Solar-Grid Charging Station

For

Wireless UAV(Drone) Charging

By

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Executive summary

Solar energy is a major renewable energy resources humans use in the modern world. So, it is important to develop wireless charging stations powered by solar energy as the primary energy provider to generate electricity. the paper will introduce solar energy and how a solar grid is working. then the paper is discussing about requirements of building a solar grid. The paper will also discuss about wireless charging technology and its history. Ihe paper also will explain the electromagnetism and potential of wireless charging for building a charging station. Finally the proposed wireless charging station architecture will be described. Then final sector is for describing how the station can be used for multiple drone charging and requirements.

Introduction:

Solar energy or solar power is one of the major clean and renewable energy resources in the earth today. Solar and nuclear powers have become the major sustainable clean energy resources in the modem world. Simply solar power is considered as the process of converting the energy of sunlight into electricity by using photovoltaic cells or solar thermal systems. Advancements in photovoltaic technology, energy storage solutions, and grid integration are helping to overcome the obstacles, enabling wider adoption across residential, commercial, and industrial sectors. This paper examines the potential use of solar grid for transferring wireless energy. The paper will discuss about the architecture and technical approach to create a solar grid that use wireless charging technology.

1. Solar Energy:

In a basic term, the solar energy is collected from heat and radiation from sun light. Sunlight can be directly extracted in the earth. According to the research conducted throughout the years, 30% of the radiation comes from sun bounce back in to space, while 70% absorb by the earth surfaces

and atmosphere. Generating solar power and convert to electricity is mainly caused by this absorbing energy portion. The large magnitude of solar power available makes highly appealing source of electricity.

To generate the direct current by solar power, photovoltaic (PV) cells are being used. Usually, PV cells are being created using semiconductor materials with the both negative and positive charge. This technology can be used to create higher energy conversion efficiency. Solar cell PV absorbs sunlight, releasing electrons from silicon atoms and drawing them off by metal conductors, resulting in a flow of electric direct current. The fundamental building elements of a PV system are solar cell circuits that are enclosed in an environmentally friendly laminate to form a PV module. Two or more PV modules can be collected into create a PV panel. PV cells of this panel are connected in series. PV cells are linked to form individual solar panels. Numerous PV cells connected in parallel and series make up this system. While parallel connections are in charge of raising the array's current, series connections are in charge of raising the module's voltage. In direct sunlight, its maximum output is 180W. The array will generate more solar electricity if its entire surface area is larger.

There are several advantages of using solar energy including, saving the energy generation cost, can be used in most areas including sea levels and mountains. Also, rooftop, which eliminates the need for additional space and allows all users, whether residential or commercial, to produce their own electricity. Sunlight is a free, renewable, environmentally favorable resource that is widely available. It generates power without the need for any extra fuel other than sunlight and has no moving parts. No requirement for fuel or water. Non-renewable energy sources are known to the majority of people. Because of its financial advantages, solar energy has grown in popularity. Even on overcast days and at night, solar energy can supply electricity around-the-clock with battery backup. This is also utilized with continuous power supply inter-grid systems. When compared to alternative energy sources like petroleum resources and fossil fuels, it offers more advantages. It is a reliable and constant solution to address the rising demand for energy. Research on solar energy and solar cells holds promise for the future globally.

2. Wireless charging technology:

Wireless technology has transformed the way we communicate by enabling data transfer without requiring physical connections. This technology utilizes electromagnetic waves—like radio, microwave, and infrared signals—to convey data over varying distances, from just a few meters to thousands of kilometers. It includes a range of systems such as Wi-Fi, Bluetooth, cellular networks, and satellite communication, each designed to meet specific connectivity requirements in personal, industrial, and commercial settings.

2.1 Electromagnetism:

Electromagnetism is the pioneer of modern wireless technology. The examination of electromagnetism was started from1819 when H.C. Oersted found the electric flow creates magnetic field around it. Later on, Ampere's Law, Biot-Savart's Law and Faraday Law had derived to give some central property of the magnetic field. Following them, in 1864 J.C. Maxwell familiar a couple of conditions with portray how the electric and magnetic fields are delivered and modified one another. Later in 1873 creation of Maxwell book 'A Treatise on Electricity and Magnetism' which really bound together the power and magnetism. Starting now and into the foreseeable future the power and attraction are said to be constrained by an equivalent power. Then the greatest inventor of early 20th century, Nikola Tesla did conduct several tests on the subjects of wireless force trading using microwaves. He also introduced the 'Tesla curl'. The 'Warden-Clyffe tower' which was one of Nikola tesla's final projects ws designed based on the idea of transmitting electricity through air without any wired connections. Another significant development occurred in 1899, where 108 volts of high-frequency electrical power were transmitted over a distance of 25 miles to illuminate 200 bulbs and operate an electric motor. However, the technique that Tesla implemented had to be put on hold due to the potential dangers high voltage transmission posed to people and electrical devices nearby.

