TESLA

Daniel Bolton

Frank Cangialosi

Anu Challa • Tim Furman

Tyler Grover • Patrick Healey

Ben Philip • Brett Potter • Scott Roman

Andrew Simon • Alex Tabatabai

Liangcheng Tao

Mentor: Steven Anlage

GEMSTONE
UNIVERSITY OF MARYLAND

physics
University of Maryland

Agenda

1. Motivation and previous Literature
   a. Introduction to wireless power
   b. How time reversal works
   c. Applying time reversal to wireless power transfer
2. Where Team TESLA Comes In
   a. Big picture research goals
   b. What we hope to create
   c. Team organization and intermediate steps
3. Applications and Conclusions

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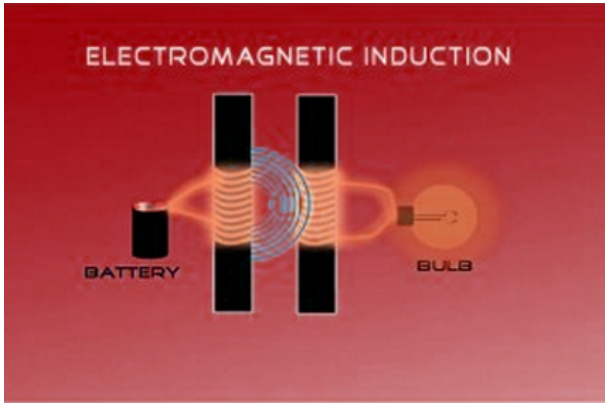
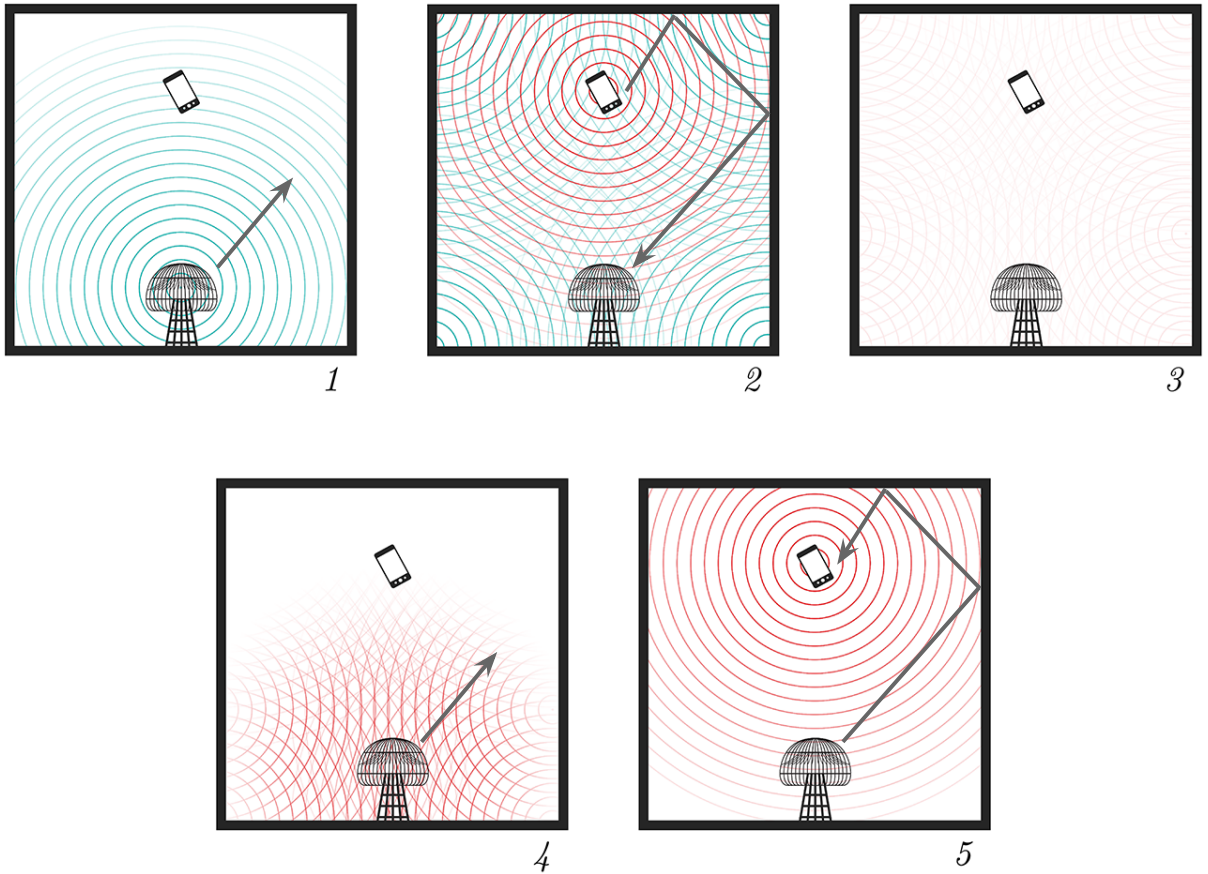
Basic overview of wireless power



