A Novel on Wireless Power Transmission: An Innovative

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Abstract— According to the latest researches, this paper outlines the development of wireless power transmission and introduces the latest applications of wireless power transmission in life. To describe the wireless power transmission technologies in detail, the paper presents the short-range, medium-range and long range wireless power transmission, respectively. In addition, the paper also depicts some unique properties of wireless power transmission system to make readers understand WPT system better. At last, the existing problems and developing trends are presented. This paper proposes application of wireless power transfer for charging of electric-powered Unmanned Air Vehicles (UAV)

Key words: UAV- Unmanned Air Vehicles, WPT- wireless power transmission, MAV-Micro Air Vehicle

I. INTRODUCTION

Wireless Power is literally transmission of electrical energy without wires. Often compare the wireless transmission of electrical energy from the transmission of information, for example, radio, cell phones, or Wi-Fi Internet access. The main difference is that a radio or microwave transmissions - is a technology for recovery and transport information, rather than the energy that was originally issued for starting. Wireless electricity is a relatively new field of technology, but dynamic. We developed methods to deliver energy effectively and safely to a distance without interruption.

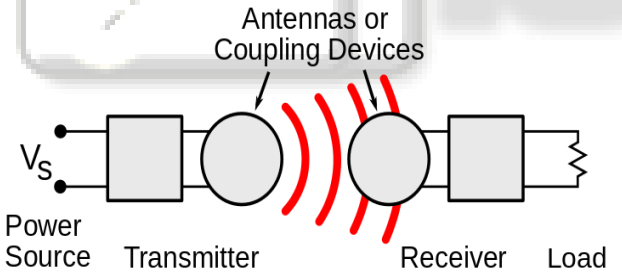

Fig. 1: basic Concept of WTP

The concept of wireless power transmission (WPT) goes back to the days of Heinrich Hertz and Nikola Tesla, who discovered that energy could be transported by electromagnetic waves in free space.

It has been around for a number of applications, intense interest in WPT recently. These include long-distance driving vehicles, the transmission of solar power from space and wireless battery charging. Micro- Air - Vehicle (MAV) drive is the main application of interest in this research. Mavs are a category of unmanned aerial vehicles (UAV), developed around the world. TheFor example, this technology can be applied to extend the range of UAVs used for the inspection of power transmission lines and towers. Presented project investigate capabilities and limitations of the wireless power transmission, for particular UAV application, i.e. for the infrastructure inspections

II. CLASSIFICATIONS

Wireless energy transfer to classify on the basis of the distance between transmitter and receiver.

A. Short Range:

These methods can achieve more than a few inches.

1) Transformer Coupling:

The basic concept behind electromagnetic approach of WPT is magnetic induction between two coil say transmitting and receiving coil. Energy transfer between the two coils by magnetic fields, but in this method, the influence of an electric transformer is the simplest example of the wireless power transmission. The primary and secondary circuits of the transformer are electrically isolated from each other. The transfer of energy takes place by electromagnetic coupling through a process known as mutual induction.For transmitting power through this method for long distance we have to introduce intermediate coils between transmitter and receiver as shown in fig.3.In general term this intermediate coils is called repeaters These repeaters increase efficiency of transmission

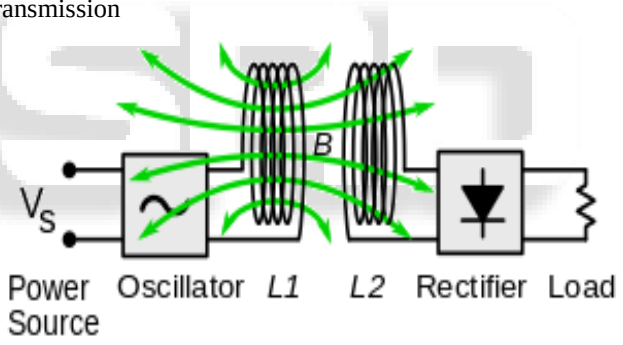

Fig. 2: Transformer Coupling

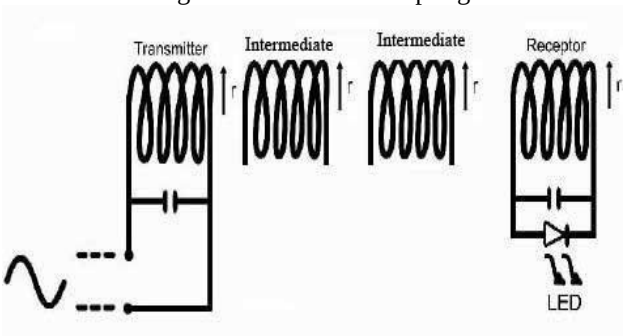

Fig. 3: WPT with intermediates

B. Moderate Range:

These methods achieve up to several meters.

