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Wireless Charging for Multi-Node Using Wireless Charging Vehicle

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Abstract: **Wireless energy transfer based on magnetic resonant coupling is a developing technology. Charging one node at a time cause serious scalability problem. Recent advances in magnetic resonant coupling show that multiple nodes can be charged at the same time. Here one wireless sensor network will be created and investigate whether it is a scalable technology or not. Create one Wireless Charging Vehicle (WCV) and that will periodically travelling inside a WSN and charging sensor nodes wirelessly. The two-dimensional plane is divided into hexagonal cellular structure and based on charging range the sensor nodes are charged. Follow a formal optimization framework by jointly optimizing travelling path, flow routing, and charging time. By using discretization and a novel Reformulation-Linearization Technique (RLT), develop a provably near-optimal solution for any desired level of accuracy. Through numerical results, demonstrate that our solution can indeed address the charging scalability problem in a WSN.**

Keywords: **Wireless energy transfer, Reformulation-Linearization Technique (RLT), WSN.**

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1. INTRODUCTION

Wireless power transmission" is a collective term that refers to a number of different technologies for transmitting power by means of time-varying electromagnetic fields. The technologies, listed in the table below, differ in the distance over which they can transmit

power efficiently, whether the transmitter must be aimed (directed) at the receiver, and in the type of electromagnetic energy they use: time varying electric fields, magnetic fields, radio waves, microwaves, or infrared or visible light waves.

In general a wireless power system consists of a "transmitter" device connected to a source of power such as mains power lines, which converts the power to a time-varying electromagnetic field, and one or more "receiver" devices which receive the power and convert it back to DC or AC electric power which is consumed by an electrical load. In the transmitter the input power is converted to an oscillating electromagnetic field by some type of "antenna" device. The word "antenna" is used loosely here; it may be a coil of wire which generates a magnetic field, a metal plate which generates an electric field, an antenna which radiates radio waves, or a laser which generates light. A similar antenna or coupling device in the receiver converts the oscillating fields to an electric current. An important parameter which determines the type of waves is the frequency f in hertz of the oscillations. The frequency determines the wavelength $\lambda = c/f$ of the waves which carry the energy across the gap, where c is the velocity of light.

Wireless power uses the same fields and waves as wireless communication devices like radio, another familiar technology which involves power transmitted without wires by electromagnetic fields, used in cell phones, radio and television broadcasting, and WiFi. In radio communication the goal is the transmission of information, so the amount of power reaching the receiver is unimportant as long as it is enough that the signal to noise ratio is high enough that the information can be received intelligibly. In wireless communication technologies generally only tiny amounts of power reach the receiver. By contrast, in wireless power, the amount of power received is the important thing, so the efficiency (fraction of transmitted power that is received) is the more significant parameter. For this reason wireless power technologies are more limited by distance than wireless communication technologies.

The ambient energy may come from stray electric or magnetic fields or radio waves from nearby electrical equipment, light, thermal energy (heat), or kinetic energy such as vibration or motion of the device.[76] Although the efficiency of conversion is usually low and the power gathered often minuscule (milli watts or microwatts), it can be adequate to run or recharge small micro power wireless devices such as remote sensors, which are proliferating in many fields. This new technology is being developed to eliminate the need for battery replacement or charging of such wireless devices, allowing them to operate completely autonomously.

2. EXISTING SYSTEM

- Kurset al. Recently developed an enhanced technology that allows energy to be transferred to multiple receiving nodes simultaneously.
- Heet al. found that a receiver can only obtain about 1.5 mW powers when it is 30 cm away from the RF transmitter, with about 1.5% energy transfer efficiency.
- Efficient energy transfer in the preliminary experiments by Kurset al. is still limited by meter-range

3. PROPOSED SYSTEM

The advances in multi-node wireless energy transfer technology to charge the batteries of sensor nodes in a WSN and also to investigate whether it is a scalable technology to address energy issues in a WSN.Consider a wireless charging vehicle (WCV) periodically travelling inside a WSN and charging sensor nodes wirelessly. Based on charging range of the WCV, propose a cellular structure that partitions the two-dimensional plane into adjacent hexagonal cells.Pursue a formal optimization framework by jointly optimizing travelling path, flow routing, and charging time. By employing discretization and a novel Reformulation-Linearization Technique (RLT),develop a provably near-optimal solution for any desired level of accuracy.

