Wireless Inductive Charging

By Tesla Unplugged

Ari Ferro    Jeff Thacker    Zach Wilcox

http://www.eng.utah.edu/~zwilcox/senior_project/
Intro

Comprised of four main parts:

● Base Station

● Electric Vehicles

● Charging Circuit

● Computer for data collection
Overall Block Diagram
Base Station

- Arduino Mega
- XBee Radio
- XBee Shield
- Light Sensors
- Voltage Sensors
- Inductive Chargers
- PC Connection
Arduino Mega

54 digital I/O lines
We need 11
XBee Radio needs two pins:
Rx, Tx (0,1)
Light sensors need two each:
SDA, SCL
Rx1, Tx1
Rx2, Tx2
Charge pad enable needs pins:
2, 3, 4

Compatible with XBee Radio

16 analog I/O lines
We need 6
Read power from three pads:
A0, A1, A2, A3, A4, A5
XBee Radio + Shield

Uses pins 0 and 1 on Arduino
Easy to use
Easy to set up
802.15.4 Network Topology
Broadcasts
Colored Light Sensors

Use I2C interface
All sensors on address 0x74
Need three I2C busses

22 Registers to read from
Two bus accesses to read/write
1.2ms to read full sensor value
Cars

Arduino Uno
Voltage Sensors
Color LEDs
XBee Radio
XBee Shield

Diagram:
- Battery
- Voltage Sensors
- Charging Circuit
- Arduino Uno
- Xbee
- Color LED
- Car
Arduino Uno

Cheap & Simple

14 Digital IO pins
   We need 4
   XBee Radio needs two pins:
      RX, TX (0,1)
   LED needs one pin:
      Pin 2
   Charge enable switch takes one:
      Pin 3

5 Analog IO pins
   We need 3
   Read voltage received (A0)
   Battery voltage (A1)
   Power Consumption (A2)
Inductive Circuit

How do we create an inductive wireless charge?

WITH SCIENCE...

...Magnets...

...and Miracles!!

Audience Cue: "What Three Things?!!"
Inductive Circuit

Not that complicated:
AC Power + Coils = Magnetic Field!
Magnetic Field + Coils = AC Power!

Our solution: Google!

Following Guide found on Instructable.com
"Wireless Power Charger!"
Inductive Circuit

Broken into two parts:
1 Primary Circuit
   a) Powered with AA batteries
   b) Controlled by base station
2 Secondary Circuit
   a) Connects to USB LiPo battery charger
   b) Located on Car
3 Coils (3 Turns)
   Each about 7-9 feet of 14 gauge wire
Primary Circuit

12 - 24 volts

200 - 400 uH

3+3 turns of 14 gauge wire

IRFP250

470 ohm 2w

10k

12v

470 ohm 2w

10k

12v

400+ v
Fast diodes

IRFP250

Must be MKP 2uF
Secondary Circuit

Using Buck Converter

- LT1070 boost converter
- DC-to-DC Converter
- 93% efficient [7]
Battery Charger

- Vehicle natively uses 5-AA batteries (1.5 V ea)
- Initial testing shows our vehicle stops functioning below 2 V.
  - Runs fine at 3.7 V
- Single Cell LiPo Battery Supplies 3.7 V
- Selected a LiPo USB Battery charger
  - 'SYS OUT' - "allows connection from the charging circuit directly to the load without disconnecting the charger " [9]
  - Hopefully will allow us to charge battery while it's in use
Database

Authentication
Vehicle history information

MySQL Community Server
- Can easily handle our data
- Uses Standard Query Language (SQL)
- Free
Data Flow
Data Visualization

Data for each vehicle

- Battery voltage levels
- Current provided to charge
- Length of time charged
# Breaking it Up

<table>
<thead>
<tr>
<th>TASK</th>
<th>LEAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts Acquisition</td>
<td><strong>Everyone</strong></td>
</tr>
<tr>
<td>Charging System</td>
<td><strong>Zach</strong></td>
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<tr>
<td>Base Station Control of Charging Circuit</td>
<td><strong>Zach</strong></td>
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<tr>
<td>Car Battery Monitor</td>
<td><strong>Ari</strong></td>
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<tr>
<td>Car to Base LED / Color Sense</td>
<td><strong>Ari</strong></td>
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<tr>
<td>Base Station to PC Communication</td>
<td><strong>Zach</strong></td>
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<tr>
<td>Database</td>
<td><strong>Jeff</strong></td>
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<tr>
<td>GUI</td>
<td><strong>Jeff</strong></td>
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<tr>
<td>PC Software to Store Data</td>
<td><strong>Jeff</strong></td>
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</tbody>
</table>
Schedule

- Fine Tuning & Troubleshooting
- PC Interface Software to Store
- GUI
- Database
- Base Station to PC Communication
- Car to Base Communication (Xbee)
- Car to Base LED/Color Sense
- Car Battery Monitor
- Base Station Control of Charging...
- Charging System
- Parts Acquisition

Dates:
- 5/1/2013
- 5/3/2013
- 6/30/2013
- 7/30/2013
- 8/29/2013
- 9/28/2013
- 10/28/2013
- 11/27/2013
- 12/27/2013

Legend:
- Troubleshooting
- Software
- Base Station
- Communication
- Car
- Charging System
- Parts Acquisition
Risks

- **High Risk:**
  - Inductive Circuit
    - Found a Design online that works

- **Medium Risk**
  - Charging Battery while vehicle is in use

- **Low Risk**
  - Electric Noise
  - XBee Radio interference
# Damage (BOM)

<table>
<thead>
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<tbody>
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**Grand Total:** $513.74
References

Questions?

Comments?

Concerns?