From E. John

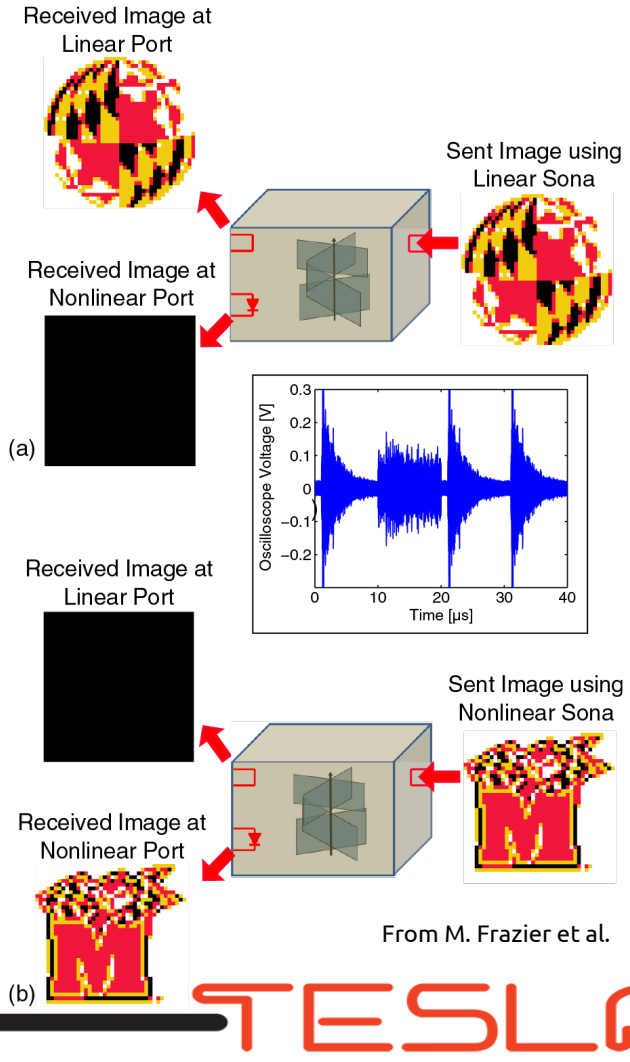
- Wireless power history
  - First demonstrated by Nikola Tesla
  - Modern Methods
    - Qi charging pads
    - Witricity and Cota
    - Microwave beaming
- What problem are we attempting to solve and why is it important?
  - Drawbacks of current methods

Explanation of Time Reversal (TR)



Current TR Applications

- Acoustic
  - Detecting structural faults
  - Medical Imaging
  - Eliminating kidney stones
- Electromagnetic
  - Secure data transfer
  - Localized communication
  - Motion Detection



Putting the two pieces together

- How do we apply time reversal to wireless power transfer?
- Received signal == AC voltage
- Wave path is not dependent on amplitude of the wave.
  - Thus we can amplify the signal before rebroadcasting and rectify the reconstruction!

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Big Picture Research Goals

What do we want to end up with at the end of our four years? Beyond?

