Design of Unmanned Aerial Vehicle Automatic Endurance System

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Abstract. With electricity as the main power energy, the UAV has been affected by the impact of battery storage on the flight time and flight time, which makes the UAV need to constantly replace the battery to ensure the long-term operation. The automatic endurance system takes the remaining power of the UAV as the independent variable, and the average value of the flight data of the UAV battery for nearly three times as the judgment basis. It realizes the automatic navigation in the UAV area, charges the base station after landing accurately, and improves the endurance time of the UAV.

Keywords: UAV · Automatic endurance · Wireless charging · Electromagnetic induction

1 Introduction

With the rapid development of technology, drone applications have become more and more extensive, but due to the bottleneck problem of drone battery technology, the flight time and flight distance limitations in practical applications are subject to [1]. The design of the subject's automatic endurance system has become one of the key technologies to realize the automatic endurance of the UAV area.

2 Overall Design of UAV Automatic Endurance System

The system design plan is intended to propose a design theory for an automatic drone endurance system. The automatic drone endurance system consists of a wireless charging base station, a drone endurance management system, and an automatic endurance system general controller (hereinafter referred to as the total controller) partly composed.

The charging base station controller monitors the working status and GPS position of the base station in real time, and sends these status information to the general controller at the same time. After receiving the screening of the status information of the base station, the general controller sends the location of the currently available base

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station to each drone. The UAV monitors and counts its own battery status information, calculates the distance that can be flown per unit of power in different power ranges, and uses it as reference data for the next flight; and sets a remaining power threshold θ based on the battery information when the battery monitoring module finds When the remaining power reaches the remaining power threshold θ, the UAV starts to receive the current available base station position coordinates, compares and calculates it with the current own position coordinates, selects the most suitable base station and sends a charging request to the general controller. After receiving the request, the master controller locks the base station to avoid repeated selection by other drones. The process is shown in Fig. 1.

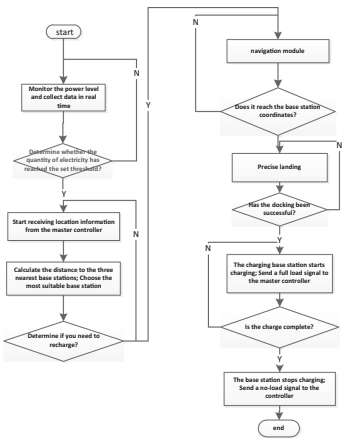

Fig. 1. Design flow chart of UAV automatic endurance

3 Wireless Charging Base Station

The wireless charging base station is one of the key points of system design. The basic principle adopts the electromagnetic induction method. The alternating current of a certain frequency in the primary coil generates a certain intensity of current in the secondary coil through electromagnetic induction, thereby transferring energy from the transmitting end to the receiving end. A transmitting coil is set in the base station, and a receiving coil is mounted on the bottom of the drone, and the electric energy can be transmitted from the transmitting end to the receiving end [2, 3]. It is composed of base station controller, charging circuit, GPS module, base station monitoring module, etc. The wireless charging base station is powered by external 220 V AC power, and is converted to DC power by switching power supply and buck regulator module all the way to power the controller and other functional modules; All the way is directly connected with the launch coil, controlled by the relay, and it is charged when the drone is landing. The overall structure of the wireless charging base station is shown in Fig. 2.

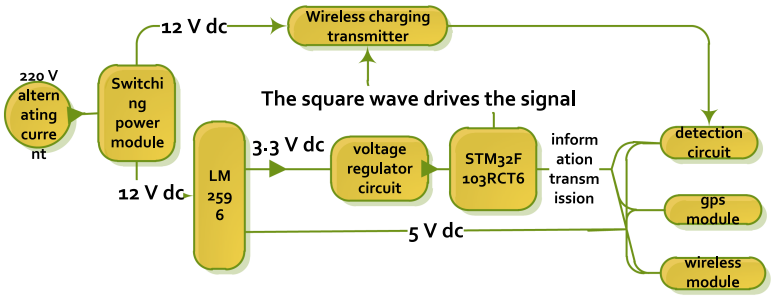

Fig. 2. Overall design structure diagram of wireless charging base station

Using STM32F103RCT6 as a wireless charging base station controller, cortex-M3 high-performance core, low power consumption, short delay, strong interrupt handling ability, very suitable for base station control and management. STM32F103RCT6 as a base station controller in addition to controlling the GPS module and wireless communication module to achieve positioning and information transmission, also has an important role is to use the TIM timer to generate PWM square wave after TPS28225 conversion, drive NMOS tube to achieve push-pull output, To the resonant circuit to achieve the transmission of electrical energy. The transmitter circuit of the wireless charging base station is shown in Fig. 3.

