Rise4: Inductive Charging for Medication Adherence Tracking System

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December 3rd, 2020

Background

Background: Glaucoma

- Leading cause of irreversible blindness worldwide
- Poor adherence to medication regimen
- Standards for medication adherence
  - Smart pill containers
  - Wearable sensors
  - Ingestible sensors
- Smart eye dropper sleeve

Background: Previous Work (Mechanical)

- Inner “skeleton”
  - Harder plastic
  - Holds Reed switches (2) and PCB (4-6))
  - Allows for easier assembly
- Cap with 3 bar magnets (1) placed over bottle cap
- Cylinder with copper tape for fluid level detection (3) inside “skeleton”
- Silicone-like cover
  - Window for on/off switch

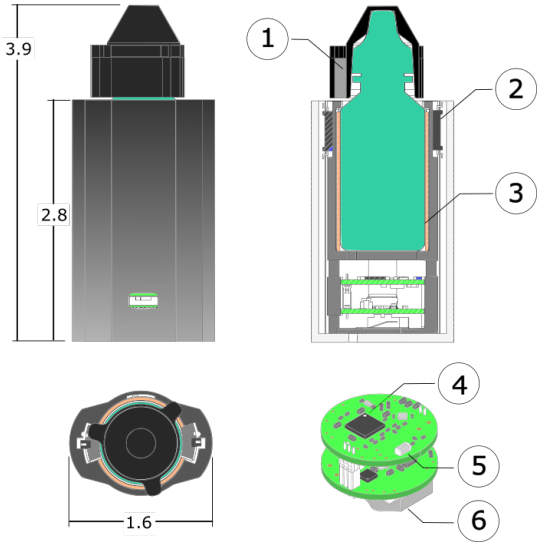


Figure 1: Eyedropper Sleeve Overview[3]

Background: Previous Work (Electrical)

- IMU/Capacitance-to-digital converter on board
- Locations to wire capacitance sensor/reed switches
- Bluetooth (BLE) module for connection
- On/off switch for testing
- Includes LEDs and microcontroller (MCU)

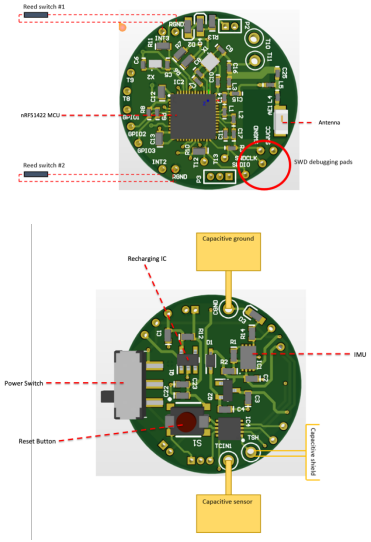


Figure 2: Eyedropper PCB Overview[3]

Background: Results

- System that could…
  - Identify 97% of use cases
  - Measure fluid level at a 0.4 mL resolution
  - Transmit data to healthcare provider
  - Operate for 7 hours unattended

Overview

Overview: Elaboration on Previous Work

- Increase ease of use by minimizing system complexity
  - Inductive charging
  - Enclosed sleeve design
  - Seamless charging base station design

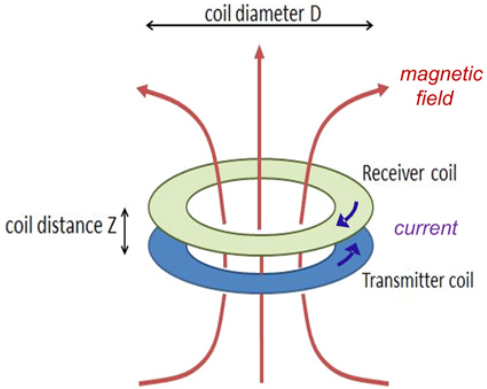
Overview: Project Objectives

- Electrical
  - Understand electrical characteristics of current system
  - Understand constraints of inductive charging
  - Design or find inductive charging unit
- Mechanical
  - Alter sleeve design to fit inductive charging
  - Design charging station for device

Approach

Approach: Inductive Charging

- Current running through lower coil generates magnetic field
- Magnetic field induces a current on receiver coil
- Considerations
  - Alignment
  - Proximity
  - Shielding



- *Current in primary coil (transmitter) generates magnetic field*
- *Magnetic field induces current in secondary coil (receiver)*
- *Received current is used to charge battery or power load device*

Figure 3: Open Loop Inductive Charging[4]

Approach: Inductive Charging

- TX power transformer
- RX communication
  - In Band
  - Out of Band

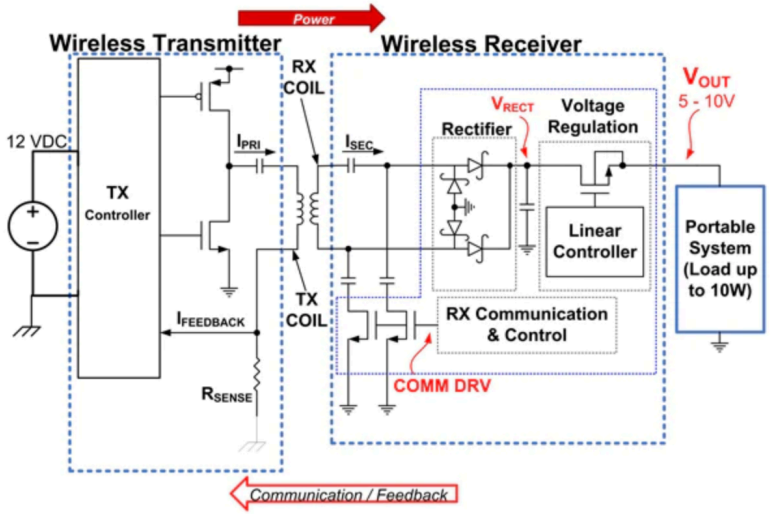


Figure 4: Smart Inductive Charging[4]

