International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 6 Volume No.6 October - November – 2022
DOI:10.46647/ijetms.2022.v06i06.079 ISSN: 2581-4621

# DESIGN AND CONTROL OF HYBRIDHELIUM ORNITHOPTER

**Sona Fowzeya S[1] , Rithikashree P V[2] ,Raghunath M[3]**
[1]*UG - Mechatronics Engineering,Bannari Amman Institute of Technology, Erode,Tamilnadu.*
[2]*UG - Mechatronics Engineering,Bannari Amman Institute of Technology, Erode,Tamilnadu.*
[3]*Assistant Professor, Mechatronics Engineering,Bannari Amman Institute of Technology, Erode,Tamilnadu.*

**ABSTRACT**
Unmanned Aerial Vehicles (UAV) are devices that can be operated without human presence inside them. In the era of developing technologies, the need for humans tomonitor their surroundings much more feasibly proposes an important need. In that way,this paper proposes to develop a hybrid helium blimp structure filled with helium gas. The structure can be operated at six degrees of freedom, which adds to its much-improved userexperience and various flight methods. To record motion and see the environment around the blimp, an advanced camera is placed on the bottom of the structure, to record the motion of the surroundings. The external surface is elastic matter, which when it comes incontact with humans or other surroundings doesn't pose a threat, due to its buoyancy property. The entire model can be transported from one place to another, by just removing the external portionsof the blimp when traveling. The user on the ground can navigate and control the blimp, with the help of a user interface. The paper showcases the design, working, and real-life results of the structure.
**Keywords:** Unmanned Aerial Vehicle, Helium, Nylon material, Camera.

## 1. Introduction

In the developing world of technology and science, the mobile robotics field has achieved great heights, with their innovation. In this paper, we combine it with the aeronautical technology available, for the use of humans. In recent just like the mobile robotics, humans have spent their time in developing and learning about the Unmanned Aerial Vehicles (UAV), they have used its help in the fields of agriculturemonitoring, surveillance, transportation, entertainment purposes and so on. The design of the blimp consists of a hull, which is spherical in shape, which is surrounded by a four tetrahedrally arranged thrusters. In the center of the sphere is located the center of gravity of the blimp, which results in more advantages during the flight mechanisms, which will be talked about in the results section of this paper Holonomic motion can be achieved by the blimp, which occurs a result. when the controlled degrees of freedom, matches with the total degrees of freedom present in the structure. The blimp is designed in such a way, that it can move in any motion, beit linear or any kind of motion, without any difficulties imposed on the user nor on the design of the blimp. The camera used for capturing footages is placed on the bottom portion of the hull, it can record and save the live movements of humans and the nearby environment for the required and necessary purposes.

## 2. Experimental Methods or Methodology

According to the author, the wheeled blimp maintains its balance by standing on theground and employing a passive wheel system similar to a caster. Since the stationary blimp system responds sensitively to air flow even in inside situations, stationary position control is necessary in tele-guidance applications to allow the wheeled blimp naturally converse with humans in standing phase. The controller's effectiveness will be tested using an actual wheeled blimp system.

[1] This study suggests using the idea of a hybrid blimp to create a safe drone thatcan avoid collisions even in the absence of any power. The vehicle is meant to fly indoors, eliminating the need for such worries. This project will investigate the deployment of the hybrid blimp drone to facilitate logistics inside shopping malls.Such aircraft often have poor wind-worthiness outdoors.