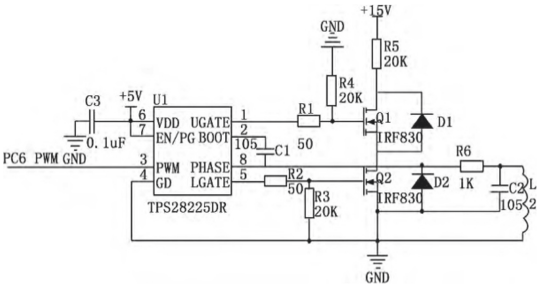

Fig. 3. Wireless charging transmitter circuit diagram

STM32F103RCT6 uses TIM3_ch2 to generate PWM with resonance frequency as a signal to drive the inverter circuit. The flow chart of PWM generation and configuration is shown in Fig. 4.

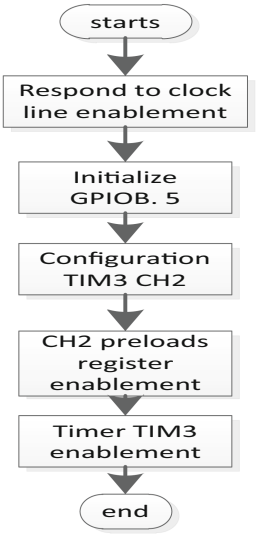

Fig. 4. PWM initialization program flow chart

4 UAV Endurance Management System

Accurate real-time monitoring of the battery's status is the basis for automatic drone battery life. The reception of electric energy, the measurement of remaining power, the setting of the UAV charging threshold based on battery characteristics, and the best choice of charging base stations are the innovations and design priorities of the system design.

4.1 Wireless Charging Receiver Design

The receiving end of wireless charging is composed of a coil at the receiving end, a high-frequency voltage stabilizing rectifier circuit, and a charging management circuit. The wireless charging receiving and rectifying circuit is shown in Fig. 5.

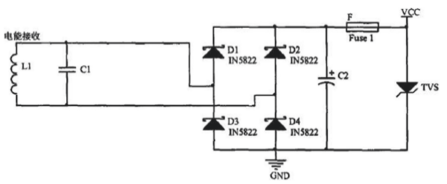

Fig. 5. Wireless charging receiving circuit diagram

The charging management circuit is built with the CN3703 integrated circuit as the core, indicating the charging status of the battery through the on and off of the LED light, and adjusting the charging current by changing the size of the resistor. The specific circuit design is shown in Fig. 6.

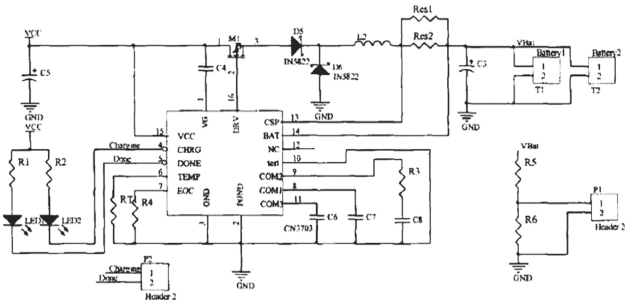

Fig. 6. Receiver charge management circuit diagram

4.2 Acquisition of Remaining Power

The microcontroller sends a voltage detection command to the DS2762 every 88 ms. If the pressure difference is positive, the battery is in the charging state; when the pressure difference is negative, the battery is in the discharging state. The single chip microcomputer can use the control command to control the DS2762 to monitor the battery voltage, current, charge and discharge status and remaining power and other parameters in real time, and automatically store the data into the corresponding register, which is read and used by the single chip microcomputer [4–6].

To obtain the remaining power, the microcontroller can directly read the value in the current accumulation register. The DS2762 automatically monitors the current value in real time and stores it in the current accumulation register. During the reading process, you need to check the status of the EEC flag first. The specific procedure The process is shown in Fig. 7.