- Proof of concept with toy car in idealized environment
- Standalone system in real-world environment
- Commercialization

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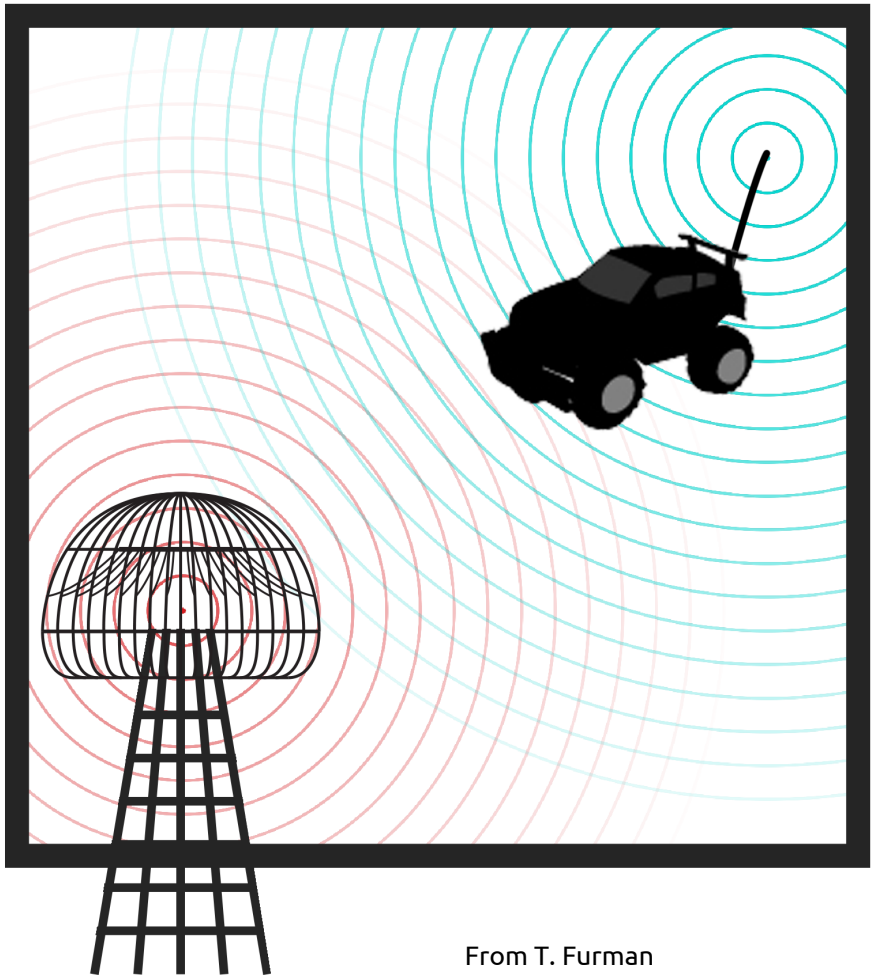
Hypotheses

1. We believe that 1 Watt can be effectively transferred from source to load using the time reversal method.
2. We hypothesize that a moving receiver can still be suitably powered using frequent interrogation pulses.
3. We also posit that time reversal will prove to be robust over a variety of room geometries and lossy features.

Proof of Concept

- To demonstrate that a WPT scheme is feasible
- Electric toy car inside a reflective environment, which gets zapped with power continuously



From T. Furman

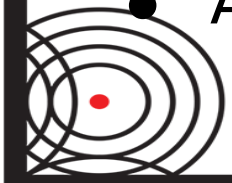
Thinking Outside the Box

- The next step after the proof of concept is to create a time reversal mirror to test in a non-ideal environment.

- Incorporation of more realistic environments/parameters will give a more practical answer to the question: is a time reversal WPT system feasible?

Unintended Receivers

- What is an unintended receiver?
  - Are there health concerns?
  - Can TR damage other electronic equipment?
  - What about defibrillators or pacemakers?
- From TESLA's experiments in a very reflective environment, unintended receivers can only collect ~6% of outputted power.
- As such, problems are not anticipated.