[2] The biggest progress can be made with inflated blimps where lighter than air gases can be used, since most aerodynamic research is focused on how to improve lift by developing its

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aerodynamic shape. Holonomic motion can be achieved by the blimp, which occurs a result when the controlled degrees of freedom, matches with the total degrees of freedom present in the structure. The blimp is designed in such away, that it can move in any motion, be it linear or any kind of motion, without any difficulties imposed on the user nor on the design of the blimp. The camera used for capturing footages is placed on the bottom portion of the hull, it can record and save the live movements of humans and the nearby environment for the required and necessary purposes. To reduce the impact of the collision with a human or any other surrounding, the gas filled inside the blimp is helium gas, with the neutral buoyancy property, which poses extremely less danger for any objects or humans when it comes with contact to them. The bad scenario only occurs when the hull structure of the blimp gets damaged. The problem is resolved in this paper, with the help of a double hull like structure, which will be discussed in the design section of this paper.A ring and a grill like structure, is fixed with the propellors for adding safety when someone or something comes in contact with it. The main purpose of this blimp is togive many flexible methods of using it, without losing any of its flight or navigation properties. Every purpose is to be achieved with high precision and perfect flight in any given conditions.

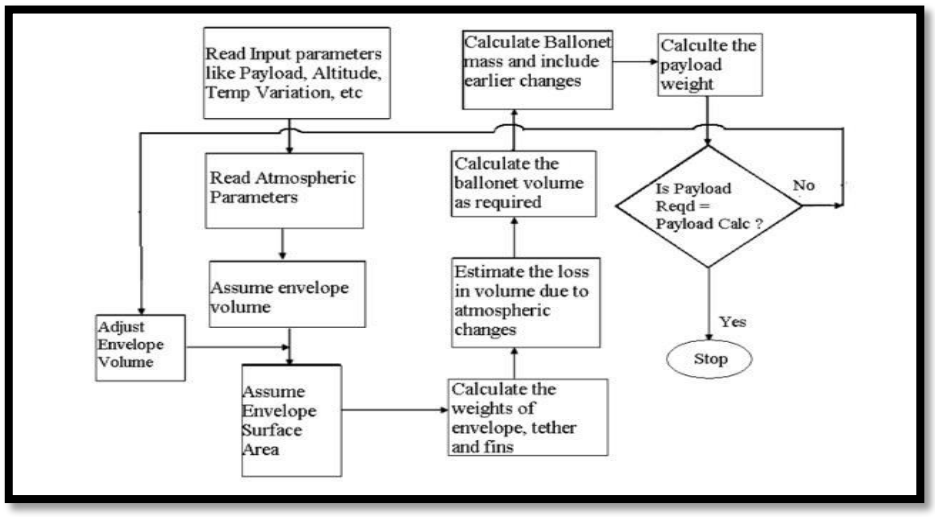


**Fig 1 Methodology Proposed**

The design of blimp is constructed in such a way, that it can survive and operate in longer durations when operated in different conditions. The use of propellers adds a better navigation and flight experience to the user controlling the blimp on the groundlevel. The blimp comes from the background of a low manufacturing cost and easy tomake process. In conclusion, the goal of this project is to develop and control a wheeled blimp for telepresence that is not constrained by impediments on the ground.By using this advantage, the combination of a wheeled vehicle and a blimp, the difficulty of maintaining a constant posture while on the floor becomes simpler. Additionally, by affixing numerous audiovisual and multi-media communication tools,the Wheeled blips are inexpensive and lightweight.

Helium balloons provide the lifting force needed to lift the drone, therefore low- performance equipment (such as dc motors, propellers, batteries, etc.) can be utilized to make the drone. As a result, the drone's cost decreased while its flight time improved. The drone's components may all be purchased from offline or onlinemarkets, making production simple.

## 3. Literature Review

According to the author, the wheeled blimp maintains its balance by standing on theground and employing a passive wheel system similar to a caster. Since the stationary blimp system responds sensitively to air flow even in inside situations, stationary position control is necessary in tele-

