



A low cost spying quadrotor for global security applications using hacked digital cameras

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www.esiea-recherche.eu

Warning

We apologies, but this is a first draft of our presentation slides. Look up for the last version on DEFCON's and faucon noir's website :

- www.defcon.org
- [http ://fauconnoir.esiea.fr](http://fauconnoir.esiea.fr)
- www.esiea-recherche.eu

Thanks for reading us,

Faucon Noir team.

Summary

- 1 Introduction
- 2 Flight of the Bumblebee
- 3 With bird eyes
- 4 Taming of the camera
- 5 Views from up-there
- 6 Flight Demo

Summary

1 Introduction

- Who the heck are we?

Who the heck are we ?

Student team

- From October 2007 to June 2009
- Engineering grad school students & PhD student



Development & Research laboratory

- Signal and Image Processing dept. ATIS, one of ESIEA engineering school's labs.



- Université Paris-Est : PhD funding

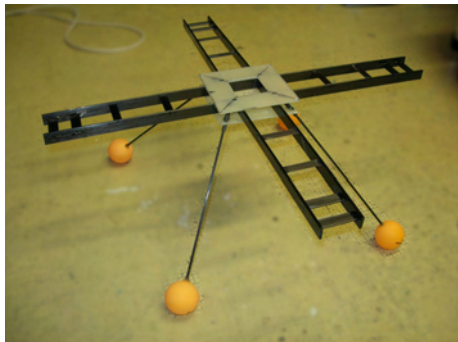


Summary

- 2 Flight of the Bumblebee
 - Take-off of the project
 - Basic Control
 - Advanced Control
 - Ground station

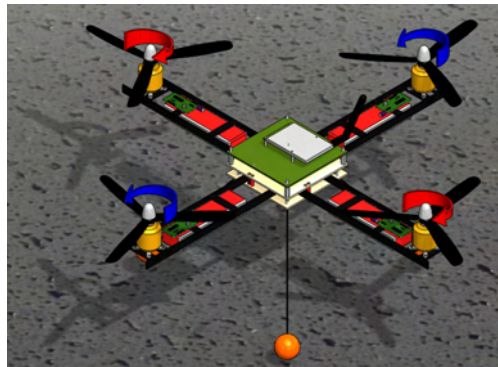
What is a quadrotor ?

- a rigid structure

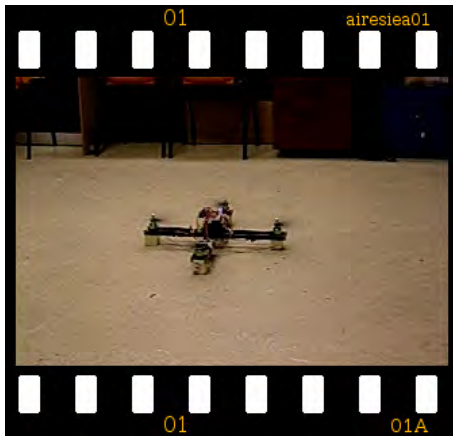


What is a quadrotor ?

- a rigid structure
- several rotors



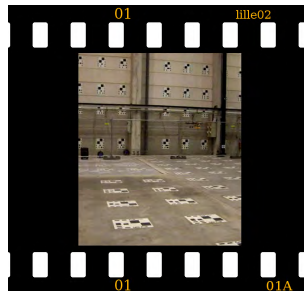
Video : First fly



Not so simple

- A quadrotor without smart electronic to control attitude goes nowhere but in the wall !
- Let the Flight Assistant do the hard work.

