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Frontier Guard

-- wireless charging scenery intelligent connection UAV network

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Abstract

In the vast no man's land, the power facility rangers are facing great life safety problems. In response of the above problems, the team proposes drones to conduct safe and efficient regional inspection, utilize abundant light and wind energy resources and combine wireless charging technology to reduce the waste of human resources, and provide data picture transmission and cloud monitoring functions to obtain regional status information, and improve the patrol efficiency and monitoring capability. The uav system based on the wind and solar complementary, the wireless charging technology truly realizes the safety of the no-man's land, ensuring that the rangers are far away from the restricted area of life.

Keywords

Wireless charging, unmanned aerial vehicle , Energy self-sufficiency, Defend the border.

1. Introduction

The wireless charging technology is applied to the UAV line patrol. The system integrates wireless charging, wind-solar complementary, cloud monitoring and other functions, realizing the three-in-one intelligent line patrol without manual intervention of "function, charging and monitoring". The whole system utilizes abundant light and wind energy resources and combines wireless charging technology to realize the energy self-supply and reduce the waste of human resources. The microcontrol processor processes the data collected by the equipment sensor and transmits it to the cloud data terminal using the communication module, and then uses the cloud computer to realize cloud monitoring and intelligent display.

2. Development background and significance

In remote areas, there are special workers who risk them to perform specific tasks. For example, large forest rangers and frontier patrols; today, thanks to the rapid development of drone technology and wireless charging technology, the team pioneered the combination of two emerging technologies to provide a safer, more effective and more energy efficient solution for these tasks. Based on the integration technology of landscape storage, we build intelligent energy base station, so that the uav can be self-sufficient to complete various inspection tasks. Compared with the traditional uav inspection, it solves the problem of various security risks faced by human execution, and also provides a new solution for the high-quality application of energy conservation and emission reduction technology.

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Fig. 1 Snow map on the border line

Fig. 2 The dense forest fire protection survey

3. Feasibility analysis

3.1. Wireless patrol

According to the flight mileage calculation of the UAV, the energy base station is planned on the patrol line. The wireless charging technology equipped with it can provide convenient charging service for the UAV, while reducing the safety risk and operation cost brought by artificial battery replacement.

3.2. Safety detection

China's manual border defense inspection is faced with various problems. The UAV can make use of air advantages for reconnaissance and data transmission by carrying cameras and networking modules, which can not only replace human patrol and detection, but also collect reliable field data.

3.3. Plenty of energy

In northwest China, the annual sunshine time is up to 3000 hours, and the annual wind power density is up to 400W / m^2. This project makes full use of the local natural energy advantages, and uses wind-solar complementary power generation devices to provide energy support for the UAV system.

3.4. Economic benefits

The energy base station designed by our team, single deployment, without additional supplies and manual maintenance, small and compact body structure, not only improve flexibility, but also reduce manufacturing costs, with good economic benefits.

4. Design scheme

4.1. System design

The system is based on the energy base of landscape and storage integration technology, combined with wireless charging and Internet of Things technology, to complete the intelligent UAV monitoring and inspection task of energy production and self-use. The cloud visual inspection image acquisition system is controlled by the microcontroller, using the three-port DC-DC converter and lithium ion battery to improve the power quality and stability, and provide continuous and stable energy for the system. Build a number of energy base stations to achieve a wide range of continuous and accurate monitoring tasks.

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4.2. System structure block diagram