1) Resonance Induction Coupling:

Magnetic resonant coupling uses the same principles as inductive coupling, but it uses resonance to increase the range at which the energy transfer can efficiently take place Resonance can be two types: (a) series resonance & (b) parallel resonance. In these both types of resonance, the

principle of obtaining maximum energy is same but the methods are quite different.

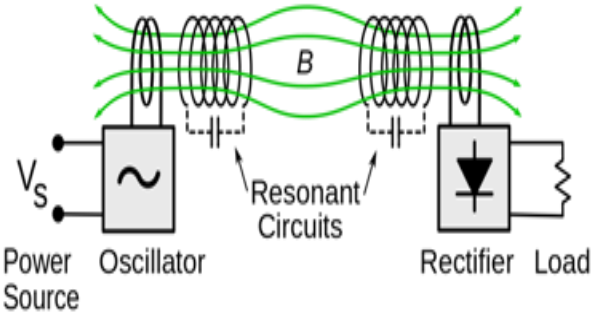

Fig. 4: Resonance Induction Coupling

Quality factor (Q-factor) is a dimensionless parameter that describes the characteristic of an oscillator or resonator, or equivalently, characterizes a resonator's bandwidth relative to its centre frequency. Higher Q indicates a lower rate of energy loss relative to the stored energy of the oscillator; the oscillations die out more slowly. determines the qualitative behavior oscillators. A system with low quality factor to be overdamped. Such a system does not oscillate at all,but when displaced from its equilibrium steady state output,it returns to it by exponential decay, approaching the steady state value asymptotically. System with (Q> ½) is said to be under damped. Under damped systems combine oscillation at a specific frequency with decay of the amplitude of the signal. A system with an quality factor (Q = ½) is said to be critically damped an over damped system, the output does not oscillate, does not overshoot its steady-state output (i.e.,it approaches a steady-state asymptote). Like an underdamped response, the output of such a system responds quickly to a unit step input. The efficiency of the coupled system depends on how much energy is transferred from the transmitted to the receiver circuit

2) Laser Beam Transmission:

In the case of electromagnetic radiation closer to the visible region of the spectrum (tens of micrometers to tens of nanometers), power can be transmitted by converting electricity into a laser beam that is then pointed at a photovoltaic cell This mechanism is generally known as 'power beaming' because the power is beamed at a receiver that can convert it to electrical energy. At the receiver, special photovoltaic laser power converters which are optimized for monochromatic light conversion are applied

Advantages compared to other wireless methods are:

- Collimated monochromatic wavefront propagation allows narrow beam cross-section area for transmission over large distances.
- Compact size: solid state lasers fit into small products.
- No radio-frequency interference to existing radio communication such as Wi-Fi and cell phones.
- Access control: only receivers hit by the laser receive power.

Drawbacks include:

- Laser radiation is hazardous. Low power levels can blind humans and other animals. High power levels can kill through localized spot heating.
- Conversion between electricity and light is limited. Photovoltaic cells achieve 40%–50% efficiency
- Atmospheric absorption, and absorption and scattering by clouds, fog, rain, etc., cause up to 100% losses.
- Requires a direct line of sight with the target.

C. Long Range:

These methods are for kilometers.

1) Radio and Microwave Energy Transfer:

Power transmission via radio waves can be made more directional, allowing longer distance power beaming, with shorter wavelengths of electromagnetic radiation, typically in the microwave range. A rectenna may be used to convert the microwave energy back into electricity. Rectenna conversion efficiencies exceeding 95% have been realized. Power beaming using microwaves has been proposed for the transmission of energy from orbiting solar power satellites to Earth and the beaming of power to spacecraft leaving orbit has been considered. Power beaming by microwaves has the difficulty that, for most space applications, the required aperture sizes are very large due to diffraction limiting antenna directionality. For example, the 1978 NASA Study of solar power satellites required a 1-km diameter transmitting antenna and a 10 km diameter receiving rectenna for a microwave beam at 2.45 GHz. These sizes can be somewhat decreased by using shorter wavelengths, although short wavelengths may have difficulties with atmospheric absorption and beam blockage by rain or water droplets. Because of the "thinned array curse," it is not possible to make a narrower beam by combining the beams of several smaller satellites.