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guidance applications to allow the wheeled blimp naturally converse with humans in standing phase. The controller's effectiveness will be tested using an actual wheeled blimp system.[1]
This study suggests using the idea of a hybrid blimp to create a safe drone that canavoid collisions even in the absence of any power. The vehicle is meant to fly indoors, eliminating the need for such worries. This project will investigate the deployment of the hybrid blimp drone to facilitate logistics inside shopping malls.Such aircraft often have poor wind-worthiness outdoors. [2]
The biggest progress can be made with inflated blimps where lighter than air gases can be used, since most aerodynamic research is focused on how to improve lift by developing its aerodynamic shape. The gases that are lighter than air will significantly improve aerodynamics by lifting the air with their bouncing forces. Wecan readily deal with the gravitational forces of aerodynamic objects by using an inflatable envelope and gases that are lighter than air. In this essay, a design strategyfor this type of inflatable envelope will be presented. [3]
In order to increase flight time, a new hybrid drone design that uses helium assistance is put forth in this study. The majority of drones with VTOL (vertical take-off and landing) capabilities, as is well known, have a short operational time, which limits their capacity to carry out sustained operations for the assigned missions.
Therefore, this study intends to design a hybrid drone system with the obvious goal of increasing flight time, where a helium balloon is used to serve as a lifting force forthis purpose.
The hybrid drone's suggested design provides a number of advantages over previoushybrid drone types, including ease of manufacturing and a more compact size. The shape and size of the balloon, the buoyant force, the flight time, and the connector design are only a few of the assessments done for the design of the hybrid drone system. Real-world tests have shown that the hybrid drone can extend flying time bymore than 2.5 times while maintaining steady motions. This thorough research ensures that the BSJ strengthens the system's stability and resistance to swingingmotions by allowing the drone's movements to be independent of those of the balloon.
[4] The surface of a blimp can serve as an effective, lightweight projection screen for a large screen display. This research also addresses the blimp body's posture control, which is compromised by air flow. Last but not least, we plan to install thisWB in a busy public space like an exhibition hall or a department.
[5] This study provides a brand-new indoor airship concept with a stationary position control and passive wheeled system. The wheeled blimp may function both on the ground with a wheeled vehicle component and in the air with a floating blimpcomponent. The wheeled blimp balances itself on the ground using a passive wheel arrangement that resembles casters. Experiments with the actual wheeled blimp system are used to demonstrate the controller's functionality.
[6] The goal of the research paper is to demonstrate the use and potential of dronesusing cutting-edge technology. First, the use and limitations of present drone technology were discussed.
[7] Later on, we talk about the design and construction of the drone, which includes the lifting force, frame design, propellers, DC motor, and electronic system as its most crucial components. Numerous assessments are carried out for the hybrid dronesystem's design, including balloon size and shape, buoyant force, flying time, and connector design.

## 4. Design

*A) Hull*

This is the most important part of the structure, which contains all the necessary partsof the blimp such as the camera system, the propellers and so on. Nylon Fabric is usedto create the outer structure of the blimp which gives great strength to fly in harsh environmental condition, without giving much stress to the design of the blimp. It is mixed with a Polyurethane membrane adds more elasticity behavior. A design criterionwas established, which states that the bending of the actuation unit owing to full thrust induced by hull deformation must be less than one degree because there is no rigid framework connecting the individual AUs. At the point where the hull and AU meet, a baseplate was intended

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to transmit the thrust force uniformly to the envelope and minimize fabric stress peaks. Higher overpressure must be present to satisfy the requirement without reducing the size of the baseplate, which is connected to weight.However, the strength of the nylon fabric prevents the overpressure from exceeding 70 mbar. Since the inner pressure greatly varies on external factors like temperature orexterior pressure, the starting operation pressure must be considerably lower than thislimit.

*B)* CONTROL AND CAMERA MODULE

The hull holds all the electronic components such as the camera for the surveillance purposes and so on. A communication system on the blimp is necessary to address the AUs. A customized differential RS485 bus technology is used to implement it. This customized approach enables thin cable implementation, and its differential format assures reliable data transfer over the great separations between thenodes. Straight through the interior of the hull is an LED chain. An AU is attached to a wire that exits the hull outlet. A DC-to-DC converter mounted on an AU's electronicsboard supplies power to the chain. The pilot can select the LED color on a color panelon the GUI, and the color is controlled by an I2C bus. The same channels used for motion control inputs are used for its transmission.

