RC BLIMP: AN UNMANNED AERIAL VEHICLE FOR VIDEO SURVEILLANCE

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Abstract
Flying drones have been successful in capturing videos and images in crowd gathering places like stadiums, seminar halls, conference rooms, indoor stadiums club and party events etc., Drones are highly expensive and have a complex operational procedure. This paper on RC Blimp is an idea generated from hot air balloons which were used as a mode of transport in early days. Blimp is an Unmanned Aerial Vehicle (UAV) is a lighter-than-air mobile system. RC (remote controlled) blimp is a helium balloon which acts as a surveillance system for capturing videos and images restricted to indoor applications. The system design has a RF Transmitter and Receiver which is lifted up in the air naturally as the balloons that contain inert gas like helium. RC Blimp design is simple, economical, consumes less power and can be operated in 3600. RC blimps have a very little risk of damage and the novelty of this project is RC blimp can move in several directions for effective surveillance. Propellers are used in the system to control the speed and to maintain smoothness of operation.
Keywords
RF, Helium balloon, Computer Vision, and Electronic Surveillance Systems.

1. Introduction

The surveillance system is vital in today's world to provide security and acts as a watchdog of activities in the area of Computer Vision. It is not affordable due to high cost and complexity in operation. Flying drones play a vital role capturing videos and images in various events and places. Flying drones comes under aerial robots – an unmanned aerial vehicle (UAV) that will undoubtedly play a growing role in the near future. [1]

In the context of development of a project, we had recently initiated a Remote Controlled blimp (RC Blimp). While not being unconditional promoters of blimps and airships, we are convinced that the ever on-going developments in a wide spectrum of technologies, ranging from actuator, sensors and computing devices to energy and material will ensure lighter than air machines a promising future. As for small-size unmanned radio-controlled models, which size is of the order of a few tens of cubic meters, their domain of operation is currently essentially restrained to advertising or aerial photography. But their properties makes them a very suitable support to develop heterogeneous air/ground robotics systems: they are easy to operate, they can safely fly at very low altitudes (down to a few meters), and especially their dynamics is comparable with the ground rovers dynamics, as they can hover a long time over a particular area, while being able to fly at several tens of kilometers per hour, still consuming little energy and power. Their main and sole enemy is the wind. [2]

Unmanned aerial vehicles in general have advantages over unmanned ground vehicles. They are able to reach locations where it is hard for ground vehicles to reach due to hazards or terrain limitations. They also have the advantage of a larger field of view making them able to survey and collect data of a larger area of terrain at a given instance. Unmanned aerial vehicles are also faster and have better maneuverability.[3]

Blimps also have advantages over winged unmanned aerial vehicles and helicopters. Blimps have much safer failure degradation. They can hover over one area for a long time, achieve low altitude flights and do not suffer from maneuverability constraints. They also have minimal vibration and do not influence the environment they are in. The properties previously mentioned make them ideal for data collection, exploration, monitoring and research applications. They take off and land vertically.
This means that they can be easily deployed with no need for a runway, which makes them attractive as platforms for rescue operations or as communication beacons when communication is cut-off from a certain area. Other attractive properties include long flight durations and low energy consumption as they depend on buoyancy to achieve vertical position. The blimp’s relatively slow speed makes it also an attractive platform for computationally expensive algorithms that need many state updates such as simultaneous localization and mapping (SLAM). [4]

2. Literature Review

Literature review discusses about the work done on surveillance and vision systems used for blimp feedback and control. The vision systems introduced cover both ceiling cameras as well as on board cameras. Visual feedback control using receding horizon control, also known also model predictive control, applied to unmanned planar blimp system is presented in (Kawai, Hirano, Azuma, & Fujita, 2004). The camera is fixed on a ceiling looking down on the test area and blimp. The camera identifies two characteristic points drawn (black dots) on top of the blimp envelope. These characteristics points have different sizes and can always be seen from the ceiling camera. The position and orientation of the blimp can be deduced by image processing techniques applied to the characteristics points. Visual feedback control using two different controllers were applied on this platform. The first controller was a receding horizon controller using a control Lyapunov function as terminal cost to stabilize the system.
In (van der Zwaan, Bernardino, & Santos-Victor, 2000) an onboard vision system is applied on a Small-size, indoor blimp. Visual control is applied to this platform to achieve station keeping and docking; the main objective here is to maintain the blimp at a certain 3D location and orientation in reference to a specific landmark. Information about the blimp’s pose and location is extracted through the vision system; this information is then used to attain visual serving. The visual algorithm applied makes use of an initial image patch set by the user. Subsequent blimp movements would then distort this reference image. Image registration is then applied through minimization of the error function (sum-of squared-differences) to calculate optical flow.

