WIRELESS POWER TRANSFER

BY

ALEN RANJAN MINJ

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OVERVIEW

- INTRODUCTION
- HISTORY OF WPT
- TYPES OF WPT
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WHAT IS WIRELESS POWER TRANSFER?

- It is the transmission of electrical energy from a power source to an electrical load without interconnecting wires. This can be used for applications where conventional wires are unaffordable, inconvenient, hazardous, unwanted or impossible.
HISTORY

- Nikola Tesla in late 1890s
- His vision was to create a “WORLD WIRELESS SYSTEM”
- A 187 feet tall tower to broadcast energy from which people could access free energy
- Due to shortage of funds, tower did not operate
HISTORY (CONTD....)

- Tesla was able to transfer energy from one coil to another coil
- He managed to light 200 lamps from a distance of 48Km
- The idea of Tesla is taken in to research after 100 years by a team led by Marin Soljacic from MIT. The project is named as ‘WiTricity’.
Types and Technologies of WPT

- Near-field techniques
  1. Inductive coupling
  2. Resonant inductive coupling
  3. Air ionization
Contd.....

- Far-field techniques
  1. Microwave power transmission
  2. LASER power transmission
Inductive Coupling

- Primary and secondary coils are not connected with wires
- Energy transfer is due to mutual induction
- Wireless Charging Pad (WCP) is an example
- On a WCP (primary coil), the devices (Secondary coil) are to be kept, battery will be automatically charged.
Resonance Inductive Coupling (RIC)

- Combination of inductive coupling and resonance
- Resonance improves the efficiency by tunneling the magnetic field to a receiver coil which resonates at the same frequency
- When resonant coupling is used the two inductors are tuned to a mutual frequency and the input current is modified from sinusoidal to non sinusoidal rectangular or transient waveform so as to drive the system more aggressively.
WiTricity

- Based on RIC
- Led by MIT’s Marin Soljacic
- Energy was transferred wirelessly for a distance just more than 2m.
- Coils were helical in shape
- Efficiency achieved was around 40%
- Used frequencies ranging from 1MHz to 10MHz
WiTricity (Contd..)
Air Ionization

- Toughest technique under near-field energy transfer techniques
- Air ionizes only when there is a high field
- Needed field is 2.11MV/m
- Natural example: Lightening
- Not feasible for practical implementation
Advantages of near-field techniques

- No wires
- Efficient energy transfer using RIC
- Harmless, if field strengths under safety levels
- Maintenance cost is less
Disadvantages

- Distance constraint
- Field strengths have to be under safety levels
- Initial cost is high
- In RIC, tuning is difficult
- High frequency signals must be the supply
- Air ionization technique is not feasible
Far-field energy transfer

- Radiative
- Needs line of sight
- LASER or MICROWAVE
- Aims at high power transfer
Microwave Power Transfer (MPT)

- Transfers high power from one place to another. Two places being in the line of sight.
- STEPS
  1. Electrical energy to microwave energy
  2. Capturing microwaves using rectenna
  3. Microwave energy to electrical energy
MPT (contd…)

- AC can not be directly converted to microwave energy
- AC is converted to DC first
- DC is converted to microwaves using magnetron
- Transmitted waves are received at rectenna which gives DC as the output
- DC is converted back to AC
Laser

- Laser is highly directional and coherent
- Not dispersed for very long
- But, gets attenuated when it propagates through atmosphere
- Simple receiver-Photovoltaic cell
- Cost efficient
Solar Power Satellites (SPS)

- To efficiently make use of renewable energy i.e. solar energy
- SPS are proposed to be placed in geostationary orbits
- Solar energy is captured using photocells
- Each SPS may have 400 million photocells
- Transmitted to earth in the form of microwaves/LASER
- Using rectenna/photovoltaic cell, the energy is received and converted to electrical energy
- Efficiency exceeds 95% if microwave is used.
Rectenna

- Stands for rectifying antenna
- Consists of mesh of dipoles and diodes
- Converts microwave to its DC equivalent
Advantages of far-field energy transfer

- Efficient
- Need for grids, substation etc are eliminated
- Low maintenance cost
- More effective when the transmitting and receiving points are along a line of sight
- Can reach the places which are remote
Disadvantages

- Radiative
- Needs line of sight
- Initial cost is high
- When LASERs are used,
  1. Conversion is inefficient
  2. Absorption loss is high
- When microwave are used,
  1. Interference may arise
  2. FRIED BIRD effect
APPLICATIONS

- Near-field energy transfer
- Portable Consumer electronics
- Industrial, military and household robots
- Far-field energy transfer
- Solar power satellites
- Energy to remote areas
- Can broadcast energy globally in future
1) Power from mains to antenna, which is made of copper
2) Antenna resonates at a frequency of about 10MHz, producing electromagnetic waves
3) 'Tails' of energy from antenna 'tunnel' up to 2m (6.5ft)
4) Electricity picked up by laptop's antenna, which must also be resonating at 10MHz. Energy used to re-charge device
5) Energy not transferred to laptop re-absorbed by source antenna. People/other objects not affected as not resonating at 10MHz
CONCLUSION

- Transmission without wires – a reality
- Efficient
- Low maintenance cost. But high initial cost
- Better than conventional wired transfer
- Energy crisis can be decreased
- Low loss
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THANK YOU!