4. SYSTEM OVERVIEW

"Wireless power transmission" is a collective term that refers to a number of different technologies for transmitting power by means of time-varying electromagnetic fields. The technologies, listed in the table below, differ in the distance over which they can transmit power efficiently, whether the transmitter must be aimed (directed) at the receiver, and in the type of electromagnetic energy they use: time varying electric fields, magnetic fields, radio waves, microwaves, or infrared or visible light waves.

In general a wireless power system consists of a "transmitter" device connected to a source of power such as mains power lines, which converts the power to a time-varying electromagnetic field, and one or more "receiver" devices which receive the power and convert it back to DC or AC electric power which is consumed by an electrical load. In the transmitter the input power is converted to an oscillating electromagnetic field by some type of "antenna" device. The word "antenna" is used loosely here; it may be a coil of wire which generates a magnetic field, a metal plate which generates an electric field, an antenna which radiates radio waves, or a laser which generates light. A similar antenna or coupling device in the receiver converts the oscillating fields to an electric current. An important parameter which determines the type of waves is the frequency f in hertz of the oscillations. The frequency determines the wavelength $\lambda = c/f$ of the waves which carry the energy across the gap, where c is the velocity of light. the advances in multi-node wireless energy transfer technology to charge the batteries of sensor nodes in a WSN and also to investigate whether it is a scalable technology to address energy issues in a WSN.

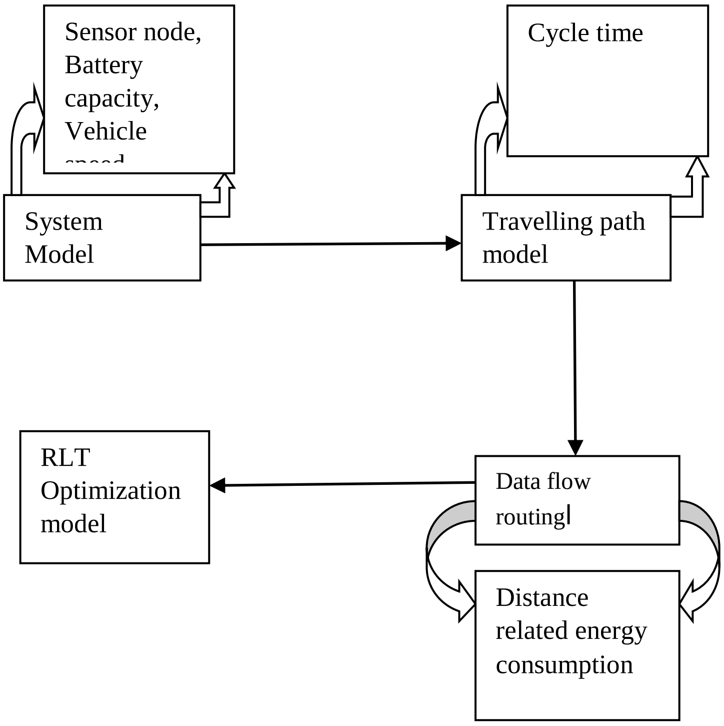

Fig.1 System Overview

5. MODULE DESCRIPTION

5.1 System model:

Here consider a set of sensor nodes N distributed over a two-dimensional area. Each sensor node has a battery capacity of E_{max} and is fully charged initially. Denote E_{min} as the minimum energy at a sensor node battery for it to be operational. Each sensor node generates sensing data with a rate R_i. Within the sensor network, there is a fixed base station (B), which is the sink node for all data generated by all sensor nodes. To recharge the battery at each sensor node, a mobile WCV is employed. The WCV starts at the service station (S), and travels to various spots inside the network to charge batteries of sensor nodes. The WCV can charge multiple nodes simultaneously as long as they are within its charging range. The charging range is determined by having the power reception rate at a sensor node be at least over a threshold.