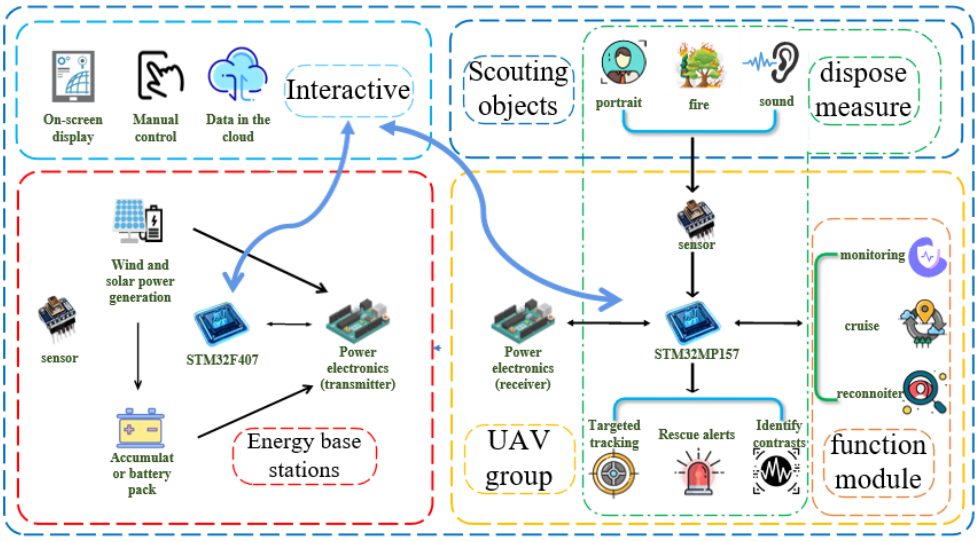

Fig.3 Block diagram of the system structure

4.3. Appearance structure design

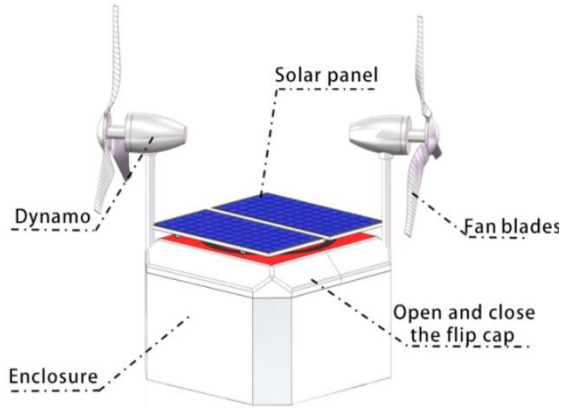

Fig. 4 Outside of the energy base station

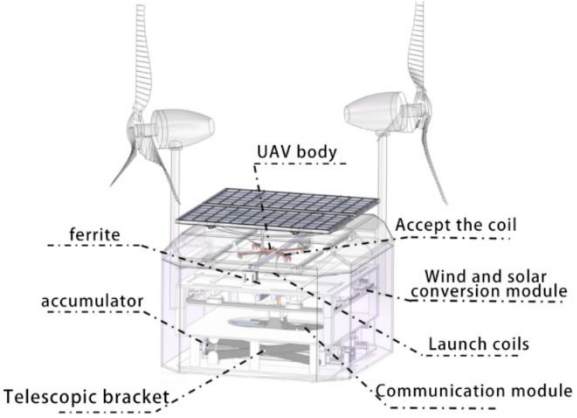

Fig.5 Internal composition of the energy base station

5. Theoretical design calculation

5.1. Wind-solar complementary power generation power

The monocrystalline silicon photovoltaic panel used in this system has an area of 1.2m2, the power generation range is 180~250W, and the average sunshine time is 9 hours. Considering the instability of the outdoor light conditions on the plateau and other factors, the power output of the solar panels will be affected, and the power generation power is 200W.

Solar daily solar power generation:

$$W_1 = P \times t = 200 \times 9 = 1.8kW \cdot h \quad (1)$$

The northwest region is particularly rich in wind energy resources, the system also designed small generator sets, which mainly consists of bracket, windshield, tail, generator and so on. Among them, the wind power generation system first uses the wind to drive the rotating blades to convert the kinetic energy of the wind into mechanical energy, and then drags it to the generator to convert the mechanical energy into electric energy to generate electricity. Considering the instability of the wind speed, the average wind speed is 5 m/s, the blade is 0.25m ^{2}, and the average air density is 65% of the sea level.

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Daily wind power generation capacity:

$$W_2 = \frac{1}{2}\rho AV^3 t = \frac{1}{2} \times 0.65 \times 1.225 \times 5^3 \times 9 = 0.45kW \cdot h \quad (2)$$

A is the stressed area (m^2); V is the wind speed V (m/s) and ρ is the air density.

Total daily generating capacity:

$$W = W_1 + W_2 = 1.8 + 0.45 = 2.25kW \cdot h \quad (3)$$

According to the calculation, it can fully meet the power supply demand of the power consumption module such as the UAV charging power, communication system, wireless charging loss and so on, and achieve self-sufficiency.