In (Azinheira et al., 2002) visual servo control of a hovering outdoor robotic airship is discussed.An onboard camera is used to identify a circle on the ground and a ball floating above it. This represents the hovering location. The circle-ball configuration was used as it has an interesting property of decoupling longitudinal and lateral dynamics which simplifies the design of the controller. Once these landmarks are extracted, their properties are transformed into visual signals. An image Jacobian is built using these visual signals and used for visual servicing.

3. RC Blimp Design

The block diagram of a RC Blimp is illustrated in Fig. 1. The design goal is to build a surveillance system using RF Communication. With the growing demands on security requirements in localities, this paper promises a successful solution in fulfilling them. It has a power supply of 9Vdc which is supplied to a RF Transmitter (443MHz) which is used to control the blimp. On the receiver end, a 9Vdc supply is given to the RF receiver which is capable of receiving signals from RF Transmitter connected to the blimp. The design is embedded to a motor driver (L293D) to drive the propellers connected to the blimp for its flying

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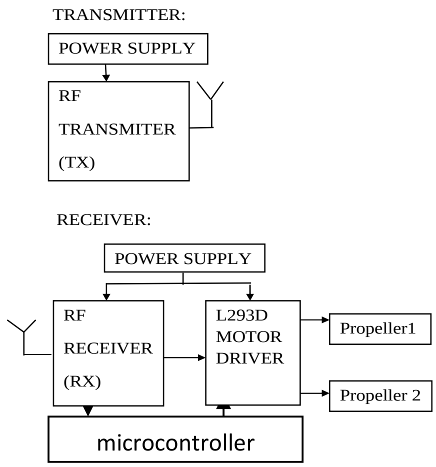

Fig. 1 RC Blimp Block Diagram

3.1 Hardware Requirements

3.1.1 RF Module:

An RF module (radio frequency module) is a small electronic device used to transmit or receive radio signals between two devices. In an embedded system it is often desirable to communicate with other devices seamlessly. This wireless communication may be accomplished either by optical communication or through radio frequency (RF) communication. For many applications the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and/or receiver. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

3.1.2 Motor Driver

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. The l293d can drive small and quiet big motors as well.

A regulated power supply is very much essential for several electronic devices due to the semiconductor material employed in them have a fixed rate of current as well as voltage. The device may get damaged if there is any deviation from the fixed rate. The AC power supply gets converted into constant DC by this circuit. By the help of a voltage regulator DC, unregulated output will be fixed to a constant voltage.

3.1.3 IP CAM Application Working:

Instead of transmitting video over a video cable to a monitor or DVR, an internet camera transmits digital video over a data connection; Ethernet, USB, Wi-Fi, etc. Everything required to transfer images over the network is built into the unit. It is connected directly to the network, just like any other network device, like a printer or scanner. Depending on what type of camera it is, it may save video to an attached memory source, connect to another device on the network for storage, or stream captured video to the internet. An internet camera captures images the same way any digital camera does. What makes it different is its ability to compress the files and transmit them over a network.

The camera connects to software on a computer in your house through your wireless network. If you have your network connected to the internet, you can connect from your phone to the IP camera (through the software on the computer) and see what it sees. Presumably you don't even need wifi service for your phone, you can use 4G.

Fig 2a

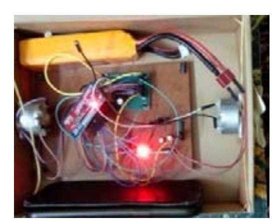

Fig 2b

4. Experimental Setup

Initially connect the power supply to the RF Transmitter and check the led light as an indicator that it’s in ON state. Now set the connection at RF receiver side. Connect RF Receiver to the motor driver and the output of motor driver to the motors fixed in the box. Give the power supply to the kit with 9v LIPO Battery and check the led light indicator. Place the mobile in the kit in which the camera is in on state and connected to wi-fi or hotspot. With the help of IP CAM Application u could see the live video on the laptop or tab that is connected with hotspot. Open the camera in the cell and place it towards the wall of the box and close the box for the next step. See that the antenna of RF Receiver is outside the box to receive the signal that transmitted by the RF Transmitter by the user. Finally, a mobile phone/ spy camera installation procedure according to the needs and device size has to be mounted in to the blimp case. Tie the helium balloons to the blimp case so that it flies up.

