VR/AR Camera
Product Requirements Document

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VR/AR Camera Design Requirements Document

Rev	Description	Date	Authorization
A	Release	November 2 2017	All
B	Updated Vision and Sensor specs	November 17 2017	All
C	Updated Vision	December 1 2017	All
D	Added Full Test Protocol	December 12 2017	All
E	Added Cost and Final Formatting	December 14 2017	All

NOTE: Customer Approval was given as of Revision D on 12/8/2017. Revision E was emailed to customer and no response was provided.

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The customer, Raptor Vision LLC, has provided a commercially available fisheye camera lens with 250° field of view for experimentation. While Raptor Vision has developed dewarping software to stream video from this lens rectilinearly, they still do not produce their own lenses. Various tests will be performed and will aim to provide Raptor Vision with information that will eventually contribute to the development of their own, in-house fisheye optic(s) with an even wider field of view. All resources and assistance are provided by Raptor Vision employees James Francis (Chief Executive Officer), Magnus Jansson (Chief Technologist), and Oleksandr Lysenko (Computer Vision Engineer), along with our faculty advisor, Aaron Michalko.

Vision:

The project vision is for an:

> Application-specific, field-varying resolution classification of the fisheye camera lens for use in a VR/AR video streaming system. Because Raptor Vision's desired camera system will be placed in a wide variety of venues across the globe (sports, music, entertainment, etc.), each application will have its own set of resolution requirements. This information will be very helpful to the customer as they begin to design and prototype their own optic(s). Eventually, the project will hopefully include a video demonstration of these different applications and how different variations of resolution across the field can provide unique viewing experiences for the user.

Environment:

As a camera lens to be used in an outdoor sports arena, it needs to operate in the following environment:

Temperature

0-40 degrees Celsius - temperature range for stadiums across the globe

Relative Humidity

5%-100% relative humidity

Testing Environment:

Temperature

Standard Lab Temperature - 65-75°

Relative Humidity

Standard Lab Humidity - ~45-50%

Regulatory Issues:

None

Fitness for Use:

Testing Procol

Something similar to the following testing protocol will be followed:

To test the optic, the entire FOV must be looked at. We will rotate the lens around a bar target and test both resolution and MTF at various points in the field. This will allow us to get a good understanding of how the lens will perform in various environments. Resolution from such a wide angle will vary from a standard lens, as it has such high angles. y=f(tan(theta)) will go to infinity at 90°, and we will clearly pass that with a 125 ° HFOV. We will use the information we receive from the tests to define resolution for ourselves.

Test Setup

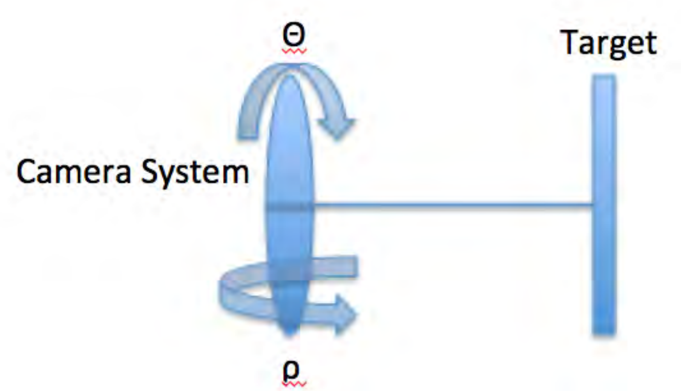


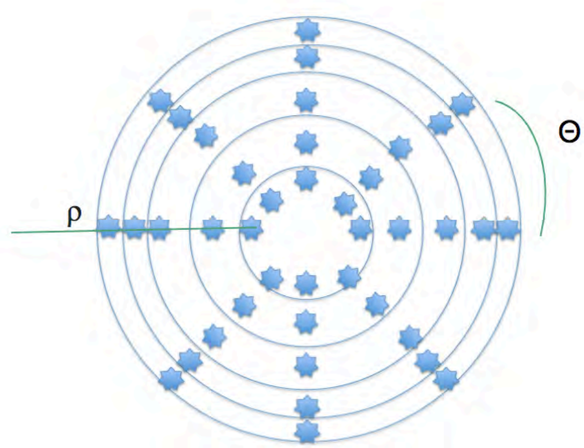
Figure 1: Rough white-board sketch (left) and computer block diagram (right) of potential testing set-up including the lens being tested and a bar target. Data will be recorded at a number of polar (lens) and azimuth (bar target) angle combinations.

This will allow the team to determine how far away the camera is able to be placed to still resolve objects such as a soccer ball or the drummer in the back of the stage.

Measurements

To test the optic, the team must investigate the entire FOV must be looked at. We will rotate the lens around a bar target and test resolution at various points in the field. The team plans on recording resolution data across the entire FOV at specific locations. These locations will not be placed linearly, but rather in equally weighted circles around the field, which will allow for an equally weighted view of the field. We plan to take 5 rho rotation measurements at the angles defined in the table below across 8 symmetrical theta rotations every 45° as seen in the figure below. This calls for 40 total measurements. Our definition of resolution will be dependent on available software. The resolution results will be presented in a color map of the entire field, so that the customer can visualize where in the field there is good and bad resolution.

r_5	125°
r_4	111.80°
r_3	96.82°
r_2	79.06°
r_1	55.90°



System Description:

The test set-up will:

Contain a camera lens with 250° field of view

- Entanyia Product

Contain a sensor of the following (or similar) specifications:

*Lens has both S and C mount capability, so any off-the-shelf detector can be used

- 60+ fps
- 1.1” diagonal

- Color
- 12+ megapixels of ~4.5 micron size

For now, using GoPro camera sensor provided by customer

Utilize a bar target as a resolution standard

Test the lens in various real world environments.

- This will allow us to see how the lens will perform in a sports, concert, etc. environment before shipping the lens back. We would also like to test the lenses' performance in these environments so that problems in the differences can be targeted and fixed. This will allow the team to determine how well the lens will perform, and where Raptor Vision should take the design when the semester is over.

Required For Testing

From Customer	From U of R
Entanyia 250° FOV Fisheye Lens	Mechanical Mount for Camera • Theta Rotation • Rho Rotation
Camera Sensor	Resolution Chart/Point Source

The Entaniya lens and camera sensor provided by Raptor Vision together cost ~$2000. The entire test set-up, outside of these things provided by Raptor Vision, is provided by The Institute of Optics for free.

It is desirable that:

We create a video demonstration of the test results and their potential effect on video streaming experience. Such as a Yellowjackets sports game, on-campus concert, and other popular campus events.

- This is dependent on our access to Raptor Vision's dewarping software, and/or also on the help of a computer science graduate student from the University of Rochester.

This project will not:

Involve any lens design or prototyping

- Instead, the group will be specifically gathering pertinent resolution information for future design efforts based on the company's specific vision for their product in the future.

Fall Semester Timeline

October – November	Initial meetings with Raptor Vision Early design/test set-up brainstorming
December	Finalization of testing protocols Collection of testing materials Final formatting of PRD

Spring Semester Timeline

As Events Occur	Test lens in specified environments
January - February	Record Images
	Process Data
March	Create Data Map
	Investigate Details inside Regions of Interest
April	Create Conclusive Report Including all aspects of the project