



# Wireless Recharging System

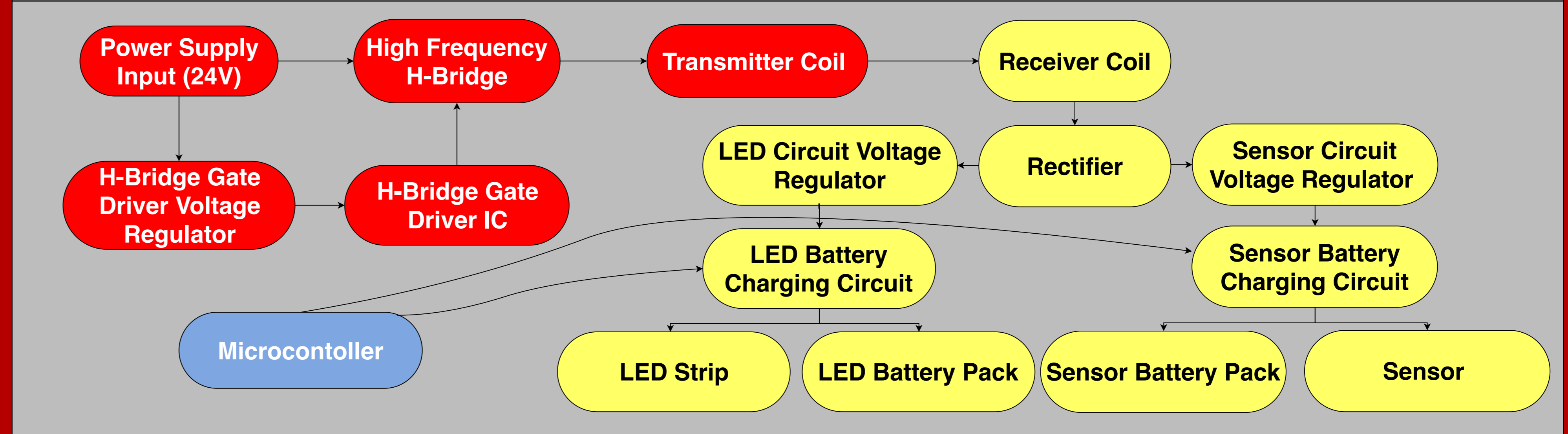
Miguel Hennemann | Benjamin Gisler | Doruk Er | Kyle Henricksen  
 Client: National Carwash Solutions  
 Advisors: Craig Rupp & Andrew Bolstad



## Project Summary

Problem Statement	Solution
Our client NCS, uses a battery to power a safety sensor. Replacing the batteries regularly creates waste and can be time-consuming. The sensor resides on a pivoting point of the washing arm that rotates. Wires can not be connected directly for powering the device due the consecutive rotation cycles of the arm. This powering problem applies to all devices located on the arm.	A wireless method of power transfer will be adopted due to the inability to use physical electrical cables. Resonating two coils via magnetic induction coupling will allow sufficient power to be transferred for all of the systems. Our design specifically uses the transferred power to charge batteries powering a sensor and a strip of LEDs. This much power now allows rechargeable batteries to replace the wasteful ones.