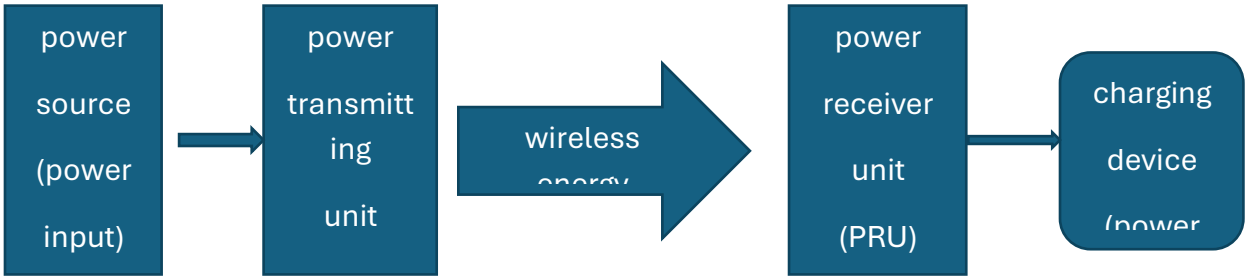
2.2 Fundamental theory behind wireless charging:

History of wireless technology goes back to the early 20th century. Then the new revolutionary digital era expanded potential of this technology. At present, wireless technology is fundamental to various industries, such as telecommunications, healthcare, logistics, and smart urban development, allowing for immediate data sharing, device connectivity, and the growth of the Internet of Things (IoT). It has reshaped societal and economic frameworks by enhancing global connectivity and enabling the expansion of mobile internet, which empowers individuals to interact, work together, and innovate without being limited by geographical boundaries.

The main advantages of wireless charging are follows:

- Solving the problems in linked charging method.
- Upgrading adaptability.
- Can be used in several devices in several band since there are no specific port shape.
- Increasing the sturdiness.
- Wireless charging can give the requested control by the charging devices on demand form and thusly progressively versatile and viable.

Wireless force can make a movement from the transmitter into the receiver and it will be at just like a wireless text messaging system. The process will look like this:



Just like in the previous figure, process is starting from the power source. In most cases it can be a A/C power source such as a plug point from the main house grid. Then electrical current will go into power transmitter unit. This unit has an energy amplifier, matching circuits, A/C to D/C converters, correspondence module, a primary resonator and energy transmitter. Then the energy will be transferred between transmitter unit and receiver units using electromagnetic waves. Receiver unit also will have the secondary resonator, rectifiers, DC-DC converters, correspondence module. This is the basic structure of a wireless charging process.

There are 3 major wireless Charging types.

A. **<u>Radiative wireless charging:</u>**
   In this technological method, the charging units transfer EM waves, Radio Frequency waves or Microwaves as the force trade through a radiation medium. The energy which is being traded between transmitter and receiver unit is depended upon the radiative electromagnetic wave field. These charging units typically work on low energy force region. The reason for that are the concern about RF(Radio Frequency).
B. **<u>Non-radiative wireless charging:</u>**
   As in the name itself, they are using nonradioactive wireless charging methods to transmit energy between units. These units have AC/DC rectifier to convert from substituting energy to coordinating energy and AC/DC converters to convert from Alternative current to Direct current.
C. **<u>Acoustic Wireless charging:</u>**

In this method the sound waves or more specifically ultrasonic waves are being used to transmit the force through the dielectric air media. This innovation is a recently developed one to have biocompatible Wireless force move procedure in bio-clinical implantation i.e., implantable clinical gadgets. The main standard mentioned is "Ultrasonic resonance". The generation of ultrasonic waves occurs at frequencies much lower than those of electromagnetic waves, which are used in inductive coupling or radiative technologies. An ultrasonic wireless power transmission device can be easily designed and proposed to operate at a short wavelength with relatively low operational frequency. Therefore, by utilizing ultrasonic waves, it is feasible to transmit power over significant distances while keeping the overall size of the device relatively small compared to those that use electromagnetic waves.

2.3 Efficiency of the wireless charging:

Total process includes several energy converting stages. According to energy conversion law, there will be losses of energy in every stage. So, there will not be a 100% of energy transferring from the power source into receiver end. According to early research conducted, the modern wireless charging technology only can transfer 45-75% of energy to receiver end. This also depends on the wireless charging method. Radiative charging is has a 70-75% efficiency and acoustic charging has 55-65% efficiency while non-radiative charging efficiency is less than 60%.

3.Solar Grid:

The concept of solar grid to connect a series of solar power systems situated in different areas work together to create a cohesive, decentralized energy network. It serves as a renewable energy source that harnesses energy from solar panels and supplies power to residences, commercial establishments, or even whole urban areas. To create a general solar grid, there are essential components or the parts that needed to be gathered around.

