Technical Layout of Harbin Engineering University UAV for the International Aerial Robotics Competition

Feng Guo No.1
Harbin Engineering University, China
Peiji Wang No.2
College of Aerospace and Civil Engineering, Harbin Engineering University, China
Yuan Yin No.3
College of Aerospace and Civil Engineering, Harbin Engineering University, China
Xiaoyan Zheng No.4
College of Aerospace and Civil Engineering, Harbin Engineering University, China
Rui Sun No.5
College of Aerospace and Civil Engineering, Harbin Engineering University, China

ABSTRACT
This paper briefly describe the technical layout of HEU(Harbin Engineering University) UVA for IARC, the UAV consists 4 parts, the first is the basic flying vehicle, a specialized quadcopter which can provide lift and basic platforms for equipment; the second part is a two camera system for ranging and image recognition; the third part is an auto-pilot system based on the quadcopter, designed for stabilizing, control and communicate with ground control station; the forth part is a ground control station which runs at a laptop, the functions are process the imagine files and send control orders to UVA.
KEYWORDS: UAV; ground control station; quadcopter

INTRODUCTION

An unmanned aerial vehicle (UAV)[1], commonly known as a drone, is an aircraft without a human pilot onboard. Its flight is either controlled autonomously by computers in the vehicle, or under the remote control of a navigator, or pilot (in military UAVs called a Combat Systems Officer on UCAVs) on the ground or in another vehicle.

There are a wide variety of drone shapes, sizes, configurations, and characteristics. Historically, UAVs were simple remotely piloted aircraft, but autonomous control is increasingly being employed[2].

Our goal in IARC the 6th mission is to participate in and hopefully earn some experience, and the following technology report is the concept and practical design of our UAV, the whole system is given to get an overview of our UAV, then the 4 sub-systems are described separately.

SYSTEM LAYOUT OF HEU UAV

In order to finish the mission of IARC, and also fully functioning the ongoing control system. Our UAV consists 4 sub-system, the first is the basic flying vehicle, a specialized quadcopter which can provide lift and basic platforms for equipment; the second part is a two camera system for ranging and image recognition; the third part is an auto-pilot system based on the quadcopter, designed for stabilizing, control and communicate with ground station; the forth part is a ground station which runs at a laptop, the functions are process the imagine files and send control orders to UVA, fig.1 shows the layout of HEU UVA.

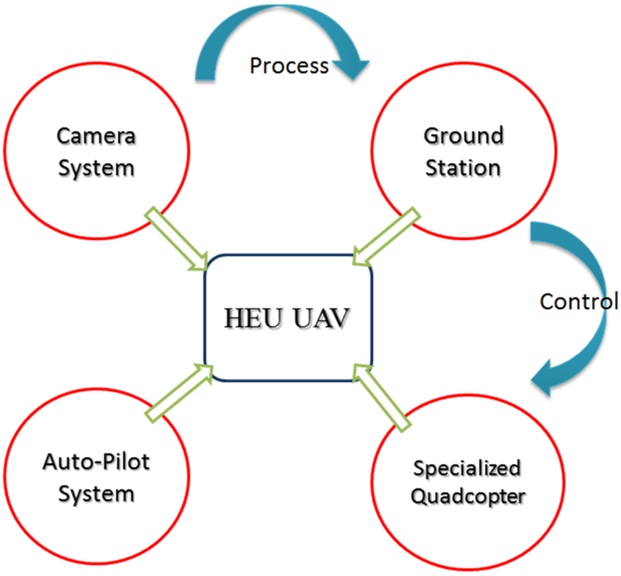
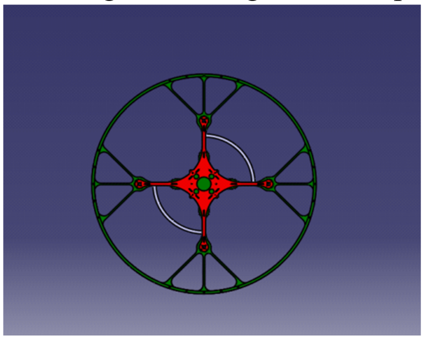


Fig.1 Layout of HEU UVA

The following chapters will demonstrate each sub-system in our UVA.

QUADCOPTER (Sub-System 1)

The carbon fiber was adopted as the main material. CATIA was accepted for modeling design, and the frame is a traditional cruciform structure, which divided into two layers, first layer is the carbon fiber sheet cutting into integration, the middle layer is connecting sheet using AB glue bonding together, so the whole frame is a structural I-beam: firm, more strength. Around with protection, which makes the system more secure. The buffer gear is designed for impacts from landing. The cameras are under the platform.