## Concept Diagram



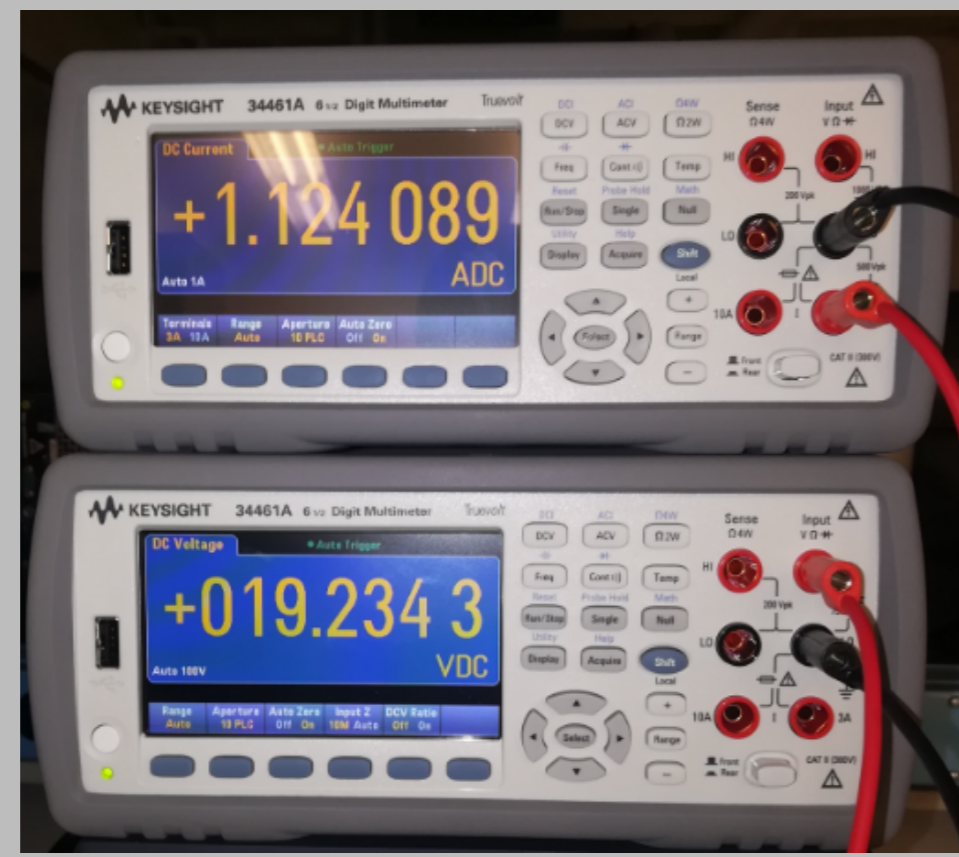
## Requirements

Functional	Nonfunctional	Applicable Standards	Best Practices
<ul style="list-style-type: none"> <li>3V/100mA supply for sensor load</li> <li>12V/1A supply for LED strip load</li> <li>Battery charging systems for both loads</li> <li>Separated branches for sensor and LED loads</li> </ul>	<ul style="list-style-type: none"> <li>Environmentally protected against water and heat</li> <li>Must alert user in case of critical battery state</li> <li>Battery-pack lifespan should be long</li> </ul>	<ul style="list-style-type: none"> <li>RoHS compliant circuit parts</li> <li>Samsung safety tests for the batteries</li> <li>IEEE code of ethics</li> </ul>	<ul style="list-style-type: none"> <li>Adding a fan to increase longevity of the system</li> <li>Increasing the power delivery efficiency by better heat management</li> <li>Using a higher quality 3D printer with ABS as the filament material</li> </ul>

## Testing and Evaluation

### Transmitter PCB Testing

- H-Bridge Functionality
- Resonant Frequency Tuning
- Power Delivery
- Heat Loss Minimization



