Journal of Computing and Electronic Information Management

ISSN: 2413-1660

# Design of Small Logistics Distribution UAV and Its Distribution System

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**Abstract:** Based on the background of the rapid development of the Internet of Things, this paper analyses and explores the great role and significance of UAV in logistics distribution from various aspects, and carries out in-depth research on the basis of demonstrating the feasibility of UAV in the last kilometer distribution. It creatively puts forward the use environment, customer group attributes and its shape, function and load capacity of UAV in logistics distribution. Detailed design requirements for durability, safety, etc. Finally, some suggestions are given for the design of the last kilometer UAV distribution system.

**Keywords:** Internet of Things, UAV distribution, last kilometer.

## 1. Introduction

With the development of information technology, as the extension and expansion of the Internet, the Internet of Things emphasizes communication and information exchange between things. It has gradually become the core of the new generation of information technology and ushered in a wave of development.

It can be said that the Internet of Things is another major productivity to promote the development of the world market. Its proposal embodies the concept of great integration, and strengthens the links among the elements in the integration circle, breaks the traditional mode of separating physical facilities from information facilities, and largely solves many practical problems in the transportation, transportation, medical and other industries. Among them, the combination of Internet of Things and express business is considered as a good opportunity for the transformation of traditional express industry to intelligent express industry. It is of great significance for the development of express industry to study the problems and demand points of express service under Internet of Things.

## 2. Overview of Design Ideas

(1)Background Internet of Things (IOT) for logistics UAV refers to a network that intelligently identifies, locates, tracks, monitors and manages any object through radio frequency identification, infrared sensors, laser scanners and global positioning system (GPS) and links it to the Internet for information exchange and communication in accordance with the agreed agreements. The rapid development of Internet of Things has gradually laid a solid foundation for the development of express industry. It can be said that the Internet of Things and express service have been integrated into all aspects of public life, and gradually become the basic elements of modern production and circulation, there is a huge space for coordinated development in the future. Therefore, increasing the integration of the Internet of Things and express delivery industry and promoting the development of intelligent logistics will play a great role in promoting China' s economic and social development and industrial upgrading and transformation.

(2) Necessity and application scenarios

Unmanned aerial vehicle (UAV) aerial photography and performance are common, but these applications are only the tip of the iceberg. It is also widely used in crop protection, power inspection, geographic mapping, search and rescue and logistics, especially in the logistics industry, which has broad prospects. China& apos;s logistics industry has a huge volume and a large space for improvement. The in-depth development of mobile e-commerce, mobile payment, unbounded retail and the change of people& apos;s consumption habits objectively put forward higher requirements for the service level of logistics.

UAV logistics emerges at the historic moment and is a model of combining advanced technology with market demand. As early as 2013, the concept of UAV logistics was introduced to the public by Amazon, the American business giant. Shunfeng, the Chinese express giant, was also one of the earliest companies to lay out UAV logistics. Advanced enterprises often have a forward-looking strategic vision, with the courage to try first, through innovative technology and services to maintain the industry& apos;s leading, in their own success at the same time, but also to make outstanding contributions to human society. In short, UAV logistics is to carry out logistics activities with UAV as the main tool, or to achieve key tasks with UAV in logistics activities. Its scope includes UAV express delivery (terminal distribution), regional UAV transportation, and inventory and warehousing management with UAV.

## 3. Selection of Fixed Wing and Rotor

### 3.1 Characteristics of Fixed Wing UAV

Long take-off distance makes it difficult to find a suitable take-off and landing place in

the city. There is a minimum speed limit when flying. It is not suitable for flying in complex urban buildings. It has a narrow space for carrying, and it is not suitable for taking-out transportation.

### 3.2 Characteristics of Multi-Rotor UAV

Unmanned aerial vehicles (UAVs) have poor endurance, long battery charging time, poor weather resistance and can not be dispatched in harsh weather. There is no special place for express delivery in existing UAVs. They are easy to dump when transporting goods, and are prone to heat or super-cooling during transportation.

The structure of UAV is composed of ground system and air system. The ground system includes ground control system, charging power supply, and air system includes UAV body, actuator, sensor and so on.