5.2 Travelling path model:

Denote Q as the set of hexagonal cells containing at least one sensor node. Re-index these cells in Q as k and denote the set of sensor nodes in the k_{th} cell. Then

$$N = \cup_{k \in Q} N_k$$

Denote T_k as the time that the WCV stays at the center of cell $k \in Q$. Throughout T_k, the WCV recharges all sensor nodes within this cell simultaneously via multi-node charging technology. After T_k, the WCV leaves the current cell and travels to the next cell on its path.Assume that the WCV visits a cell only once during a cycle. Denote $P = (\pi_0, \pi_1 \dots \dots, \pi_{|Q|}, \pi_0)$ as the physical path traversed by the WCV during a cycle, which starts from and ends at the service station and the kth cell traversed by the WCV along path P is Π_k .Denote as the physical distance of path P and $T_p = D_p/V$ as the time spent for traveling over distance D_p. After the WCV visits the |Q| cells in the network, it will re-turn to its service station to be serviced and get ready for the next trip.Call this resting period vacation time. Denote t as the time of a cycle spent by the WCV. Then, this cycle time can be written as

$$T = T_p + T_{vac} + \sum_{k \in Q} T_k$$

5.3 Data flow routing and model:

To model multi hop data routing, denote f_{ij} and f_{iB} the flow rates from sensor node i to sensor node j and the base station B, respectively. Then, have the following flow balance constraint at each sensor node i:

$$\sum_{k\in N}^{k\neq i} f_{ki} + R_i = \sum_{j\in N}^{j\neq i} f_{ij} + f_{iB} \quad (i \in N)$$

Although both flow routing and flow rates are part of our optimization problem,assume they do not change with time. To transmit a flow rate of f_{ij} from node i to node j, the transmission power is C_{ij} . f_{ij} where C_{ij} is the rate of energy consumption for transmitting one unit of data from node i to node j.C_{ij} is modeled as

$$C_{ij} = \beta_1 + \beta_2 D_{ij}^{\alpha}$$

5.4 RLT optimization model:

To remove the non linear terms in the 0-1 MINLP, employ a powerful technique called RLT. To replace the nonlinear constraint,need to add RLT constraints, which are linear. The new linear constraints are generated by multiplying existing linear constraints for variables. Through RLT,eliminate all bilinear terms in the 0-1 MINLP and obtain a 0-1 MILP.

6. TECHNIQUE

6.1 Reformulation-Linearization Technique:

To remove the non linear terms in the 0-1 MINLP, here employ a powerful technique called RLT. To replace the nonlinear constraint, need to add RLT constraints, which are linear. The new linear constraints are generated by multiplying existing linear constraints for variables. Through RLT, eliminate all bilinear terms in the 0-1 MINLP and obtain a 0-1 MILP.

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Begin

For linearization

    Initialize objective function, constraint.
    Equivalence the constraint with respect to zero
    Randomly generate routing path and compute objective function
    Update the routing path until the vacation time will be maximum

end
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7. EVALUATION

The advances in multi-node wireless energy transfer technology to charge the batteries of sensor nodes in a WSN and also to investigate whether it is a scalable technology to address energy issues in a WSN. Through numerical results, demonstrate that our solution can indeed address the charging scalability problem in a WSN.

7.1 Throughput:

Throughput means amount of work done in a given period of time. At first iteration the throughput is low after few iteration the throughput will increase i.e) large amount of work will done in a given period of time.

