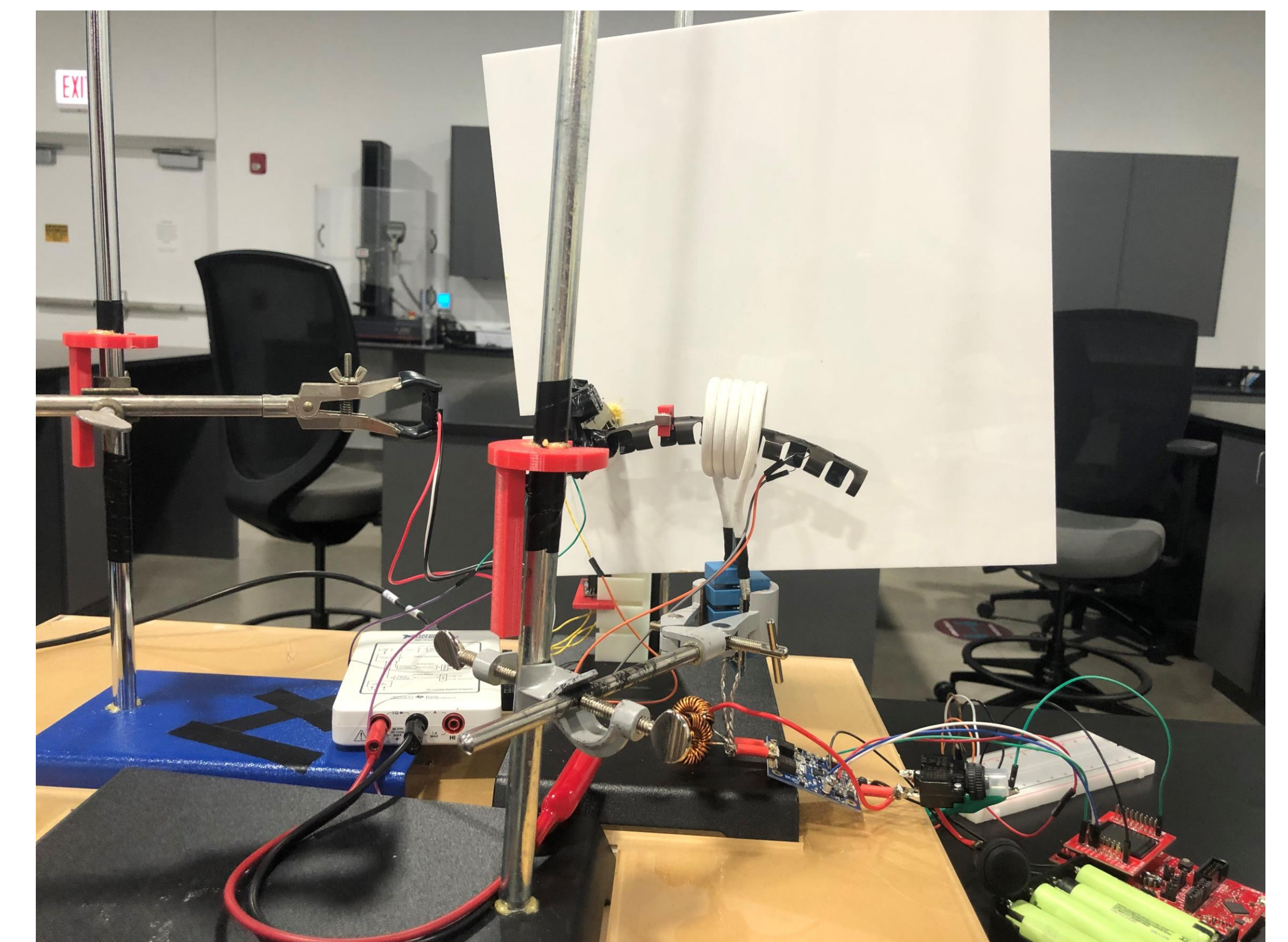


Figure 5. Test Bench

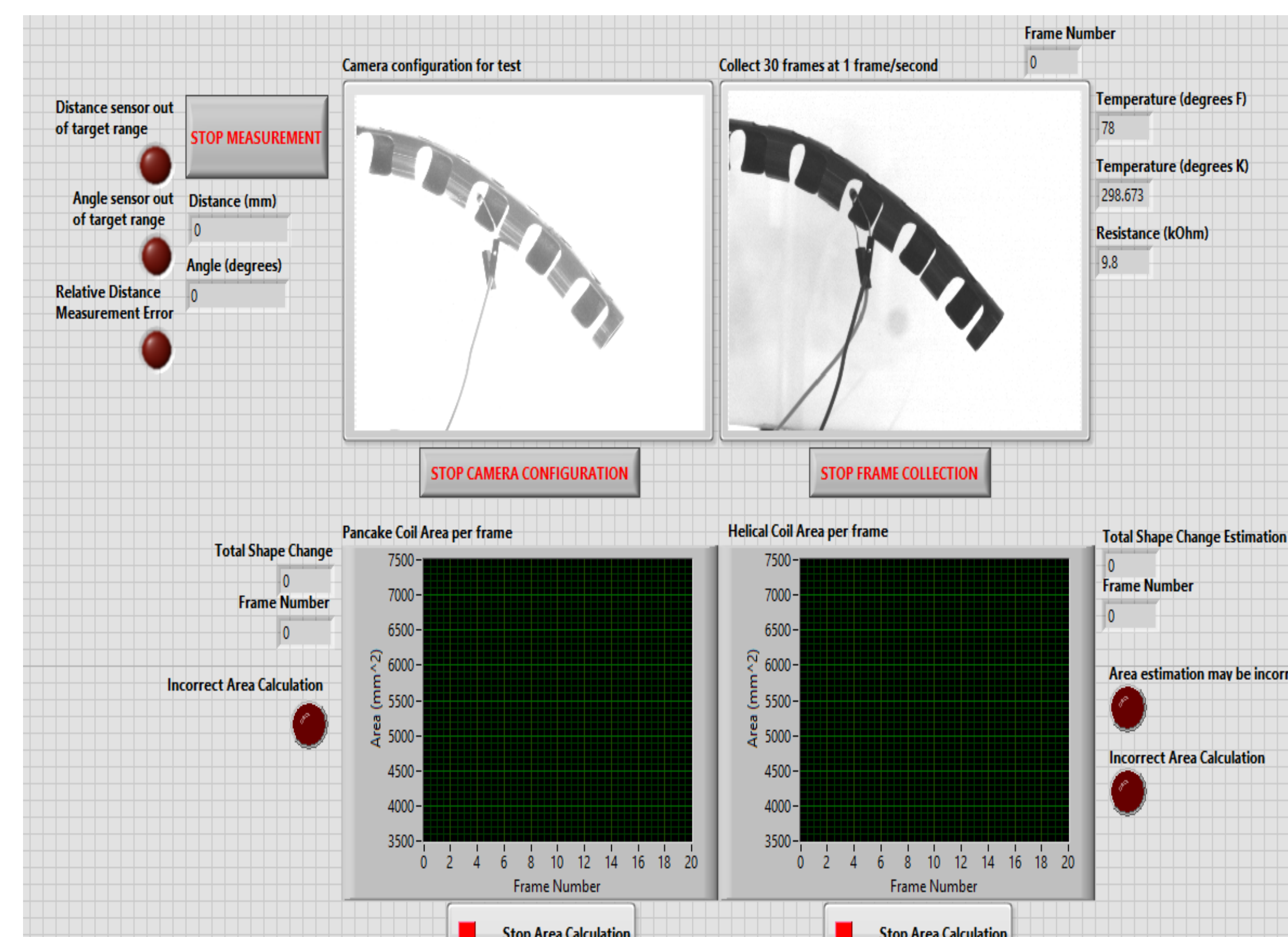


Figure 3. LabVIEW Front Panel

### Conclusion

Our induction heating wand and test bench designs have undergone a software Risk Analysis process to pinpoint and mitigate any software risks. We also have performed Design Verification Testing protocol on our distance sensor to ensure the precision of the measurements. To test our induction wand, we plan to utilize a 2k factorial design test to determine the optimal variation of our design.

### Acknowledgements

We would like to thank our Faculty Advisors, Dr. Gail Baura and Dr. Vincent Chen, in their guidance and support throughout this process. We would also like to thank our sponsors at Uronext LLC for providing us with an excellent opportunity to put our knowledge and skills to the test: Dr. Alberto Colombo, Dr. Brian Le, and Dr. Kevin McVary.