The camera on the blimp captures the needed images and records the footages and stores them on an SSD module and then transfers it to the user via the wi-fi module.

The camera has the operating voltage of 5V. The specifications of the camera are 5MP and has the refresh rate of 30 Frames per second (FPS). The main advantage produced by the camera is the compact size and its low weight of just 20 grams.

*C. Actuation*

A thrust-generating propeller fitted on a rotational shaft makes up an actuation unit. A servomotor supplies the rotational torque, which is then transferred to the shaftby a gear mechanism. There can be an infinite number of revolutions thanks to this structure. A slip ring that must be in axis with the shaft is used to convey the electric current and signals for the thrust motor and controller. Using a light barrier sensor, allactuation units move to a predetermined location automatically after system startup.

*D. Algorithm*

To enable a more logical code design, the control algorithm has been divided into two halves. The necessary force and moment are determined by the controller's initial component. An Extended Kalman Filter (EKF) is used to calculate a quaternion as thestate feedback. Allocation, or the second stage, involves converting force and momentinto thrust and position for the AUs.

*E. Pilot Control*

The six degrees of freedom of the blimp is manually controlled by the computer interface which is connected to the blimp with the help of the wi-fi module present init. The live feed, the blimp's current attitude and position, and a map are all displayedvia the graphical user interface. In the event that the tablet and blimp are unable to communicate, this gadget serves as a redundant.

## 5. RESULT AND SIMULATION

*A. Specifications*

The diameter of the blimp consists of 8x8 diameter. The maximum payload capacity that the blimp can support is 4kg. The lifting capacity given by the blimp is 10kg. Three days is the maximum endurance limit given by the blimp. The maximumheight that the blimp now can currently able to achieve is 100 feet. The time taken to assemble the complete model is just 3 hours.

*B. Battery*

The power required by the blimp is supported by the batter attached with the blimp. The battery provided with the blimp consists of 16000 mah of power. Lithium polymermaterial is used to make the batteries for the blimp. Six cells are present inside the battery and 12V is the discharge rate of the battery. The property of constant current flow is the main purpose of choosing this class of batteries.

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C. Quantitative Analysis

For the adherence of the blimp to a certain rotating motion, quantitative findings are given. The sensor system's predicted angular velocity and the input angular velocity are contrasted. By applying a sinusoidal angular velocity input in the z-direction. By adhering to the crossover frequency (c), which is typically set two octaves below the characteristic frequency (char), controller gains were discovered. The ambient pressureand temperature have an impact on buoyancy. Each AU has tuning weights that can beadded or taken off to change the buoyancy while keeping the COG in place.

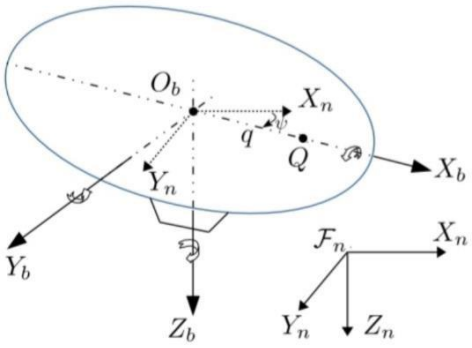


*Fig. 4. Equational Analysis*

## 6. CONCLUSION

This study introduces a spherical helium blimp with holonomic motion appropriate forclose-range entertainment purposes. The study included preliminary quantitative analysis along with qualitative findings. The research can be viewed in light of the current fascination with using quadrotors to create flying displays. Although quadrotors can move quickly and in a variety of ways, there are existing safety issuesthat must be addressed before they may be flown over or close to people. The blimp we designed in this paper, has been released safely within touching distance of throngsof people because the blimp is nearly neutral in buoyancy and can be easily pulled away and because a nylon plate protects the propellers. The blimp has a further benefit for human environments, such as entertainment, in that it operates quietly. Helium provides the lifting force, and thrust is only activated when it is necessary for a desiredmotion or to fight wind disturbances. The blimp can be used for various agricultural benefits and surveillance purposes around the globe.

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