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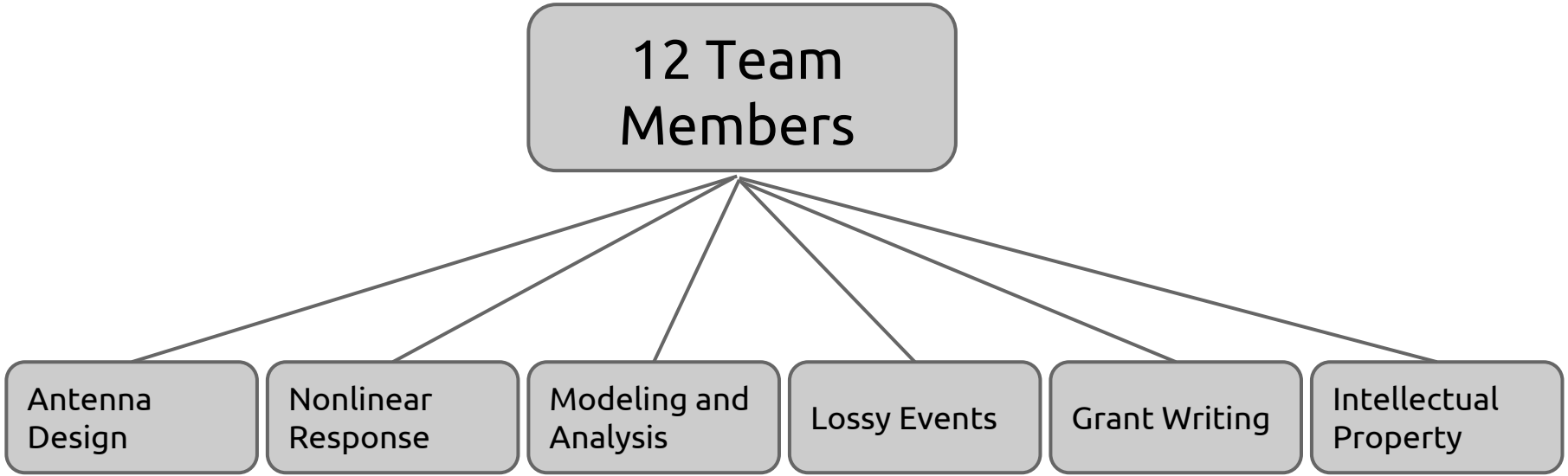
Current Team Organization



Itemized Budget

Item	Quantity	Cost per Unit	Total Value	Total Cost
High Speed Coaxial Microwave Switches	2	$2,500	$5,000	$5,000
Frequency multipliers	5	$50	$250	$250
Power Amplifier	1	$1,600	$1,600	$1,600
Circuitry Components	N/A	N/A	$500	$500
Computer Work Station	1	$1,000	$1,000	$1,000
Camera	1	$75	$75	$75
Numerical Simulations (software, consulting)	1	$2,000	$2,000	$2,000
Lab Workspace (in kind)	N/A	$50/hr	$5,000	$0
Stub Tuner (in kind)	1	$700	$700	$0
US Patent	1	$10,000	$10,000	$10,000
Machine Shop	N/A	$2,000	$2,000	$2,000
Total:			**$28,125**	**$22,425**

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Timeline

Spring 2014

1. Experimental background
2. Thesis Proposal and Defense
3. Design proof of concept
4. Begin ongoing literature review

Fall 2014

1. Proof of concept testing and improvement
2. Present at Junior Colloquia
3. Begin design of standalone TRM

Spring 2015

1. Present at Undergrad Research Day
2. Construct standalone TRM
3. Submit patent application
4. Begin writing Senior Thesis

Fall 2015

1. Iterative refinement of standalone TRM design
2. Attend a conference

Spring 2016

1. Finish Senior Thesis
2. Defend Senior Thesis
3. Explore options beyond graduation

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Applications

- Coffee shop or airport scenario
  - Number of People >> Number of Outlets
- Charging electric cars
  - Toyota, Honda, and Nissan
- Selective and secure power
  - Government facilities

From Auto Express

In Summary

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Artwork Citations

Slide Number

P. Healey, *Tesla Logo*. 2013. [1]

E. John. “Magnetic Field - AndroidNova.org.” 2013. Available: http://www.androidnova.org/tag/magnetic-field/. [3]

M. Frazier, B. Taddese, T. Antonsen, and S. M. Anlage, “Nonlinear Time Reversal in a Wave Chaotic System,” *Physical Review Letters*, vol. 110, no. 6, Feb. 2013. [5]

T. Furman, *Tesla Block Figure*. 2013. [4]

T. Furman, *The Human Condition and Sadness*. 2014. [9]

Auto Express. *“Just back the car over the plate…”*. 2011.

Thank you!

TESLA would like to thank:

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Questions?

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