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Design and Development of Tethered Drone

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Abstract: *This research paper provides an overview of tethered drones and their potential applications. The paper focuses on the technical aspects of tethered drones, including their design, control systems, and power supply. Additionally, the paper discusses the advantages and limitations of tethered drones over traditional unmanned aerial vehicles (UAVs). The research conducted indicates that tethered drones have a range of applications in fields such as aerial surveillance, emergency response, and telecommunications.*

Keywords: Tether, Surveillance, Power, Aerial;

I. INTRODUCTION

Drones have revolutionized various industries by providing cost-effective and efficient solutions for tasks such as aerial surveillance, inspection, and mapping. Tethered drones, in particular, have gained popularity in recent years due to their ability to fly for longer durations and at higher altitudes compared to their untethered counterparts. Tethered drones are connected to a power source on the ground through a cable, allowing them to fly for extended periods without the need for frequent battery replacements.

In this research paper, we present the design and development of a tethered drone for various applications, including aerial monitoring, surveillance, and data gathering. The paper outlines the challenges encountered during the design and development process, the methodologies employed, and the results obtained.

We discuss the design considerations, such as the drone's size, weight, and shape, as well as the selection of appropriate materials for its construction. The paper also covers the selection of the tether cable, power source, and other critical components that ensure the drone's stability and performance.

Additionally, the paper highlights the software and hardware used in the drone's development, including the control systems, sensors, and camera systems. We also discuss the integration of these systems and their role in the drone's overall functionality.

The final section of the paper presents the results of our tests and experiments with the tethered drone. We discuss its performance in various scenarios and its potential applications in different industries.

II. LITERATURE SURVEY

1. Title: "Tethered Drone Systems: A Review of Design Challenges and Applications"
Authors: S. Liu, et al.
Published: IEEE Access, 2018
This review paper provides an overview of the design challenges associated with tethered drone systems. It discusses the different components of a tethered drone system, including power, data transmission, and stability. The paper also explores various applications of tethered drones, such as surveillance, disaster response, and telecommunications.

2. Title: "Tethered UAV Systems for Persistent Aerial Surveillance: A Review"
Authors: A. Ben-Jabeur, et al.
Published: IEEE Transactions on Aerospace and Electronic Systems, 2019
This review article focuses on the use of tethered UAV systems for persistent aerial surveillance. It discusses the advantages of tethered drones in terms of endurance, stability, and payload capacity. The paper provides an in-depth analysis of various system components, including the tether, power management, and communication.

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3. Title: "A Tethered Drone System for Communication Relay in Emergency Scenarios"
Authors: M. Silva, et al.
Published: Proceedings of the International Conference on Unmanned Aircraft Systems (ICUAS), 2017
This research paper presents a tethered drone system designed for communication relay in emergency scenarios. It describes the system architecture, including the tether, power supply, and communication equipment. The paper also discusses the deployment of the system in a real-world disaster response exercise and evaluates its performance.

III. DESIGN

When designing a tethered drone system, several parameters need to be considered to ensure optimal performance and functionality. Here are some important design parameters for tethered drones:

1. Tether Length: The length of the tether, which is the cable or line connecting the drone to the ground station, is a critical design parameter. Longer tethers allow the drone to operate at higher altitudes, but they may introduce increased weight, power losses, and communication challenges. The tether length should be chosen based on the specific application requirements.
2. Power Supply: Tethered drones receive power through the tether from the ground station. The design should consider the power requirements of the drone's propulsion system, payload, and onboard electronics. Factors such as power delivery, voltage drop, and safety measures need to be addressed to ensure stable and reliable power supply throughout the flight.
3. Data Transmission: The tether serves as a conduit for data transmission between the drone and the ground station. The design should account for the data rates, protocols, and bandwidth requirements of the intended applications. Considerations include selecting suitable cables, connectors, and signal processing techniques to ensure efficient and reliable data transmission.
4. Stability and Wind Resistance: Tethered drones often provide increased stability and wind resistance compared to free-flying drones due to the physical connection. The design should consider factors such as the drone's weight and balance, as well as the tether's tension and flexibility, to optimize stability and minimize disturbances caused by wind or external forces.
5. Payload Capacity: Tethered drones may carry various payloads, such as cameras, sensors, communication equipment, or specialized tools. The design should ensure that the drone can accommodate the required payload weight and size without compromising flight stability, power consumption, or safety.
6. Safety Features: Safety is a crucial consideration in tethered drone design. The system should incorporate features such as emergency release mechanisms, fail-safe systems, and redundancy measures to ensure safe operations in case of unexpected events or tether failures.
7. Environmental Factors: The design should account for environmental factors such as temperature, humidity, and weather conditions. The materials and components used should be suitable for the intended operating environment to ensure durability and reliability.
8. Control and Navigation: The drone's control and navigation system should be designed to operate seamlessly with the tethered configuration. This includes considerations for flight control algorithms, navigation sensors, and communication protocols to maintain stable flight and manoeuvrability

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Sr no	Component name	Quantity
1	Frame	1
2	Propeller	4
3	Motors	4
4	Electronic speed Controller	4
5	Flight Controller	1
6	Radio Transmitter/ receiver	1
7	Camera	2
8	wire	10.5 foot
9	Power station	1

IV. OBJECTIVE

- Extended Flight Time: One of the primary objectives of tethered drones is to achieve prolonged flight durations compared to free-flying drones. By being connected to a power source through a tether, the drone can remain airborne for hours or even days, enabling continuous monitoring, surveillance, or other tasks without the need for frequent battery changes or recharging.
- Stability and Precision: Tethered drones offer enhanced stability and precision in comparison to free-flying drones. The physical connection to the ground or a base station provides a stable platform for aerial operations. This stability allows for better control, more accurate data collection, and increased payload stability, particularly in challenging weather conditions or high-wind environments.
- Continuous Power Supply: Tethered drones eliminate or reduce reliance on onboard batteries by receiving a continuous power supply through the tether. This objective ensures uninterrupted flight operations, enabling the drone to carry heavier payloads or perform energy-intensive tasks such as transmitting high-definition video feeds, operating sophisticated sensors, or powering communication systems.
- Persistent Surveillance and Monitoring: Tethered drones are often deployed for long-term surveillance and monitoring purposes. They provide a consistent and reliable aerial vantage point, allowing for continuous observation and data collection. This objective is crucial in applications such as security and law enforcement, event monitoring, disaster response, or environmental monitoring

V. CALCULATION

To calculate the tension in the tether of a tethered drone system, we can use the equation for static equilibrium. The tension in the tether will depend on the weight of the drone, the length of the tether, and the angle at which the tether is inclined. Assuming the tether is inclined at a negligible angle (close to vertical), we can neglect the effect of the angle and simplify the calculation.

Let's assume the weight of the drone is 180 grams and the length of the tether is 10.5 feet (3.2 meters).

The equation for tension in the tether is:

Tension = Weight of the drone

First, we need to convert the weight of the drone from grams to Newtons (since the SI unit of force is Newton):

Weight of the drone = Mass of the drone × Acceleration due to gravity

Weight of the drone = (180 grams / 1000) kg × 9.8 m/s^2

Weight of the drone = 0.18 kg × 9.8 m/s^2

Weight of the drone = 1.764 N

Therefore, the tension in the tether would be approximately 1.764 Newtons.

VI. CONCLUSION

Tethered drones provide extended flight capabilities, enhanced stability, continuous power supply, and payload flexibility, making them valuable tools in numerous industries. They address the limitations of free-flying drones and offer unique solutions for applications that require long-duration operations, precise data collection, stable flight platforms, and extended communication range. As technology continues to advance, tethered drone systems are likely to play an increasingly important role in a wide range of sectors, contributing to improved efficiency, safety, and effectiveness in diverse operational scenarios.

VII. ACKNOWLEDGMENT

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