Eye-COPTER PROJECT

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INTRODUCTION

ITU AUVSI 2005 team has worked on autonomous flights with a helicopter. The interest of science in the VTOL(Vertical Take Off and Landing) UAV systems lead them in the decision of using a helicopter as our autonomous unmanned air vehicle. The helicopter should also be capable of transferring real time images and getting high resolution pictures of the desired objects on the ground. So they named their UAV after the missions it should accomplish, the "Eye-COPTER".

FOUNDING THE ITU AUVSI 2005 TEAM

The founders of the ITU AUVSI 2005 Team are Aerospace and Aeronautical Engineering students at ITU(Istanbul Technical University). Later on students from Electrical Electronical Engineering joined the team, mostly to work on the image transferring and the autopilot issues. The ITU AUVSI 2005 team was ready to work at the beginning of September 2004.

MAIN TRACK OF THE WORKING SCHEDULE

Starting with October 2004 the team got busy planning and realizing the Eye-COPTER Project. The team's working scheme consisted of planning the project, finding resources, system integration, image transferring, and the test flights.

For the competition is in the U.S., the team's one of the major concerns is finding sponsors because it takes a lot of money to get to the competition area as well as the expensiveness of the necessities of the mission itself. Unfortunately it was at the end of March 2005 that the team started getting money.

On the other hand, the ITU AUVSI 2005 team was busy searching the documents for finding the necessary resources that will guide them through the Eye-COPTER Project's stages. After searching for source materials and long discussions on which elements should be used in the project, the following conclusions were reached to.

THE HELICOPTER: VARIO BENZIN TRAINER

A German company is preferred to get the helicopter from, for it is easier and quicker to import materials from there. Vario Benzin Trainer 8301 is used in the Eye-COPTER Project for it allowed modifying and is capable of carrying the payload that is planned to be loaded to the UAV.

Vario Benzin Trainer 8301

Technical Features of Vario Benzin Trainer 8301:

- 23 cc Zenoah Engine
- Width: 200mm, Lenght: 1460 mm, Weight: 6.7 kg
- 2 Stage power transmission (Belt drive on first stage)
- Wide stance all meta frame construction
- Heavy duty gear set
- Fully ball bearing
- Aluminum swashplate
- Aluminum Rotor Head Centerpiece
- 5mm flybar with heavy paddles

- Wide chord 1630mm dia Fiberglass blades included
- 4 ball bearing supported stainless steel tail rotor drive shaft with claw couplers
- Adjustable tail rotor take off for scale application
- All aluminum tail rotor gearbox
- Wide chord high efficiency GRP tail blades
- Fiberglass canopy with clear windshield

THE AUTOPILOT: ROTOMOTION AFCS 2.5

Currently, there is no completed helicopter autopilot that efficiently works for unmanned helicopters among which the ITU AUVSI 200 team can get access to. The most developed autopilot among all seemed to be the one that Rotomotion Company is marketing: AFCS 2.5.

AFCS is not yet capable of taking off and landing the helicopter, but is programmed to do the rest of the autonomous flight successfully. Since the 3rd AUVSI Student UAV Competition doesn't require autonomous take off and landing, the ITU AUVSI 2005 team decided to use the AFCS for their purposes.

Rotomotion VTOL AFCS

Technical Features of AFCS 2.5:

Item	Unit	Condition	Spec.
# of waypoints		default RAM size	255
Waypoint parameters			altitude, lat, long, hold time, piroetting
Waypoint transition parameters			velocity, heading follow point
Waypoint accuracy	(m diam.)	light winds, good GPS reception	3 (standard) < 2 (with DGPS option) < 1 (with L1/L2 WAAS option)
Altitude hold accuracy	(m)	light winds, good GPS reception	+/- .5m
Hover hold accuracy	(m diam.)	light winds, good GPS reception	<2
Flight modes			manual, manual on specific control, waypoint, velocity cmd, position cmd
Flight duration	(hours)	1A @ 8V/4.5AH NiMH Other constraints apply	3
Top speed	(mph)	light winds,	40

		good GPS reception	
Safety pilot controller			Futaba PPM/PCM and JR PPM
Swashplate types			3-servo mechanical 3-servo CCPM (120) 4-servo CCPM (90) *others on request*
Ground station computer (option)			Pentium 500MHZ +, laptop recommended Windows 2000/XP MacOS X Linux
Low-range telemetry system (option)	(yards)		100yards. 500yards with manually pointed ground ant. May require additional operator to man ant. during certain routes.

THE CAMERA: CANON G5

ITU (Istanbul Technical University) has attended the 2nd AUVSI Student UAV Competition last year and used Canon G5 to take pictures of the targets that are needed to be taken the picture of. Canon G5 worked very well and provided the last year's team with high quality images. Therefore, ITU AUVSI 2005 team agreed on using the same camera for this year once more.