Compared with traditional oil-driven UAV, electric-driven UAV has less vibration, less pollution and stable flight process. It is suitable for various flight modes and various flight environments. Electric and oil-driven UAV has fast start-up speed and easy maintenance of generators and engines.

## 4. Power matching

According to the relationship between thrust and velocity, the power of UAV at constant speed is as follows:

Plev is the required power for UAV to fly at uniform speed; F is the traction force; V is the uniform speed; m is the rated weight; CD is the air drag coefficient; CL is the air lift coefficient; G is the gravity acceleration; P is the air density; S is the reference area of the wing.

The torque generated by the rotor is offset by the torque generated by the stator; the aerodynamic force generated by the relative airspeed of the aircraft relative to the air is very small and can be ignored because of the low relative airspeed in hovering state. Finally, the force and moment formula of the Four-rotor UAV is obtained.

$$X = \frac{\partial F}{\partial \delta}(\delta_2 + \delta_4) - mg\sin\theta$$

$$L = \frac{\partial F}{\partial \delta}(\delta_1 + \delta_3)v$$

$$Y = \frac{\partial F}{\partial \delta}(-\delta_1 - \delta_3) + mg\cos\theta\sin\Phi$$

$$M = \frac{\partial F}{\partial \delta}(\delta_2 + \delta_4)v$$

$$Z = mg\cos\theta\cos\Phi - T(\Omega)\cos\theta\cos\Phi$$

$$N = \frac{\partial F}{\partial \delta}h(-\delta_1 - \delta_2 + \delta_3 + \delta_4)$$

T( Ω) is the upward lifting force, in which_is the rotational speed of the rotor motor; X, Y and Z are the longitudinal force, lateral force and vertical force; Theta is the angle of

the UAV when it tilts upward; Q, S, V and H are the dynamic pressure of the rotor slip flow, the area of the steering rudder, the vertical distance from the aerodynamic focus of the steering rudder to the XY plane, and the distance from the aerodynamic focus of the steering rudder to the Z axis, respectively.CL is the lift coefficient of the rudder, and the drag coefficient is neglected because it is relatively small.

## 5. Structure Design of Small Logistics Distribution UAV

According to the structure of four rotors, the batteries are arranged on the top of the whole fuselage, and the aerodynamic requirements need to be met. The size and weight of the design should consider the lifting force of the wings. The relevant UAVs are designed according to the following schemes:

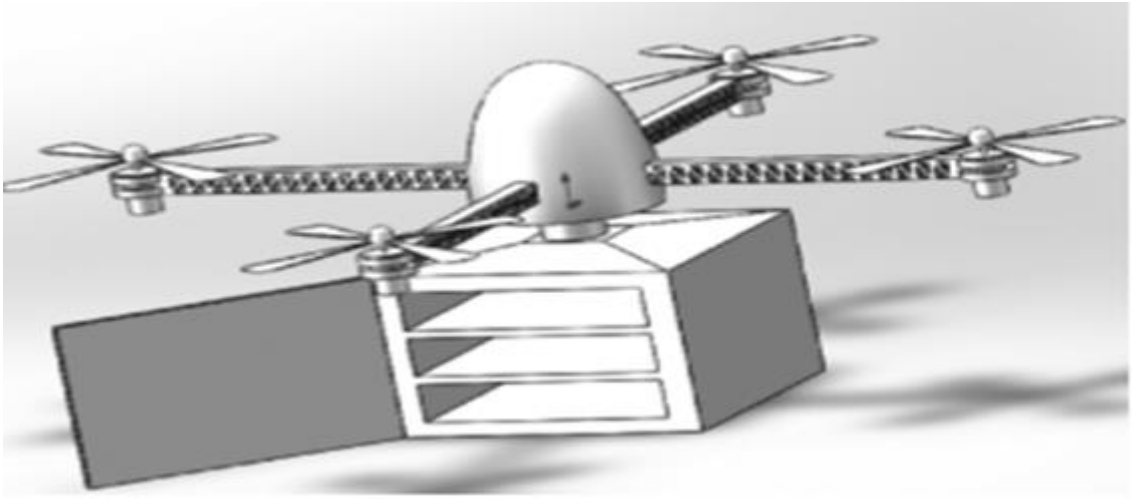
(1)Four rotors are used in the wing, and truss structure is used to connect and fix the fuselage to ensure that the fuselage has sufficient space position and battery can be reasonably arranged.