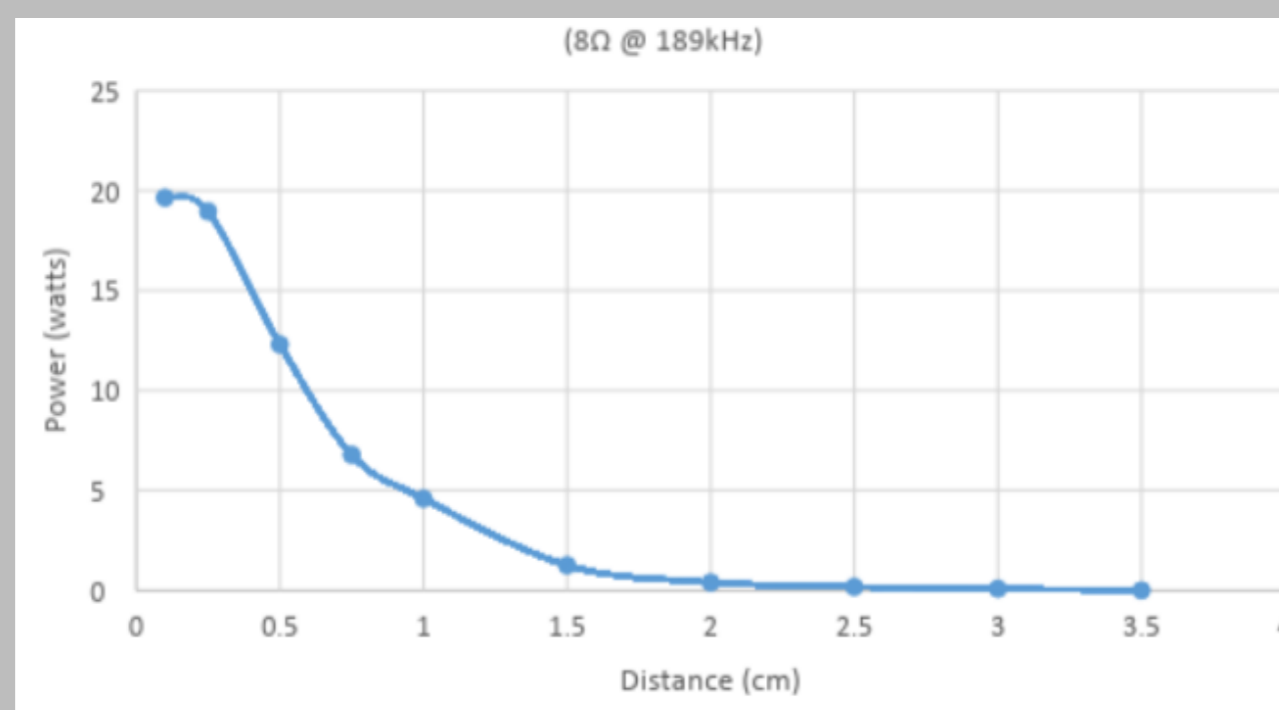
### Receiver PCB Testing

- Powering Sensor
- Sensor Battery Charging
- Powering LEDs
- LED Battery Charging