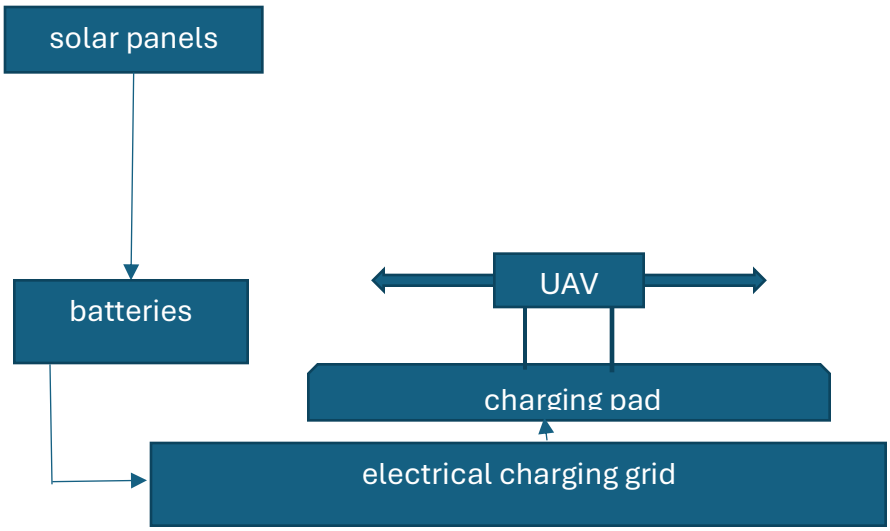
1. **Solar energy:**
   They are on the top of the system architecture and are being used to capture sunlight and convert it into electricity.
2. **Inverters:**
   There are two types of electrical current; direct and alternative currents. In the solar panels the direct current is being generated. Inverters can be used convert D/C into A/C.

3. **Batteries and Energy Storage**:
   To maintain equilibrium between power supply and demand, particularly when sunlight is not present (such as at night or during overcast days), the grid stores surplus solar energy in extensive batteries. This accumulated energy can subsequently be released when necessary.
4. **Grid Integration and Distribution Network**:
   The solar grid can connect to a central utility grid or function as a standalone distributed network. When linked to a main grid, surplus solar energy can be sent back into the broader system, and during times of high demand or reduced solar production, the grid can access energy from alternative sources.

5. **Micro-grids:**
   These are compact, localized networks that exist within the broader solar grid. They have the capability to function autonomously or link up with the main grid.
6. **Small grid technology:**
   Solar grids frequently utilize advanced technologies such as sensors, Internet of Things (IoT) devices, and artificial intelligence (AI) to monitor data in real time, enhance energy distribution, forecast demand, and manage energy flow more efficiently.
7. **Net metering:**
   Certain solar grids offer net metering, a system that rewards solar panel owners for the electricity they contribute to the grid. This encourages greater adoption and enhances the distributed solar network.

4.1Proposed architecture:

The proposed architecture is to create a wireless charging grid using solar energy for autonomous UAV drones. The basic hardware structure is following:



As shown in the structure, the proposed architecture is simple concept. On the top (mainly rooftops and open spaces), there are large number of solar panels being placed to form solar grids. Then the produced electrical energy will be stored in the batteries. When needed the stored electrical energy will be transformed to the electrical charging grid that is located underground. Top of the charging grid and above ground level, there is a charging pad. On this pad, there are multiple charging ports that can be connected to the landing gear of the drone. In the drone there is a positive and negative charging points in the landing gear that can directly be connected to the drone battery.

4.2Charging multiple drones:

The proposed architecture can be used to charge multiple drones simultaneously. One of the major advantages that can be achieved is to get ready drones more efficiently in a small time period. There are two methods to charge a drone using the charging pad.

5.1 charging technology:

1. **Wireless technology:**
   As discussed before wireless charging is very effective in the multiple drone charging.
2. **Contact-based charging:**
   In contact-based charging, pongo pins or a metallic contact from both drone end and charging pad can be used for charging purpose. contacts on both the drone and pad that align when the drone lands, allowing for direct electrical charging. This is more efficient for larger drones.

5.2 layout:

- **Parallel:**
  Designing individual charging spots for each drone with its own set of contacts or inductive coil. Each station can adjust its output based on the drone's battery needs.
- **Centralized:**
  For inductive charging, you can create a large charging mat where drones can land anywhere on the surface to charge. This requires a network of coils that activate when a drone is detected in that location.

Beside them, there are other requirements that will be needed to complete the charging pad including:

1. Landing positioning system/method.
2. Communication system.
3. Monitoring and automation system.
4. Safety system.

6.Conclusion:

The proposed architecture is to build a solar-grid charging station for the purpose of charging multiple drones simultaneously. Solar energy is the best clean and renewable energy source for modern energy requirements. Using wireless charging technology can be useful for efficient multi-drone charging. The proposed system design shows the basic plan for building a charging station. The proposed system need to complete the hardware and software requirements to fulfill the project.

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