Team F: Rescue Rangers

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ILR02

10/21/2016

1、Individual Progress

1.1、Overview

In the last week, my primary role was finalizing the type of the RGB camera, as well as calculating the ground sample distance and overlapping area between two frames based on specifications of the RGB camera, in order to plan the initial navigation strategy.

To find the most suitable RGB camera for our project, I have to firstly understand meanings of different model specifications of the camera. Afterwards, I need to analyze the importance of these specifications and set the range of important specifications based on requirements of our project. After choosing the appropriate RGB camera according to whether it suits our required range, I can calculate the ground sample distance and overlapping size if we use certain type of camera.

1.2、Important specifications

Our project requires clear photos even though they are taken at high altitude, because these photos will be processed by our human detection algorithm. To achieve that, our camera should have a high resolution, so that the distance between pixel centers measured on the ground could be limited. Below is a table showing different possible resolutions of a camera. Specifically, the RGB camera for our project should has at least 5MP resolution.

Table1 Different possible resolutions of a camera

Format	Resolution (pixels)	Aspect ratio	Image scanning
1MP/720P	1280x720	16:9	Progressive
SXGA/960P	1280x960	4:3	Progressive
1.3MP	1280x1024	5:4	Progressive
2MP/1080P	1920x1080	16:9	Progressive
2.3MP	1920x1200	16:10	Progressive
3MP	2048x1536	4:3	Progressive
4MP	2592x1520	16:9	Progressive
5MP	2560x1960	4:3	Progressive
6MP	3072x2048	3:2	Progressive
4K Ultra HD	3840x2160	16:9	Progressive
8K Ultra HD	7680x4320	16:9	Progressive

A camera's shutter determines how and when light gets recorded during an exposure. In our system, the RGB camera needs to capture images during the motion, which makes a camera with the global shutter method preferable because it can control incoming light to all photosites simultaneously. A global shutter is typically considered the most accurate representation of motion, and effectively addresses all of the potential rolling shutter artifacts[1]. Since everything within each frame happens simultaneously, rapid events could be captured.

Except for those, field of view is also a crucial factor in our autonomous system. Larger field of view results in larger area an image covers, which means the search and rescue operation could be faster. Below is an image illustrating the horizontal field of view. For our project, the required figure of view should be larger than 30° x 20° (Horizontal x Vertical).

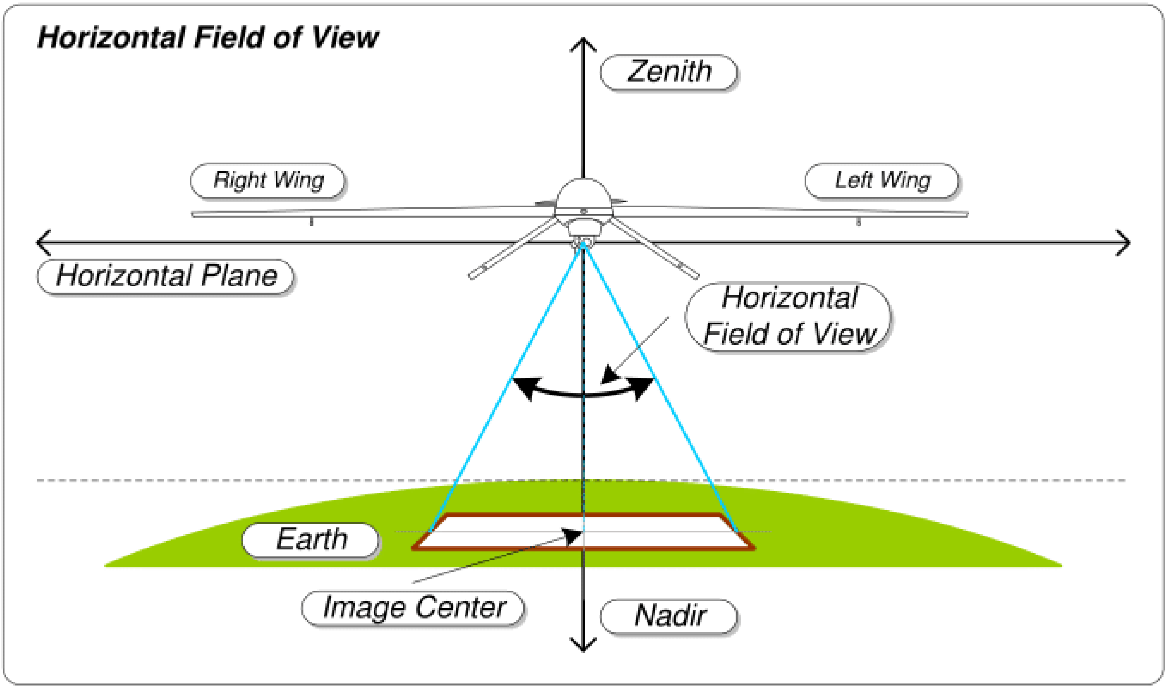

Figure1 Horizontal Field of View [2]