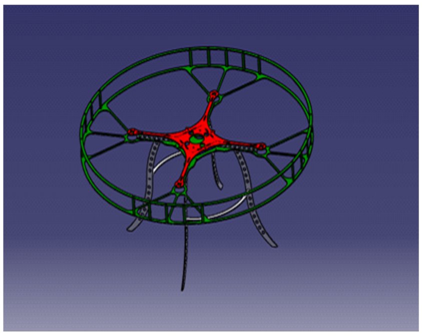


Fig.1 Frame of Quadcopter

CAMERA SYSTEM MODULE (Sub-System 2)

The mechanism of the recognition module is a simulation of human eyes (stereological technology) to deal with the scene. The module uses two calibrated cameras in real time filming the scene of the vehicle’s flight range, and the environmental information combining with relevant image matching technology are used to detect obstacles in front of vehicle. In the meantime, running information are recorded, which estimate the location and distance of the obstacle. The goal of obstacle detection and distance information acquisition is a key part of this module, which composed by two cameras and PTZ. Head and camera can be free to rotate at a certain point of view (Fig.2).

There are 5 key functions & parts of camera module: Camera calibration; Binocular vision system calibration; Feature point extraction; Image matching; Three-dimensional reconstruction, which details are shown in the table below

TABLE 1 FUNCTIONS OF CAMERA SYSTEM

	Details & Functions
Camera calibration	Communicate with quadcopter and ground station, provide fully position with camera
Binocular vision system calibration	Process the two different images
Feature point extraction	Identify characters of mission environment, like door, tables
Image matching	Search for key components, like laser, USB driver
Three-dimensional reconstruction	Provide the UAV fully path to enter, exit, search and match the environment, finish the mission