Table 1. Power consumption of each power consumption module

Power consumption module	power consumption (W)	Time per day (h)	Mean daily consumption of electricity(kW·h)
UAV system	240	8	1.92
communication system	50	8	0.04
Wireless charging loss	26	8	0.208
Total power consumption	—	—	2.168

5.2. Energy base station design

The endurance of the UAV is about 30min, and the flight distance is about 10km. Considering the actual situation, it is planned to expand the flight distance to 20km, so to build multiple energy base stations in the reconnaissance area to ensure the normal patrol mission of the UAV.

5.3. Wireless charging efficiency

The key component of the UAV radio energy transmission component is the coupling structure, which mainly includes the energy transmitting coil and the energy receiving coil. The size of its charging efficiency depends on the coil shape, size, relative position and number of turns. The UAV wireless charging coil mainly includes transmitting core (rectangular), transmitting coil (rectangular), receiving core (ring) and receiving coil (spiral). The transmitting core is composed of small ferrite, size 300×300×3mm; the energy emitting coil is a rectangular coil structure with 20 turns, the most peripheral coil size 250×250mm and the inner coil size 50mm×50mm.

The magnetic materials and experimental environmental parameters used: the magnetic material is ferrite, the ambient temperature is 20℃, and the air gap medium is air. In this experimental environment, by constantly changing the deviation Angle α, the measured minimum overall charging efficiency is 89.7%.

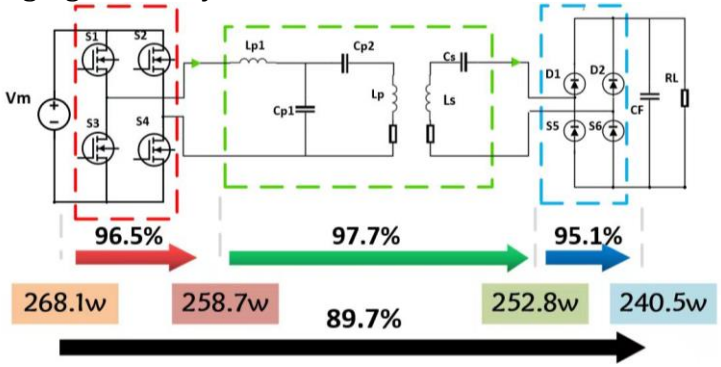

Fig. 6 Analysis of the wireless charging efficiency

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6. System principle and performance analysis

6.1. Wireless charging

Radio energy transmission technology is to realize the wireless transmission of electric energy through the electromagnetic coupling between the transmitting coil and the receiving coil. Transmitter dc electricity through high frequency inverter transformation for high frequency alternating current to provide incentives for transmission coil, in the transmission coil and receiving coil electromagnetic coupling, in the magnetic coupling structure of receiving coil induction with the frequency of alternating current, electricity in the case of no need for electrical connection can be transmitted to the system, then after rectification filter such as electrical change, can meet the demand of UAV power supply.

Hardware circuit design of transmitter: transmitter is mainly composed of control circuit, drive circuit, sampling circuit, high frequency inverter circuit, LCC compensation network and transmission coil. The high frequency inverter circuit adopts the full bridge structure, the DC input passes through the high frequency full bridge inverter and LCC compensation network, and transforms into the high frequency alternating current to provide excitation for the transmission coil.

Hardware circuit design of the receiver: the receiving end is mainly composed of control circuit, drive circuit, sampling circuit, high frequency rectification filter circuit, DC-DC conversion circuit, series compensation and receiving coil. The receiving coil is coupled to the alternating current of the same frequency, and the power supply demand of UAV can be met through the series compensation network, single-phase bridge uncontrolled rectifier circuit, filter and DC-DC transformation.