(2)Rain-proof motor is used for the motor. Drainage holes are arranged under the motor. In case of rain and snow, the UAV can fly normally without increasing its load.

(3)The fuselage adopts radiation-proof material and hydrophobic coating to prevent high temperature radiation in high altitude, affect the normal operation of UAV flight and control system, and increase the load of viscous water on the fuselage.

(4)In order to ensure the strength, the length of the boom truss of UAV is 800mm, the size of the storage box is 800 *800mm, and the storage box is three-layer design. It has the function of fixing and keeping warm. It is also suitable for the transportation of food. The storage box is equipped with a password lock, which can ensure the safety of goods through face recognition technology. The rotor of UAV adopts waterproof motor, and there are two waterproof bearings in the fan and armature to avoid a large amount of rainwater entering; the armature uses thicker enameled wires to maintain normal operation when entering a small amount of water; there is a heat dissipation fan under the armature, which generates air source through rotation, and generates gas circulation through the bearing tray and the vent of the motor shell, thus taking away surplus. Heat and water intake are used for heat dissipation and drying. The eaves are used at the ventilation ports of the motor housing to ensure that rainwater does not enter the motor interior through the ventilation ports of the motor housing when the UAV is flying. Dupont Teflon AF hydrophobic coating is applied on the surface of UAV airframe and dining cabinet to reduce the stickiness between surface and rainwater and ensure that rainwater can fall into the air smoothly during flight. In addition, the UAV is equipped with navigation device and video transmission device, which makes it convenient for the controller to monitor the distribution of the UAV remotely. The tray is filled with drainage holes, which can effectively eliminate the deposition of rainwater

on rainy days and reduce the weight of UAV.



## 6. Innovations

Short-haul logistics UAV uses the mature four-wing UAV as the platform and configures relevant modules. Its core components are hoisting containers and face recognition cameras, which are responsible for the storage of transport items, and intelligent navigation systems directly connected to large geographic data networks. The three modules are responsible for the storage, transportation and handover of distribution items, forming the KTC body of Keep & Transport & Connect to provide the UAV with the ability of independent logistics operation. Intelligent navigation system will undertake the guidance task of logistics UAV flight, plan flight route for UAV in complex urban terrain, and ensure the rapid and safe distribution process of logistics UAV. Macroscopically, the intelligent navigation module of logistics UAV will mark the starting position and destination according to the map data provided by the navigation network, calculate the optimal path to guide the UAV, and keep receiving environmental feedback in the process of logistics transportation. According to the relevant interference factors, such as the unmanned confidentiality of the first route is too high, and the destination of goods distribution changes, etc. The way forward. In the direct process of logistics UAV flight, intelligent navigation system will also help logistics UAV to avoid obstacles. At the same time, according to environmental factors, adjust speed and altitude and other flight parameters, maximize the stability of UAV flight process, ensure the safety of transport items in logistics transportation process, and guide UAV to reach its destination safely. At the same time, intelligent navigation technology will provide the UAV with return route and guide it to complete the return process after the logistics UAV completes the logistics distribution task. Intelligent navigation system is the basic guarantee for logistics UAV to complete transportation tasks.

Face recognition technology guarantees the direct handover between logistics UAV and service object. When the target of logistics distribution is the recipient himself, logistics

UAV will use face recognition technology to complete the authentication of service object. When the logistics UAV arrives near the location signal source provided by the mobile device, the camera on the UAV will open the face recognition program to recognize and proofread the face in the environment near the UAV. When the service object is identified, the UAV will slowly approach and unlock the relevant rights of the next action to complete the handover with the service object. When the face information registered by the service object is not confirmed, the container of logistic UAV will remain locked, and will not be opened by staff other than those with relevant management authority. With face recognition technology, logistics UAVs can interact with people directly, which meets the needs of direct docking with customers in "door-to-door" distribution process and catering takeaway services.

## Acknowledgements

This paper was financially supported by Binzhou University "Young Talents Innovation Project" Research Fund Project (BZXYQNLG2018011).

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