Approach: Electrical Analysis

- MCP73831 PMIC
  - 5V input
  - 510µA typical supply current
  - 14.5mA output current regulation
- Micro USB input
  - 5V output
  - Typically 1A output current

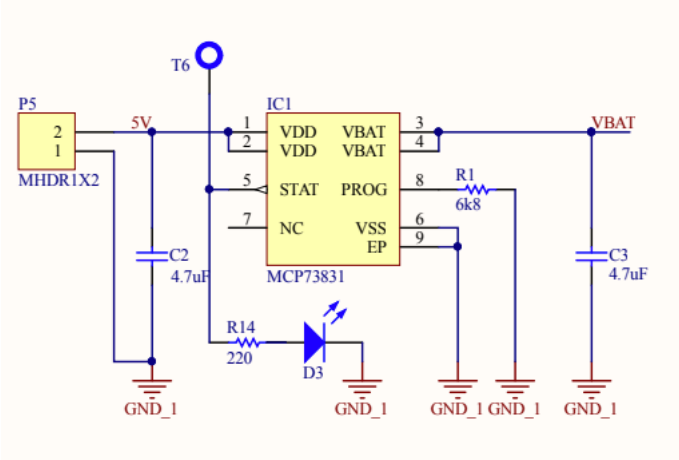


Figure 5: On Board Power Management IC

Approach: Charging Choice

- Off the shelf dev kit
  - 5V output
  - 300mA current
  - Mechanical design fits our needs
- Can be placed on updated PCBs

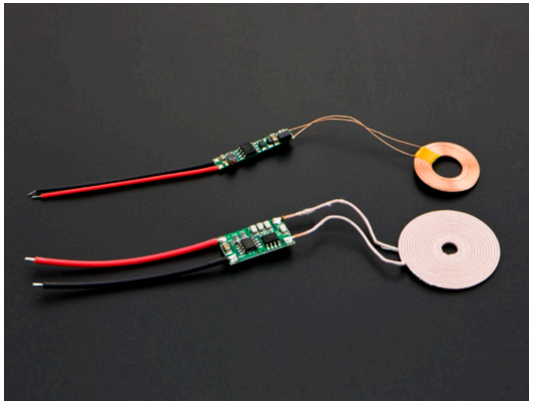


Figure 6: Smart Inductive Charging Dev Kit

Results

Results: Charging Characteristics

- Tested current through a 1KΩ resistor to compare characteristics

	Proximity (mm)	Voltage (V)	Current (mA)
USB	N/A	5.04	3.65
Inductive Charger	0	4.96	3.57
	2	4.96	3.50
	5	4.96	3.50
	10	3.85	2.65
	15	2.18	1.74
	>15	0.00	0.00

Results: Mechanical Design

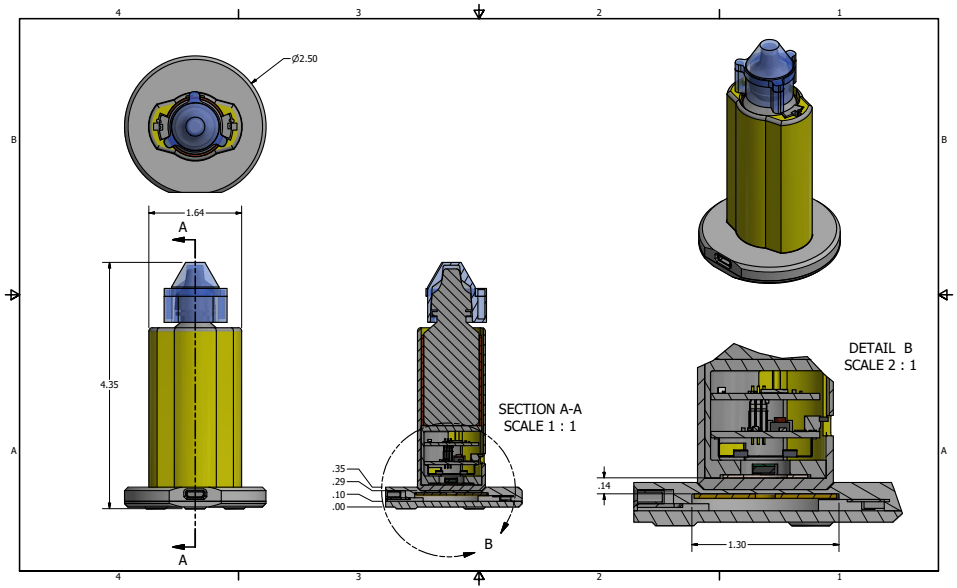


Figure 7: Revised Sleeve Design and Charging Base Station

Conclusion

Conclusion: Goals Met

- Electrical
  - Was able to match power needs with inductive charger
- Mechanical
  - Sleeve altered to hold inductive receiver
  - Charging base station designed to hold inductive transmitter

- Improvements to overall system can still be made

Conclusion: Next Steps

- Gather data on validity of device
  - Data generation
  - User experience
- Update PCB
  - Include inductive charging components
  - Less power intensive accelerometer
  - Ease of assembly

Thanks

- Dr. Shorter and Dr. Sample
- Nolan Payne, Rahul Gangwani, and Amani Alkayyali
- ESTAR Lab Members
- Barton Research Group Members
- RISE4

Questions?

References

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5. Tahar Allag, "Layout Guidelines for wireless power receiver," Application Report (SLUA710), June 2014.