For earthbound applications, a large-area 10 km diameter receiving array allows large total power levels to be used while operating at the low power density suggested for human electromagnetic exposure safety. A human safe power density of 1 mW/cm^2 distributed across a 10 km diameter area corresponds to 750 megawatts total power level. This is the power level found in many modern electric power plants.

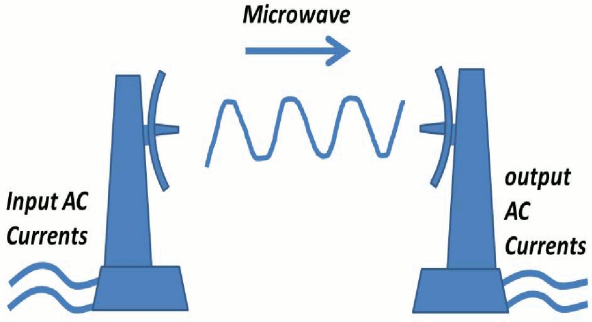

Fig. 5: Radio and microwave Energy Transfer

III. Recent Developments

Many firms and electric companies are working on making wireless based electrical equipment.

A. Inspection of Power Lines:

Our interest is in UAVs' applications for power line inspection. Power lines are a critical infrastructure

Subsystem in the supply of power to homes, hospitals, industry, etc. It needs regular inspection, maintenance and repair. This is a significant task since power lines can run for long distances, through rough and remote terrain, forests, and on high altitudes. Power line inspection

involves examining the pylons and their high voltage insulators. Even the connecting screw must be intact. This process is increasingly being performed by helicopters. Typically the smallest team is made up of an observer using dedicated equipment and a pilot. The inspection frequency depends on transmission line size.The helicopter usually hovers at a horizontal distance close enough for observation, and not too far from the ground.This means that the noise produced by the inspection limits the hours the helicopter can fly, due to noise abatement laws and disturbance to livestock.

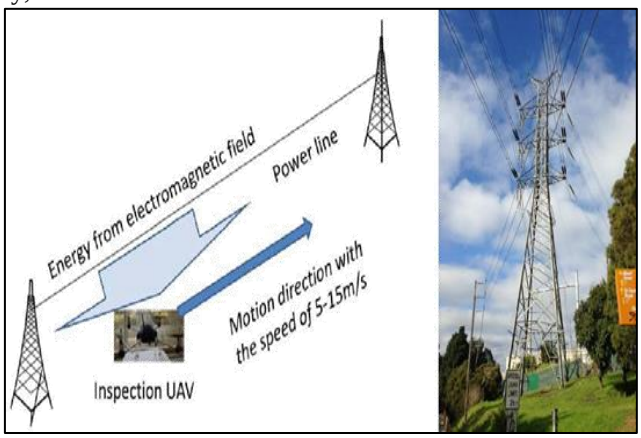

Fig. 6: Concept of powering UAV while inspecting high voltage power lines.

Fig. 7: A quadrotor for the power line inspection investigations.

Electricity providers in many countries commission the service of manned helicopter companies to conduct power line inspections, check for cracks and corrosion, wash insulators, and detect thermography problems and clear vegetation around towers and power lines. Using manned helicopters is an expensive and risky operation. Utility operators are looking for alternative ways for conducting routine inspections. Several different systems have been proposed to replace manned inspection. Some of them are quite innovative, for example robots that move along the line. For a complete survey of the power lines and towers, remotely controlled UAV are sometimes used, that fly along the length of the tower and takes infra-red, optical images, or both. The main problem is that this remains expensive for the many *km* of power lines and hundreds of towers that have to be inspected.

The real benefits for the overhead power line inspections come from UAV operations that can be done routinely and autonomously. A complete system that is reliable and effective does not exist yet, but enabling technologies are already developed. One of the main disadvantages of electric quadrotors is the need for the battery system recharging when functioning on the long distances. Applying concept presented here we could recharge the quadrotor on the job.