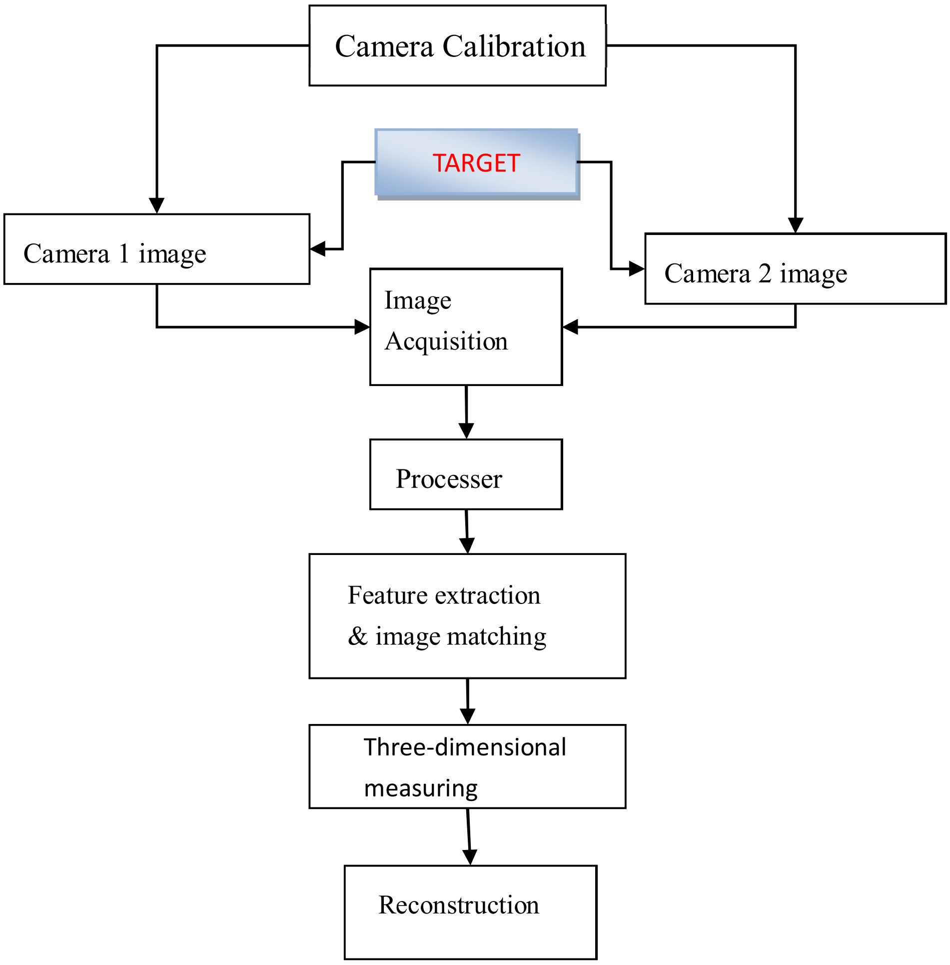


Fig.2 Camera system Module

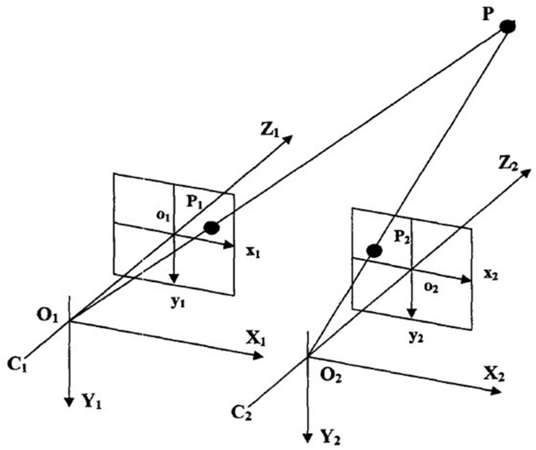


Fig.3 Binocular vision system calibration

Fig.3 briefly shows the Binocular vision system, the image matching is established through the corresponding relationship between the process of creating the conditions, that calculates the parallax in the binocular visual images. Common image matching, image registration, three-dimensional like the difference between the two cameras at the observation point from the camera when a different result of, rather than the scenery transforms, scene movement, and other factors caused. Depending on the matching primitives, stereo matching can be divided into regional matching and feature matching two categories. Our process can be characterized as following:

Match point---Gray Value matching---Contour matching---Identify objects

GROUND CONTROL STATION (Sub-System 3)

A Ground Control Station (GCS) is typically a software application, running on a computer on the ground, that communicates with UAV via wireless telemetry. It displays real-time data on the UAVs performance and position and can serve as a "virtual cockpit", showing many of the same instruments that you would have if you were flying a real plane. Our ground station consists two parts, the first part charge the communication with the quadcopter, to control the vehicle pitch, yaw and roll automatically, the second part of our ground station it to communicate with camera system to receive and process the image and generate the control instruction for our quadcopter. The User Interface (UI) is not finalized yet, which can just control and process the signals and are under testing now.

AUTO-PILOT SYSTEM (Sub-System 4)

Because this is the first time we participate in IARC, so we used commercial auto-pilot kits in our quadcopter, the APM 2[3] (ardupilot mega 2, Arduino based) and XBEE the PRO 900 digital transmission suite to communicate with GCS, the flying information of quadcopter is transfer through[4]:

- 6 Degree of Freedom IMU stabilized control
- Gyro stabilized flight mode enabling acrobatics (loops and barrel rolls)
- GPS for position hold
- Magnetometer for heading determination
- Barometer for altitude hold
- IR sensor integration for obstacle avoidance

- Sonar sensor for automated takeoff and landing capability

And the information is processed and the control signals are given to vehicle, the auto-pilot system is shown in fig.4

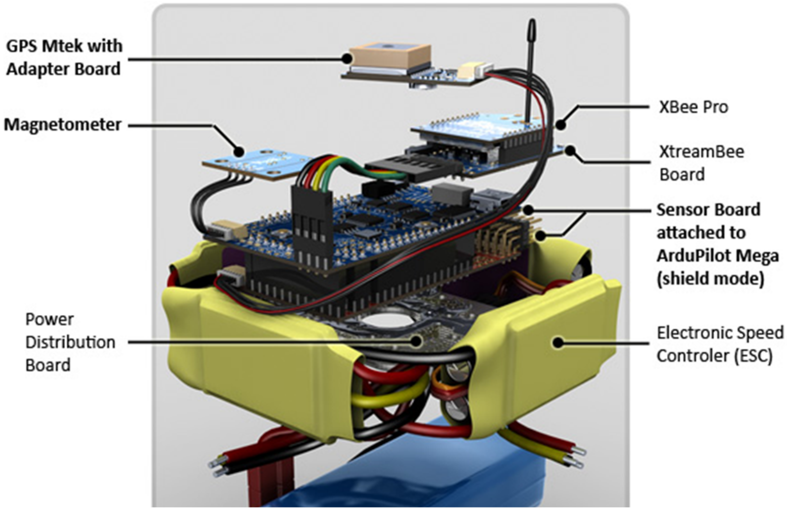


Fig.4 Auto-Pilot System Layout

CONLUTION

This paper describe the system layout of HEU UAV, which is made to attend the IARC2012, the 4 sub-system (Camera System, Auto-Pilot system, GCS, Quadcopter) of the whole system are described separately.

REFERENCE

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