Some other specifications with less importance still need to be considered, such as fps, pixel depth and image buffer. Fps refers to the frequency (rate) at which an imaging device displays consecutive images. If the moving velocities of our aerial platform is fixed, higher the fps is, larger the overlapping area between two frames is. Pixel depth is the number of bits used to indicate the color of a single pixel. Insufficient pixel depth may result in failure of image processing. Finally, enough image buffer prevents data loss when taking images in a high frequency.

1.3、Model specifications

The final model of the RGB camera for our project is PointGrey Grasshopper 3 GS3-U3-120S6C-C, with the lens type Tokina TC2016-21MP. These two models are shown below:

Figure2 Tokina TC2016-21MP[3] Figure3 PointGrey Grasshopper 3 GS3-U3-120S6C-C[4]

Important specifications are shown below:

Table2 Key specifications

Resolution	4240 x 2824(12MP)
Readout Method	Global shutter
Angle of View	36.1° x 27.2°
Frame Rate:	7FPS
Pixel Depth	14
Image Buffer	128MB

1.4、Calculations

Based on specifications above, when the image is taken at the height of 30m, the distance between horizontal pixels is: $30 \times \tan(\frac{36.1^o}{2}) \times 2 \div 4240 = 4.61\text{mm}$.

Similarly, the distance between vertical pixels is:

$30 \times \tan(\frac{27.2^o}{2}) \times 2 \div 2824 = 5.14\text{mm}$.

In terms of the overlapping area between two frames when the drone moves at the velocity of 5m/s, it can be calculated as:

$1 - 5 \times 1 \div 7 \div (5.14 \times 10^{-3} \times 2824) = 95.1\%$

2、Challenges

The main challenge I faced was that I could not find useful information about specifications of cameras. In the beginning, I only searched about motion cameras, like the GoPro5. For these cameras, it is only possible for me to find specifications like resolution, fps and supported features, including wifi, waterproof ability and gesture control. These specifications may be important to the potential customers, but they are far less enough for me to make up decisions about whether they could be applied to our project. Later after I consulted with my friend, I realized that I should have focused on professional RGB cameras for autonomous robots, which could be found on the website of PointGrey. When I finally figured out the right approach to the suitable RGB camera, things became much easier.

3、TeamWork

After the Sensor and Motor Lab, our team discussed the plan for the next week, and broke the work down as follows:

Table3 Work distribution form

Member	Work
Karthik Ramachandran	Figure out required information for the sound sensor and finalize its type
Sumit Saxena	Figure out required information for the thermal camera and finalize its type
Juncheng Zhang	Figure out required information for the RGB camera and finalize its type
Xiaoyang Liu	Get familiar with basic DJI hardware and DJI SDK.

The team worked with great coordination during execution of the entire task. Since we need three sensors to capture different human signatures, we split the sensor tasks to three different team members. Everyone did a great job and finalized the type. We also figured out the initial navigation plan based on specifications of sensors. Furthermore, Xiaoyang got familiar with the DJI hardware and software platforms, which was a good start for us to actually work on the drone.

4、Future Plans

Because we may not be able to get real hands-on experience on the drone next week, our initial plan about showing the waypoints navigation through DJI simulator has to be changed. Instead, Karthik will focus on generating intermediate waypoints based on given initial GPS coordinates. Sumit will works on a prototype for interpreting user input to identify likely locations of interests. Xiaoyang and I will design the schematic draft of the power distribution system for the system.

5、Reference

[1]. http://www.red.com/learn/red-101/global-rolling-shutter

[2]. https://en.wikipedia.org/wiki/File:MISB_ST_0601.8_-_Horizontal_Field_of_View.png

[3]. http://www.tokina.co.jp/en/security/machine-vision-lenses/tc2016-21mp.html

[4]. https://www.ptgrey.com/grasshopper3-120-mp-color-usb3-vision-sony-icx834