Video : stabilization algorithm



Agility

- Good flight dynamics



Limits

- Need at least an experimented R/C pilot
- Sensitive to wind
- Lot of altitude variation

Advanced Control

- What if anyone could fly it?
- Complete X,Y,Z control

Need for sensors

- GPS sensor, pressure sensor, ultrasonic ranger system
- Data fusion

Work in progress

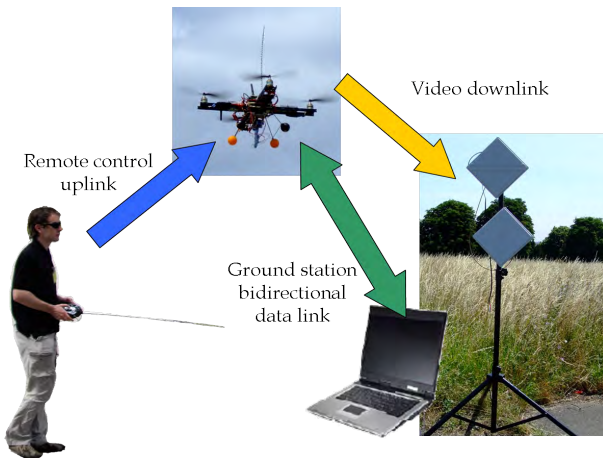
- For the moment : only Z control, sensitive to wind
- Promising results

Ground station

Critical parameters monitoring

- Security checklist
- PID coefficients setup
- Signal power monitoring
- Battery monitoring
- Status of every chip
- Real-time position and attitude

Communications



Summary

- 3 With bird eyes
 - One for fun
 - Two for stereo
 - Three for headaches

One for fun

- Look at it when it flies...
- ... or see from its eyes
- Lots of experiment before success

Tests conclusions

- Keep it simple, stupid
- Use integrated systems when possible
- Cameras are very sensitive to high frequency vibrations
- Give useful information about what is happening on the quadrotor
- Nice movies for recreation or exploration

Two for stereo

- Two eyes, two camera, two point of view
- Difference between the two images give the depth

Perspectives

- Produced images given to a PhD student.
- Waiting for experience return

Three for headaches

- He who can do more...
- Need for simultaneous vertical and side views of scenes
- Mosaics

Mosaics



Summary

- 4 Taming of the camera
 - On-the-shelf benefits & drawbacks
 - Slash & Hack

On-the-shelf benefits & drawbacks

- Professional optical system w. stabilizer
- Included storage & battery

- Big & Heavy
- Made for human eyes and fingers

Slash & Hack

- Reduce weight to the minimum
- Effective remote control
- Precise time-stamp for each picture

Slimming diet

- Weight out of the box : 145 g (5,1 oz)
- Remove everything it doesn't need



Pull the trigger

- More and more electronics in these systems
- Talking the same "Logic"
- TTL (Transistor-Transistor Logic) 3.3V

Hacking's conclusion

- Full control of digital camera
- Automatic trigger pulling
- Precise picture time-stamp (20 ms)

Summary

- 5 Views from up-there
 - French Navy Academy
 - Challenge Minidrones contest
 - Natural History Museum

French Navy Academy

- July 2008
- Presentation of the flying capacity of the quadrotor in front of navy students

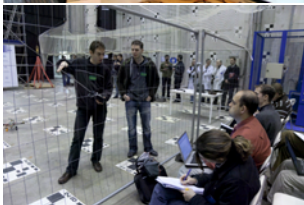
Illustration



Challenge Minidrones contest

- Started in winter 2007, final in May 2009
- Funded by French Aerospace institute (ONERA) and French Army Headquarter (DGA)
- Third rank on thirteen teams

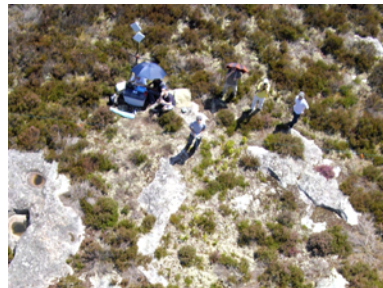
Illustration



Natural History Museum

- June 2009
- Field test in Fontainebleau forest to validate simultaneous acquisition of pictures

Illustration



Summary

6 Flight Demo

Flight Demo

- We hope will we be able to bring our quadrotor through the US customs
- In this case, we will be glad to provide you with a flight demo

Thanks

We thank you for your attention