THE FLEYE – A STUDENTPROJECT OF THE DHBW RAVENSBURG

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Abstract

The Fleye is a student project, in which frame since 2006 several airships / blimps have been build. Since then every year groups of students are working on this project to enhance it.
The actual airship is a blimp and is 7,80m long and has a diameter of 1,95m. The blimp has a hybrid mantle concept, where the external mantle has a volume of 15m³ and keeps in it two helium mantles and a ballonet. As drive system two powerful rotatable electro engines for thrust vector control are used as main drive. To support the vertical tail an additional electrical drive is mounted in the fin.
A flight computer has been developed for the Fleye. This makes remote control of the blimp easier (only speed and direction has to be commanded) and allows in the future automatic guidance and navigation based on GPS waypoints. For this reason also a mobile ground station has been developed, in order to show in real-time the status of the blimp, control the payload and log all events for debugging purposes.
The aim of this project is the development and the operation of an experimental blimp, which is capable to carry various payloads up to 3kg. Payloads that have been developed and tested together with the Fleye are:

- **WLAN- Access Point to build up a communication network (incl. VoIP Server)**
- **Gamma spectrometer to detect nuclear pollution**
- **Infrared camera and Full-HD camera with live-video downlink for surveillance and rescue applications.**

This features makes this blimp to a perfect demonstrator for a low cost blimp armada which can give support in case of catastrophic events or help during rescue operations.

1. INTRODUCTION

The development and the construction of airships have a long tradition since the pioneer Graf Zeppelin in Friedrichshafen.

Since the company Zeppelin Luftschifftechnik still produces airships in smaller quantities at the airport of Friedrichshafen, it is clear that at the Cooperative State University Baden Württemberg (DHBW) the idea was evolved to develop an airship.

In 2006 students founded the project TheFleye, which stands for flying eye at the university campus in Friedrichshafen.

TheFleye is since the foundation a project in dose frame multiple airships has been developed and successfully flown, by yearly alternating student groups.

The aim of the project was and is to manufacture and operate an airship with multiple experimental payload, such as IR-Camera, Full-HD Camera, gamma spectrometer or various communication equipment.

2. STATE OF THE ART[1]

The actual airship (see Figure 1) is realized as blimp, those mechanical reference values are:

Length: 7,80m
- Diameter: 1,95m
- Volume: 15m³
- Max. Payload: 3kg (depending on shape)

As dive system for the z- and x-Axis two swivel-mounted electric 500W engines are used for thrust vector control. For the yawing axis one electric 200W engine supports the vertical tail.

[1] This reflects the state of the project at September 2014

All structure elements are made of composite materials to reduce weight.

The designed mission profile allows the following flight parameters:

- Max. altitude: 400m (calculated)
- Max. velocity: 40km/h
- Max. flight duration: 2h (due to battery)

Figure 1. Fleye K5

2.1. Hybrid Mantle Concept

One of the peculiarities of the actual airship is the hybrid mantle concept. The outer mantle is made of a fissure stopped paraglider textile with a specific weight of 41 g/m². The inner mantel is made of Polyurethane-Foil with a specific weight of 35 g/m², which has an indicated helium permeability of 0,625l/m²/h. [2]

To compensate the loss of helium, it is split up in two different chambers and additionally a ballonet is used.

2.2. Flight Computer

The flight control is mainly realized by using commercial modelling technology.

To have a better handling of the airship a modelling flight computer (adrupilot) has been adapted by developing a new flight control software for airships from scratch.

The flight controller gives the possibility to command speed and attitude, while he handles the trust vector control. The airship can also maintain a given attitude automatically. As the flight computer has also a GPS receiver, in the future it will also be possible to fly autonomous routes based on given way points.

Due to safety restrictions a feature has been implemented in the flight computer, which makes it possible to override the control software by the manual commanding.

2.3. Payload

The airship has the possibility to carry a user defined payload with a maximal weight of 3kg. The payload is independent from the flight control, has also its own battery pack and independent communication links.

The actual payload is designed in a modular way for different scenarios.

2.3.1. Data-Downlink

For control and monitoring of the payload a stable link in the low UHF band is used.

To allow high data rates data downlinks, such as live video a WLAN access point is integrated. The corresponding ground station has the capability to track the airship based on the GPS position, which allows to use the fast WLAN downlink even on longer distances.

2.3.2. Optic and IR-Camera

In default configuration the payload is equipped with a Full-HD video camera. This allows plug & play live video streaming over the WLAN link to either the ground station or/and nearly any WLAN capable mobile device.

The Full-HD video streaming has already been successfully proven for aerial live videos on public events.

Alternative to the Full-HD camera an IR-Camera can be mounted for thermal images. The actual IR-Camera allows contemporary capture and transmission of regular optic video and thermal image.

The camera systems are mounted on a 3-axis gimbal system, to give more flexibility and change the camera view field “on the fly” to whatever is the target object. The gimbal has an integrated accelerometer, so it is also possible to keep pointing on a static object, while moving.

2.3.3. Gamma Spectrometer

For test purposes a gamma spectrometer has been added to the payload. A special intake device has been developed, to provide a controlled air volume flow to the measurement head of the spectrometer. This setup allows detection and rating of radioactive particles in the air.

The instrument data is downlinked over the WLAN link to the ground station for further elaboration.

[2] R. Richter und T. Neuhauser, Neukonzeptionierung und Bau des Luftschiffs FLEYE K5, Friedrichshafen, 2013

3. POTENTIAL APPLICATION CONCEPTS

For small airships there are many application field, only a few which have been taken into account for the Fleye project are listed in the following.

3.1. Aerial Video

As already mentioned, the Full-HD camera has already been successfully tested on public events.

Due to the inertial and stable flight behavior of the airship it is perfectly suited for such events. The long flight duration has shown an additional advantage compared to common model drones.

The airship is practically vibration free and for longer static videos there is also the possibility to fix it on ground. The 3-axis gimbal gives the airship the possibility to turn the bow in wind direction without having an impact on the view field.

3.2. Search and Rescue Operations

Another potential application field for such small airships could be a search and rescue operation.

The combination of thermal and optic image might be a low cost but not less efficient alternative to helicopters.

3.3. Air Measurements

For air measurements like smog, chemical, or radioactive pollution detection an airship is the most convenient solution.

There are no air vorticities, which could falsify the measurement. In case of using an airship for such an application is also possible to let it airship drift with the air flow in order to determinate the dispersion of the pollution.

The project is also part of a project proposal for the detection of biochemical air pollution, which has been submitted to the Federal Ministry of Education and Research (Germany). Involved parities of this project proposal are among others the Robert-Koch Institute, the Fraunhofer Society and the Bundeswehr Research Institute for Protective Technologies.

3.4. Catastrophic Events

The WLAN access point in the payload on the airship has an integrated VOIP server. This allows setting up in a very short time a WLAN based communication network, which allows voice communication by any WLAN capable smartphone using an appropriate client. Depending on the environment and on the flight attitude a good coverage of a local area can be reached.

Taking benefit of the Full-HD camera also a quick overview of the situation from above would be possible in order to optimize the activity coordination on ground.

4. SUMMARY AND CONCLUSION

The Fleye project has been founded in 2006 by students and evolving every year. It has become a good multipurpose experimental platform for various applications.

There could be many possible future application fields for such (semi-) autonomous airships which are scalable in their size and capacity for payloads.