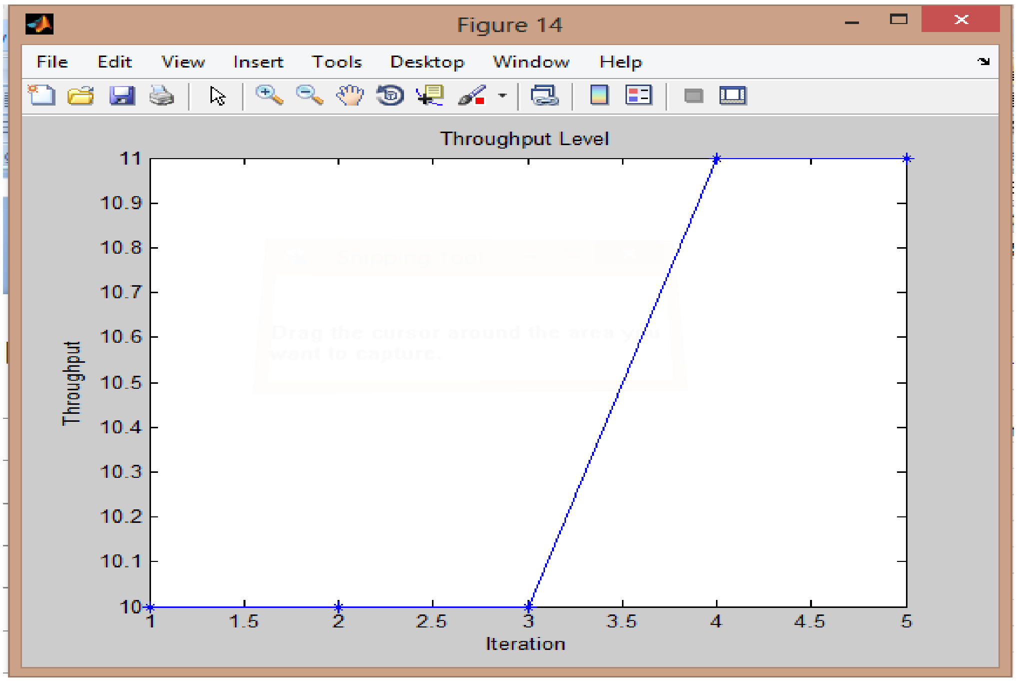

Fig: Throughput

7.2 Energy Level:

The power reception rate at a sensor node, denoted as, is a distance-dependent parameter and decreases with distance between itself and the WCV. When a sensor node is more than a distance of a way from the WCV, assume its power reception rate is too low to make magnetic resonant coupling work properly at the sensor node's battery.

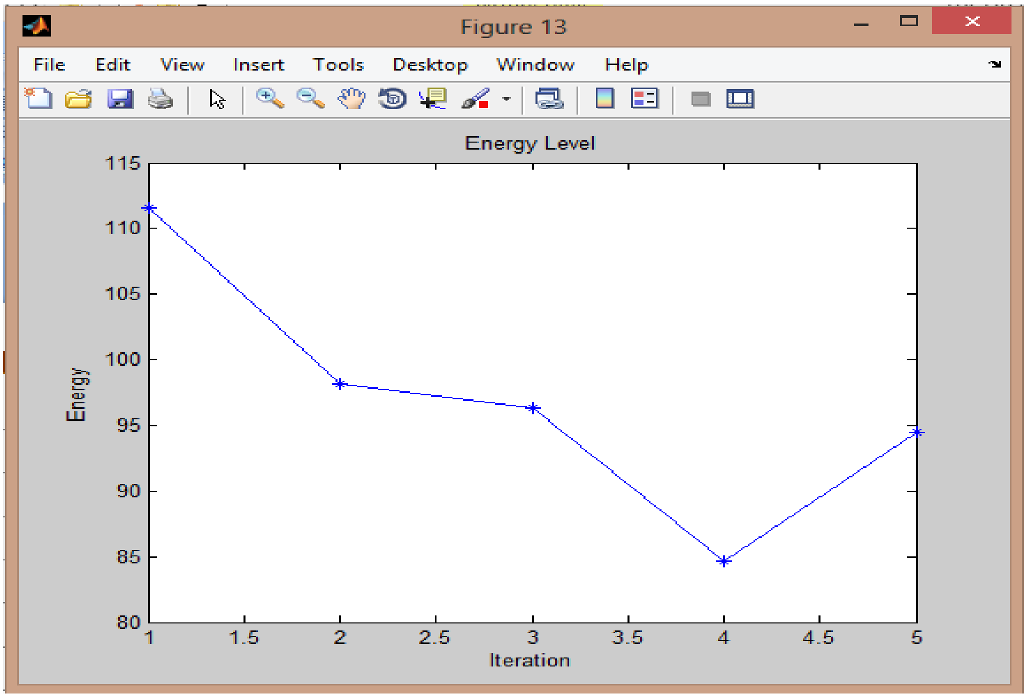

Fig: Energy level

7.3 Distance:

To find the delay calculate the distance. In this in x axis take the iteration and y axis we take number of hops. The distance is calculated by using sum of travelling path.