Future investigations and experiments should deal with the process of extracting power from the transmission system model. If that proves successful, the next step will be to scale the system up, to the real dimensions and the real high voltages on the electrical power distribution lines. In our model voltage is *240V* and the currant is just *10A*. Distribution voltages may go up to *1200kV* and the current up to *2000A*. In the real system absorbed power might be enough for the continuous UAVs' operation, but even that is not critical. We could have non inspection intervals, of any duration, that could be used for the additional charging. During the charging periods energy could be harvested based on solar collected power, or by wired based charging, from power lines, to speed up the process. For the full independency of the system, on possibly faulty power lines, photovoltaic solar cells could be placed along the infrastructure. Obviously there is large number of research questions for the future investigations

B. Wireless Charging Electric Vehicles:

Qualcomm Incorporated in recent years is working on the batteries of mobile gadgets (development Qualcomm own solution for charging smart phones called WiPower), but solution for charging smartphones called WiPower), but also the electric battery. Project to create a commercially attractive system of wireless power transmission from the car charger, called Qualcomm Halo, and the technology in the performance was named Qualcomm Wireless Electric Vehicle Charging (WEVC). It involves the use of two induction coils: first installed inside the electric vehicle, and the second - under the roadway in places marked as charging pad

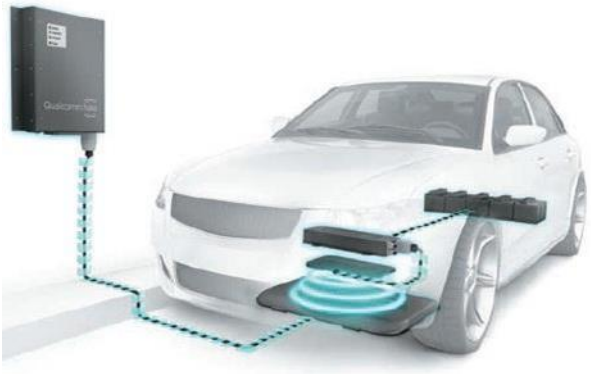

Fig. 8: Wireless Charging of Vehicle

IV. Unique Properties of Wireless power transmission System

A wireless power transmission system often has many unique properties that almost guarantee it as an important element, and probably a crucial one in the development of space. According to a number of researcher's views, we can find that these unique properties usually include the following ones:

– Energy can be transferred at the velocity of light.
– The direction of energy transfer can be changed rapidly.

- The mass of the power converters at the system terminals can be low because of operation at microwave frequencies.
- No mass, either in the form of wires or ferrying vehicles, is required between the source of energy and the point of consumption.
- No energy is lost in its transfer through the vacuum of space, and little is lost in the Earth's atmosphere at the longer microwave wavelengths.
- Energy transfer between points is independent of difference in gravitational potential between those points.

V. Advantages and Disadvantages

A. *Some of The Advantages Are as Follows:*

1) Various ways of transmitting power wirelessly have been famous for centuries. The most widely known example is non-particulate radiation, for example radio waves. While such radiation is extremely good for wireless transmission of knowledge, it's not at all feasible to apply it for power transmission. Since radiation spreads in all directions, a massive tastes power would become wasted into free space.
2) Wireless Power Transmission system would completely eliminates the previous high-tension power transmission line cables, towers and substations involving the generating station and consumers and facilitates the interconnection of electrical generation plants with a global scale.
3) Its more freedom of both receiver and transmitters. Even mobile trans-mitters and receivers might be chosen to the WPT system.
4) The power could possibly be transmitted towards places the location where the wired transmission isn't feasible. Decrease of transmission is negligible level from the Wireless Power Transmission; therefore, the efficiency with this way is a lot higher than the wired transmission.
5) Power can be purchased with the rectenna provided that the WPT is operating. The power failure because of short and fault on cables could not exist from the transmission and power theft will be not possible in any respect

B. *Some of The Disadvantages Are as Follows:*

1) High capital cost for practical implementation of wireless power transmission.
2) Another potential disadvantage is the interference of the microwaves with the present wireless communication system.
3) The effect of microwave radiations at high doses received is not suitable to human health.

VI. Conclusion

As the wireless power transmission technology continues to evolve and mature, our future life can expect to get rid of the devices power cord bound of mobile phones, cameras, laptops and other mobiles to enjoy the wireless power at the airport, railway stations, hotel offers and a variety of places. This paper describes the development of wireless power transmission and the latest applications of wireless power transmission in life. Especially, the paper presents the short-range, medium-range and remote wireless power transmission in detail, respectively. Then, this paper also concludes some unique properties that almost guarantee it as an important element, and probably a crucial one in the development of space. Also the application of wireless power transfer for charging of electric-powered Unmanned Air Vehicles (UAV)s. Multi-rotor systems, such as quadrotors, are light-weight and easy to operate.

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