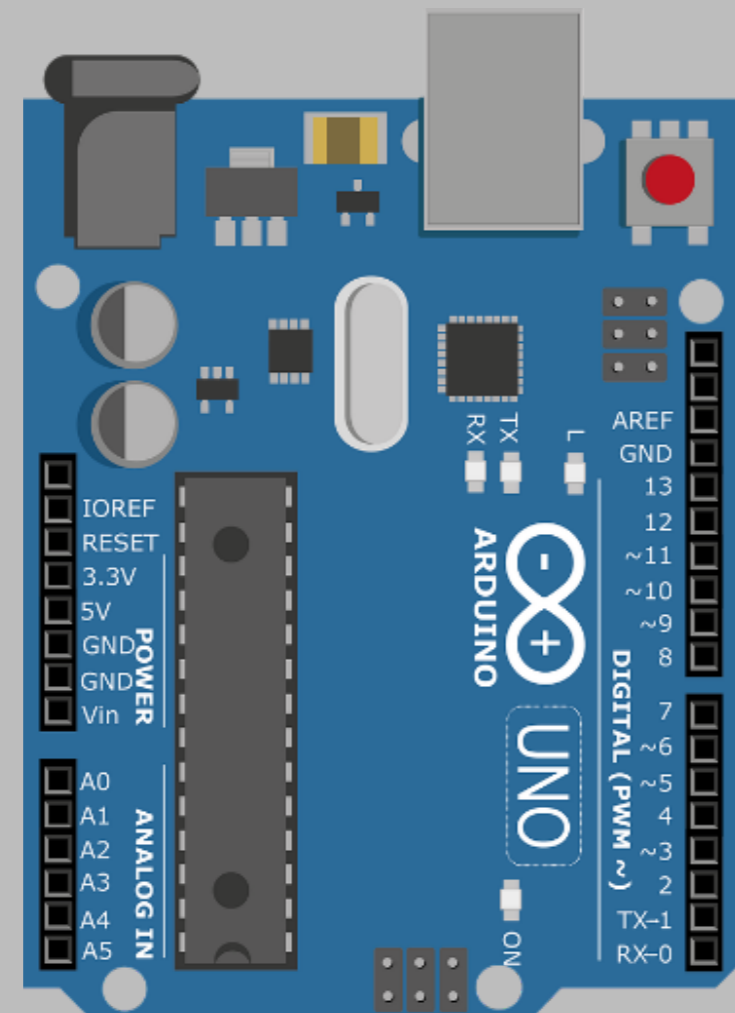
### Full Integration

- Power Transfer Efficiency
- Power Transfer vs Distance



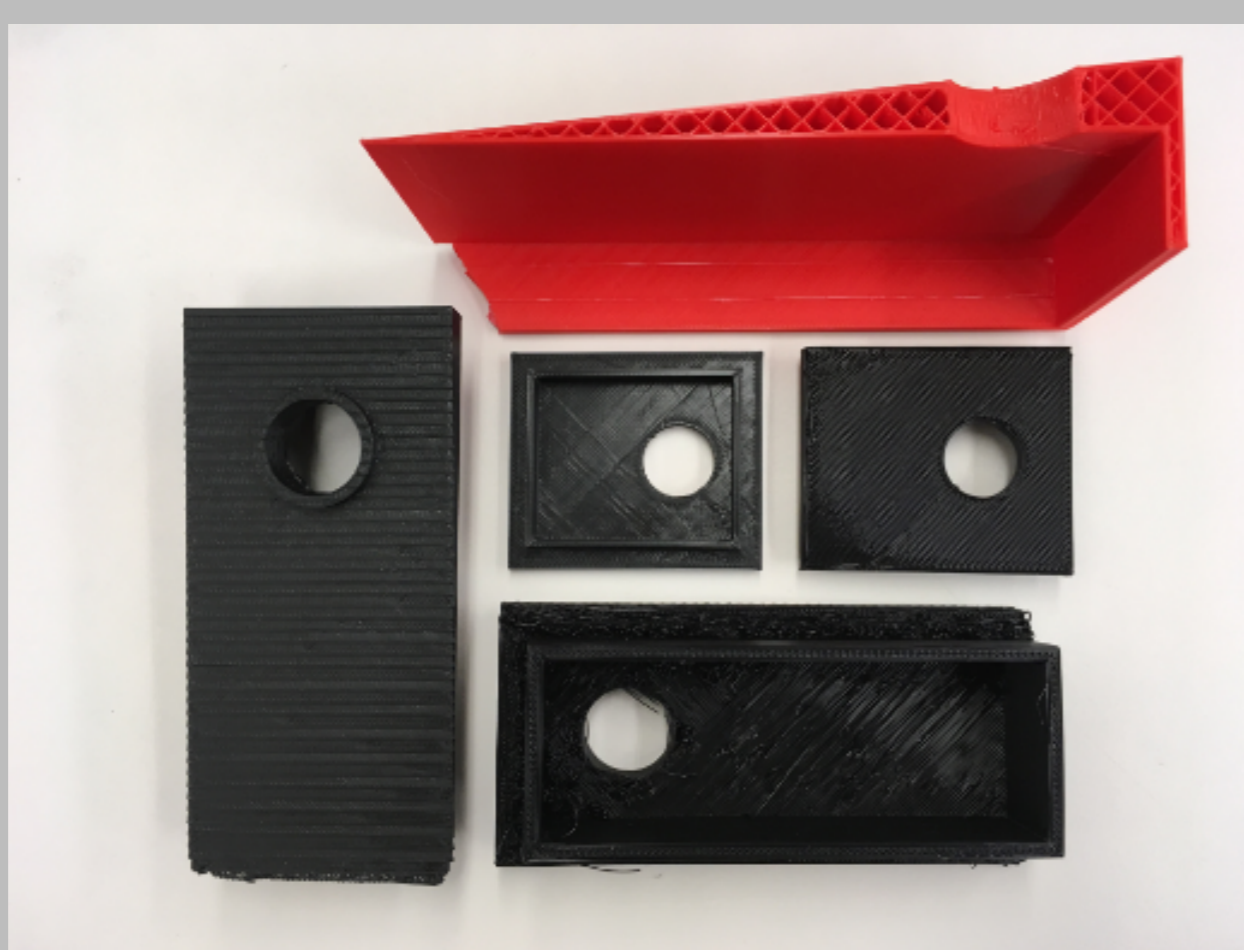
### Microcontroller Testing

- Charge Status Indication
- Fault Indication
- Battery Voltage Sensing
- LED Load Control
- Charge State Control



### Enclosure Testing

- Thickness of Surfaces
- Angle of Surfaces
- Compatibility of Parts
- Accuracy of Production



## System Architecture and Design

Transmitter	Receiver	Circuit Enclosure	Code
			<pre> Pseudocode: LED Battery{   Bcharge=Curvolt/Maxvolt   if Bcharge&gt;75     green light   elif Bcharge&gt;50 &amp;&amp; &lt;75     yellow Light   elif Bcharge&gt;25 &amp;&amp; &lt;50     red Light   else     Flash lights } Sensor Battery{   if i1==0 &amp;&amp; i2==0     flashing LED Battery()   elif i1==1 &amp;&amp; i2==0     solid green light   //charged   elif i1==1 &amp;&amp; i2==1     solid red light   //error in circuit }                     </pre>

## Implementation

Hardware	Software	Suppliers
LulzBOT Taz 6	EasyEDA	Wurth Electronics
KEYSIGHT Oscilloscope & Multimeters	Arduino Software	Mouser
Pace MBT 250 Soldering Station	SolidWorks	Battery Junction
AmScope Digital Microscope		

## Conclusion

The work done here is relatively untraversed ground. We've managed to transfer an amount of power that has not been attempted widely, and used that amount to power multiple high power electronics with relative efficiency. In total, our maximum transfer was 18 Watts and power losses originated through thermal inefficiency of the circuitry rather than the transmission between coils. So the main proposal for extension is the improvement of cooling systems for the microchips.

In regards to the charging system, there are a few more suggestions to be made. A wireless transmission signal can be added to provide an extra layer of security and ease of use. Another enhancement would be to replace the LEDs that are used to display charge states with a secured text screen to provide detailed information about the system.