To operate, press the switches at the transmitter side so that the antenna at the RF Receiver receives the signal to move the blimp in several directions. When the propellers rotates, the motor is driven due to the force generated by the air pressure through which the blimp can move either clockwise or counter clockwise dependent on the commands passed by the manual operator. This feature makes it a novel device when compared to other radio-controlled blimps because they are designed to lift themselves in the air vertically. This RC Blimp is capable of moving in several directions and not restricted to one way motion (either horizontal or vertical). The RC blimp can rotate 360^0 in the indoor environments.

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Fig 3:RC blimp in Air

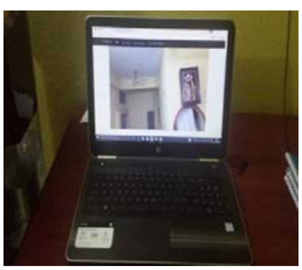

Fig4: Video using IP CAM Application

As the blimp rotates, it captures the video of the outer area in the direction given at the input by the user. Adjusting balloon position and camera position is to record the required area of the room. The Remote controlled balloon for surveillance system thus now ready to capture images and videos successfully.

5. Result Analysis

We had tried to reduce the complexity in the existing surveillance systems by using the remote controlled balloon surveillance system that is capable of telecasting the video in live in both clockwise and counter clockwise directions.

We have achieved better results when compared with existing systems. It is advisable because of its architectural simplicity, economical design, flexible, easy to operate module, and no computational complexity. Limitations of the system would be that the inert gases like helium are flammable when it comes in contact with fire and modeling the dynamics of the blimp under uncertainties. Examples of uncertainties include disturbances in the form of temperature and pressure variations that could vary the size of the blimp's envelope and vary the buoyancy, or disturbances such as wind gusts. Another problem is with blimp's envelope leaks helium varying its buoyancy from one test run to the other. The only restriction for this device is to be used in indoor applications for successful result generation.

6. Conclusion

RC blimp has been successfully implemented and tested under various conditions. It has proven to be comparatively better than existing systems. It has a new added feature of 360^0 view angle and can move in several directions. The helium balloons naturally lift the blimp case upwards and can be controlled manually to move in all directions for a clear output from the surveillance system.

7. Future Enhancements

Based upon the project knowledge and beyond, we can also discover many things that can be used either for surveillance or for general use, that deals with the flying objects. It can be also taken to the next level by redefining its compatibility where it can be employed for real time applications without any complications.

Flying an rc blimp outdoors is possible but only on completely wind-free days - even the slightest of breezes will be enough to render your airship more or less uncontrollable. Hence future enhancement would be upon designing a high end RC blimp for outdoor applications such that it may be used for military and other related applications.

8. References

[1]. J. A. Newell, A. J. Marchese, R.P. Ramachandram, B. Sukumaran and R. Harvey, "Multidisciplinary Design and Communication: A Pedagogical Vision", *International Journal of Engineering Education*, Vol. 15, No. 5, pp.376-382, 1999.

[2]. K. Jahan, R.A. Desseau, R.P. Hesketh, A, J. Marchese, R.P. Ramachandran, S.A Mandayam and J.L.Schmalzel, "Engineering Measurements in the Freshman Engineering Clinic at Rowan University", *ASEE Annual Conference and Exposition*, Seattle, Washington, Session 1326, June 28 – July 1, 1998.

[3]. A. J. Marchese, J.A. Newell, R. P. Ramachandran, B. Sukumaran, J.L. Schmalzel and J. Marriappan, "The Sophomore Engineering Clinic:An Introduction to the Design Process Through a Series of Open EndedProjects", *ASEE Annual Conference and Exhibition*, Charlotte, North Carolina, Session 2225, June 20 – 23,1999.

[4]. H. Zhang and J. P. "Ostrowski, Visual Servoing with Dynamics: Control of an Unmanned Blimp", *Proceedings of IEEE International Conference on Robotics and Automation 1999*, pp618-623, May, 1999.

[5]. E. Paulos and J. Canny, "Designing Personal Tele-embodiment", *Proceedings of IEEE InternationalConference on Robotics and Automation 1998*, May, 1998.

[6]. A. Elfes, S. S. Bueno, M. Bergerman and J. G. Ramos, "A Semi-Autonomous Robotic Airship forEnvironmental Monitoring Mission", *Proceedings of IEEE International Conference on Robotics andAutomation 1998*, pp3449-3455, May, 1998.

[7]. http://rc-zeppelin.com/