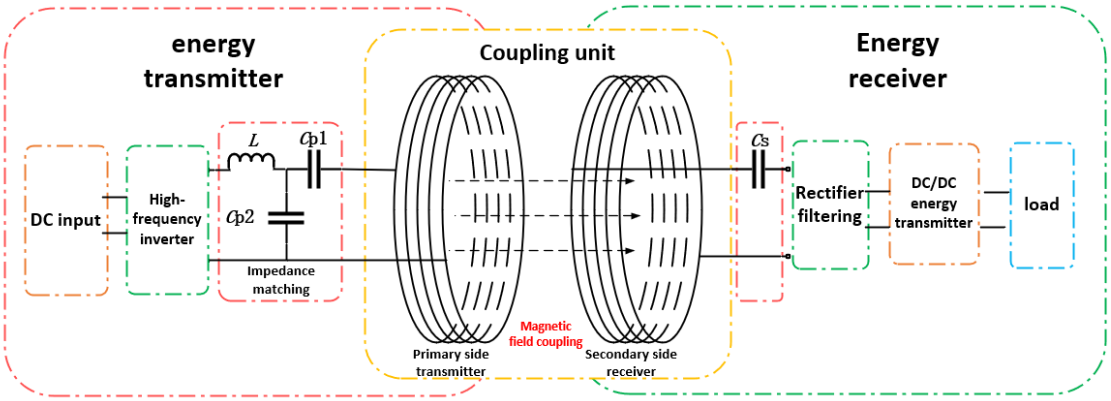

Fig. 7 Overall schematic diagram of the system hardware

6.2. Scenery complementary power generation

The principle of wind-solar complementary power generation mainly involves the complementary utilization of solar energy and wind energy. The intelligent controller controls the operation of the wind turbine and the solar cell square array according to the changes of the wind power and solar radiation. The wind-solar complementary power generation system improves the stability and reliability of the power generation system by utilizing the complementarity of wind and solar energy. At the same time, due to the use of intelligent control and optimized management, the system can also realize efficient, environmentally friendly energy utilization.

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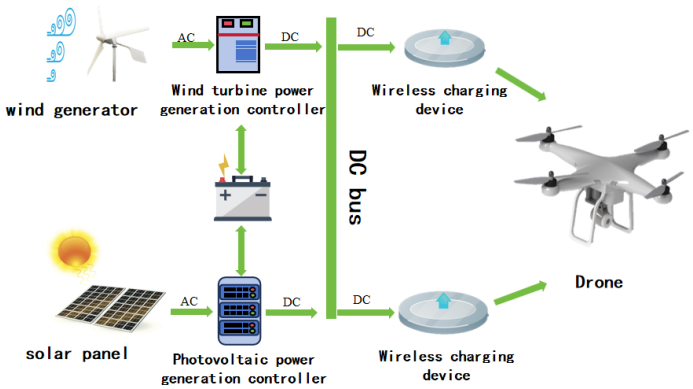

Fig. 8 Schematic diagram of wind-solar complementary power generation

6.3. Scene-based function application

Cloud platform camera and infrared sensing monitoring

The system is equipped with 4k HD anti-shake camera and no distortion HD infrared sensing module, which can timely discover individuals near the border during the border patrol work, 5G/2.4GHz transmits the picture to the cloud; in addition, illegal poaching and illegal logging in the field, bringing more extensive application scenarios to the equipment.

Real-time sound transmission

When special circumstances are found, such as illegal entry, illegal poaching and other situations, operators can conduct real-time sound transmission through the speakers of the drone in the cloud, so as to warn the current illegal behaviors to avoid further deterioration of the situation.

Light-load emergency delivery

At the bottom of the system drones set mount, maximum load 5kg, within the scope of work some personnel health safety accidents, fully capable of emergency delivery work, using the uav speed and ignore the advantages of the terrain, can be in the first time for the necessary medical supplies, precious gold rescue time for life.

Fig. 9 The drone delivers the medical boxes

Fig. 10 The drones conduct border inspection

7. Conclusion

The drones have multiple advantages, such as safety, environmental protection and intelligence. The existing drone requires operators to carry the drone to the inspection target to control and replenish the power. The wireless charging UAV designed by our team has solved the problem of battery replacement and realized the real autonomous flight operation. No need for personnel recycling, energy self-sufficiency, highly intelligent, improve the convenience of use,

targeted to solve the current problems in the current market, which undoubtedly makes the team's UAV has a wide range of market prospects.

In the field of UAV, wireless charging technology and wind-solar complementary power generation technology have broad application prospects. Wind-solar complementary power generation technology uses solar panels and wind power generation equipment on energy base stations to convert wind and light energy into electric energy. These two technologies provide more environmentally friendly and independent charging methods and lasting power support for uav, reduce the dependence on personnel control, and realize a high degree of automation and intelligence. Wireless charging UAV significantly reduces the operation and maintenance cost, improves the working efficiency of UAV in the complex environment, and further expands the application field of UAV. Using wind-solar complementary power generation technology, UAV can fly for a long time in areas with sufficient light or wind; Using wireless charging technology, UAV does not need to replace batteries frequently or rely on external power supply, which greatly improves the environmental adaptability of UAV, and lays a solid foundation for the security and stability of national border and sustainable development.

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