Canon G5

Technical Features:

- Sensor resolution: 5 megapixels
- Optical sensor type: CCD
- Effective sensor resolution: 5,000,000 pixels
- Optical sensor size: 1/1.8 in
- Light sensitivity: ISO 50, ISO 100, ISO 200, ISO 400
- Digital zoom: 5
- Shooting modes: Frame movie mode
- Shooting programs: Landscape, Night mode, Portrait mode, Stitch assist
- Special effects: Sepia, Vivid, Neutral, Black & White, Custom Effect, Low Sharpening
- Analog video format: NTSC, PAL
- Max shutter speed :1/2000 sec
- Min shutter speed: 15 sec

- Exposure metering: Spot, Evaluative, Spot AF area, Center-weighted Exposure modes: Manual, Program, Shutter-priority, Aperture-priority
- Exposure compensation: ±2 EV range, in 1/3 EV steps
- Auto exposure bracketing: 3 steps in 1/3 EV step
- White balance: Custom, Presets, Automatic
- White balance presets: Flash, Cloudy, Daylight, Fluorescent, Tungsten light, Fluorescent light (daylight)
- Digital video format: AVI
- Still image format: RAW, JPEG
- Continuous shooting speed: 2 frames per second, 1.5 frames per second
- Remote control: Camera remote control – Infrared

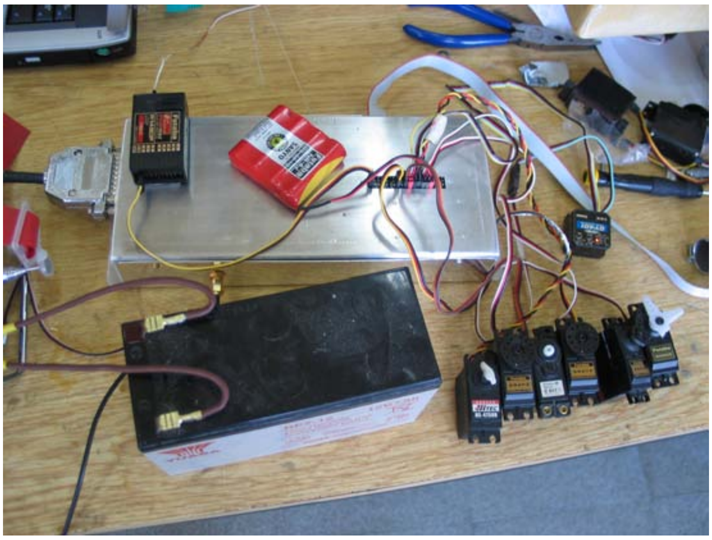
Canon G5 provides analog output for images. Via an analog to IP converter and using a radio modem, the image could be transferred to the ground station. On the other hand, an IP camera could be used to provide real time imagery and use Canon G5 just to get high quality pictures of the targets. The team preferred working with an IP camera for they had one already. Linksys "Wireless-G Internet Video Camera" is the mentioned camera.

Linksys Wireless-G Internet Video Camera

TESTS:

AFCS TESTS:

It was April when the AFCS 2.5's package arrived. Learning the working mechanism of the AFCS from the manuals took a little bit of time for it involved lot of programming knowledge. The team started by connecting the equipment together and testing the AFCS without connecting it to the helicopter at first just to see whether the AFCS is working without a problem.



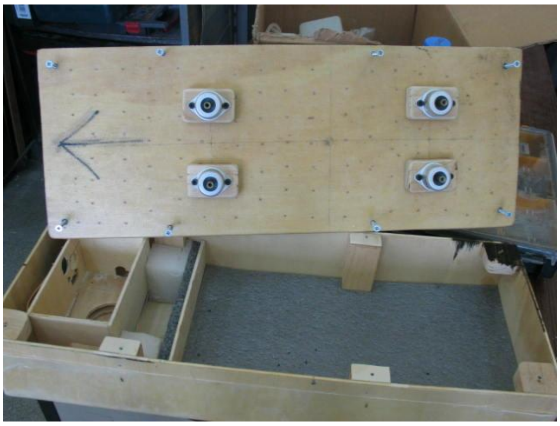
Although facing little problems at this stage occured, the team managed to get the AFCS working the way it should. The autopilot and the radio controller are then configured to work together and give the right commands in the right situations.

There were two major problems regarding the usage of the AFCS. One of them was that the interface used in the AFCS being not programmed to provide the team with the capability of making a preprogrammed flight. The interface could only fly the helicopter interactively. To prepare a predefined flight lot of knowledge was needed on programming and linux operating system. Unfortunately none of the team members were profound to do the programming in a short period of time and only a month was left to do the job. So they postponed the preprogrammed flight to next year's plan and continued working on the interactive flight.

The other problem occurred when the time to actually fly with the AFCS came. The AFCS was not configured to work with the type of swashplate the team is using which was a 4 servo 90 degrees CCPM swashplate. When contacted with the rotomotion firm for help the team learnt that they need to reflash the servo controller circuit of the AFCS. The rotomotion firm guided them into the procedure and the servo controller was successfully reflashed. But unfortunately the problems continued. The source file that the rotomotion firm has sent to us for reflashing didn’t seem to right. The servos did not move the way they should. The team members are looking forward to solving this problem still..

FLIGHT TESTS:

The team composed a box for the AFCS, the camera and their batteries using balsa covered with a sheet of glass fiber with epoxy. Put styrofoam under the AFCS to protect it from unwanted vibration.



Then this box is mounted by vibration emitting nuts and bolts to the helicopter. To fit this box under the helicopter new landing gears were made from glass fiber and epoxy.

The team had time to fly for 3 days yet and unfortunately without autonomous flight because of the problems they faced with the AFCS. The flights done were with and without payload and were helpful to fix the helicopter's control trims. Also these tests provided the team with the information on the amount of gasoline the helicopter will use. The gasoline tank was decided to be insufficient to accomplish the mission so new tanks were mounted on the helicopter.

CONCLUSION

According to financial restraints the ITU AUVSI 2005 team had very little time to deal with the Eye-COPTER Project but still they are not devastated for not being able to achieve their goals. They are aware of the needs and important points of this project and looking forward to develop the system they've started to compose.