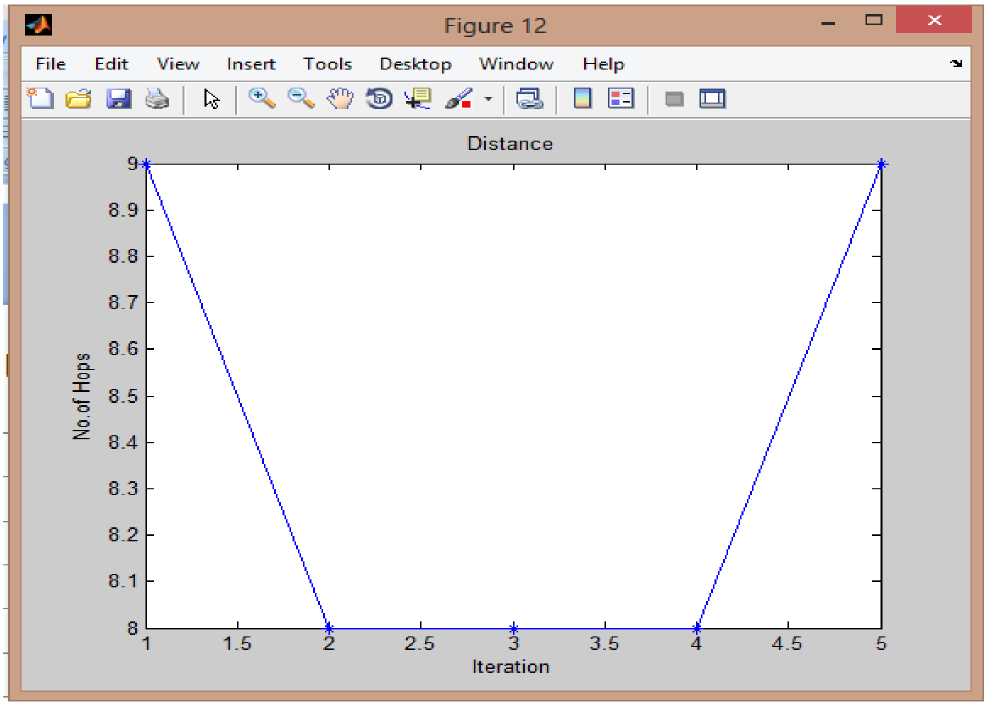

Fig: Distance

8. RELATED WORK

Current wireless energy transfer technologies can be classified into three categories, namely, inductive coupling, electro-magnetic radiation, and magnetic resonant coupling. Inductive coupling works by having a primary coil at a source generate a varying magnetic field that induces a voltage across the terminals of a secondary coil at the receiver. Although this wireless energy transfer technology has found a number of successful applications in portable electronic devices (e.g., electric tooth-brush, RFID tags, medical implants),it is not suitable for charging a wireless sensor node. This is because it has stringent requirements such as close contact and accurate alignment in charging direction, etc.

Electromagnetic radiation is a radiative technology that transfers power on a radio frequency (e.g., 850–950 MHz or902–928MHz, both with a center frequency of 915MHz). Under such radiative technology, an RF transmitter broadcasts radiowavesinthe915-MHzISMband, and an RF receiver tunes to the same frequency band to harvest radio power. Radiative technology has a number of difficulties in transferring energy. First, it requires uninterrupted LOS and is sensitive to any obstruction between an energy source and a receiver. Second, for omnidirectional radiation, the energy transfer efficiency is very low. Radiative technology has been explored for energy harvesting in a WSN. Heet al. found that a receiver could can only obtain about 1.5 mW powers when it is 30 cm away from the RF transmitter, with about 1.5% energy transfer efficiency. Similar experimental findings were also reported. Although this technology may alleviate the energy problem in a WSN to some extent, its applications are very limited, mainly due to its low energy transfer efficiency.

The third category of wireless energy transfer technology is magnetic resonant coupling, which is regarded as a major breakthrough in our time and is the technology that we explore in this paper. This technology works by having magnetic resonant coils operating at the same resonant frequency (i.e., 9.9 MHz or 6.5 MHz), so that energy can be transferred efficiently from a source coil to a receiver coil via non radiative magnetic resonant induction. Compared to electromagnetic radiation, magnetic resonant coupling has the advantages of offering much higher energy transfer efficiency even under omnidirection, not requiring LOS, and being in-sensitive to the neighbouring environment. Although efficient energy transfer in the preliminary experiments by Kurset al. is still limited by meter range (e.g.,2m with 60% efficiency), there have been rapid advances in magnetic resonant coupling to make it suitable for commercial applications such as mobile devices (e.g., cell phones, tablets, laptops) and electric/hybrid vehicles.

9. CONCLUSION

In this paper, we present the multi objective optimization for the wireless sensor networks. Design parameters such as network density, connectivity and energy consumption have been taken into account for developing the framework. Our proposed approach improves the overall efficiency and improves the performance in charging time, travelling path, flow data independently. Using numerical results, we demonstrate the advantage of multi-node wireless energy transfer technology and showed how it addressed the charging scalability problem in a dense wireless sensor network.

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