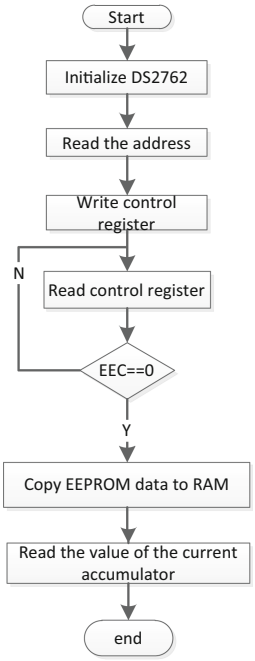

Fig. 7. Flow chart of the remaining battery reading program

4.3 Setting Method of Charging Threshold

After obtaining the remaining power of the drone, collect the relationship between the flying distance of the drone and the remaining power [5–9]. The specific methods are as follows:

Taking each w% of electricity as a detection unit, each time the drone's electricity drops by w%, record the flying distance L of the drone during this process, so as to obtain L_1, L_2, …, L_n, corresponding to the flying distance The power range is 0-w%, w %-2w%, …, (100-w)%-100%; after recording 3 sets of L_1, L_2, …, L_n data, calculate the The average value of the flight distance A_k in the same detection unit, and then each time a new set of L_1, L_2, …, L_n data is entered, replacing it with the first set of data entered; after the collected flight distance A_k corresponds to the power range After the relationship, according to the downward trend of the flight distance corresponding to each w% of power with the decrease of the power range, the flight distance of the aircraft in one or more power ranges with lower power is obtained, and the obtained flight distance is subtracted by a preset value as the final prediction.

4.4 The Choice of Charging base station

When the remaining power reaches the set power threshold, the UAV starts to receive the location information of available wireless charging base stations, and determines the most suitable charging base station based on its location information and remaining

power, and requests charging from the general controller [10–12]. The location selection scheme of the specific wireless charging base station is as follows:

When the power of the drone reaches the preset threshold θ, the drone controller reads the average value of the last three flight records in its own battery information memory, roughly estimates the current power can fly the longest distance, and records it as Q_0; the drone starts Receive the location information of the available charging base stations transmitted by the general control, and calculate and filter out the available base stations whose horizontal and vertical coordinate distances are not greater than the UAV's own GPS module, combined with the UAV's own vertical height information, calculate And select a base station with the minimum distance in the direction of the flight target available, the distance between the two is recorded as Q_1, and a minimum distance opposite to the flight target can be used as the location information of the base station, the distance is recorded as Q_2.

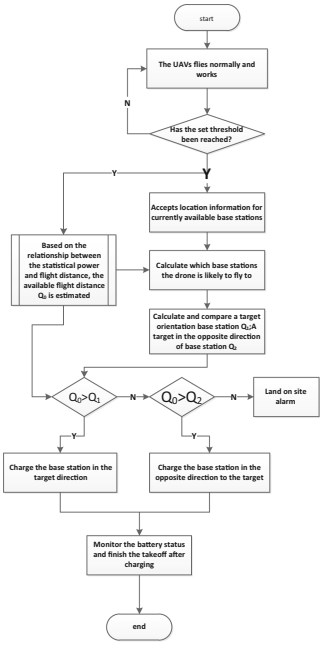

Fig. 8. Flow chart of automatic endurance station selection

The general rules for the selection of the automatic endurance base station for the drone are as follows: when $Q_0 < Q_1$ and $Q_0 < Q_2$, the drone landed in situ, and sent the location information to the general controller to alarm, waiting for the staff to replace the battery or other processing. When $Q_0 < Q_1$ and $Q_0 > Q_2$, the available base station with the smallest distance to the target is charged. When $Q_0 > Q_1$, the available base station with the smallest distance to the direction close to the target is charged. When the battery management module detects that its own battery has been charged, the drone continues to take off and fly to the target location. The process is shown in Fig. 8.

5 Conclusion

Automatic drone battery life is a problem that must be solved in the development of regional drones in the future, and it is also a basis for the realization of intelligent drone. Therefore, in the absence of innovations in battery technology, the automatic drone battery life system is One of the effective ways to solve the problem of drone power energy. The solution to this problem allows the drone to save landing time, and it can work continuously and uninterruptedly in a certain area with high efficiency, such as express delivery and delivery.

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