Motivation and Background

SouthCom MiniAWACS project

- Primary function is to use Radar to track drone swarms to provide position and vector data to drone manufacturers

Optical Project

- Due to limitations and cost of optical components for SD motivation is to determine the range of an object at “long distances” using stereo vision

Goals

Basic Goals
Acquire stereo images with adequate resolution to provide range information with less than 15% error at 100ft
Advanced Goals
Acquire stereo images with adequate resolution to provide range information with less than 15% error at 200ft
Acquire 3D depth map from stereo images to determine position of object in relation to other objects within the imaged scene
Stretch Goals
Acquire image with adequate resolution to provide range information with less than 10% error at 300ft
Provide vector information regarding motion of object in relation to it’s initial position

Objectives

Basic Objectives
Use Zemax to design optical system with off the shelf lenses including an achromatic doublet lens with an appropriate focal length to allow the system to capture images with adequate resolution to range an object at 100 ft.
Design and 3D CAD housing for lens system to attach to camera
Determine baseline between cameras that will allow for <10% error when ranging an object between 100ft
Advanced Objectives
Improve accuracy of ranging at distances 200< ft by making necessary adjustments to system baseline to reduce ranging error at longer distances
Make necessary adjustments to image processing program to provide distance and object position in cartesian coordinates relative to the system
Stretch Objectives
Attempt to develop an image processing program that can track an object's movement to provide a motion vector.

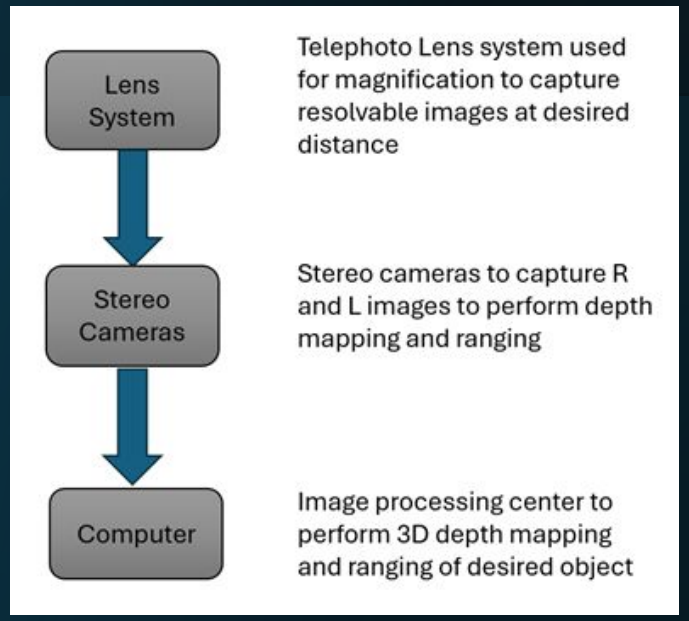
Engineering Requirements/Specs

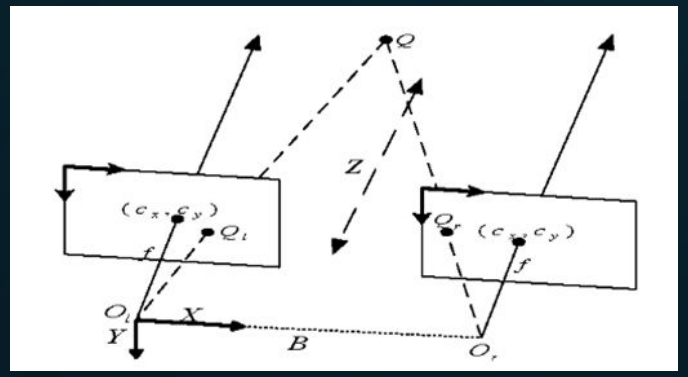
Engineering Requirement	Requirement Specification	Unit
Capture stereo images of a scene	< 1	Seconds
Complete depth map of scene captured by stereo images	< 3	Seconds
Provide range of desired object	< 5	Seconds
Stepper motor will respond to commands to rotate system	<1	Seconds
Complete depth map of scene captured in stereo video (stretch)	<10	Seconds
Provide range of objects in video (stretch)	<15	Seconds

Hardware

Component	Parameter	Specification	Unit
ELP Global Shutter USB Camera	Sensor size Sensor type Speed Shutter type	1/2.6” CMOS 90 Global	Mm CMOS vs CCD Fps Global vs. Rolling
Plano Concave Lens	Diameter Effective focal length AR Coating	20 -100 425-675	mm mm nm
Achromatic Doublet Lens	Diameter Effective focal length AR Coating	50 350 425-675	mm mm nm

Hardware


Lens System
Telephoto Lens system used for magnification to capture resolvable images at desired distance
Stereo Cameras
Stereo cameras to capture R and L images to perform depth mapping and ranging
Computer
Image processing center to perform 3D depth mapping and ranging of desired object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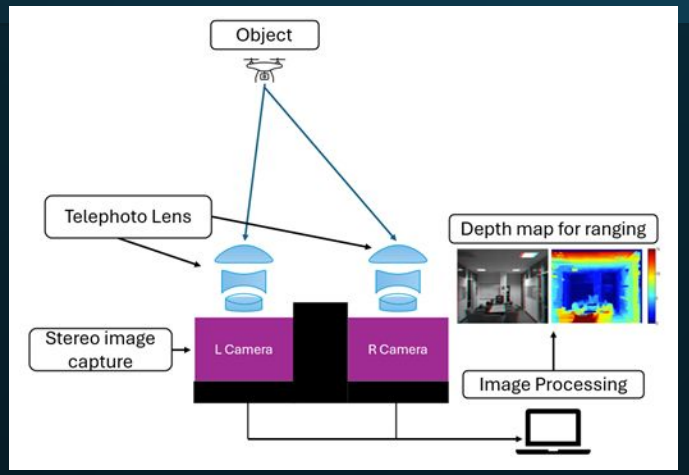
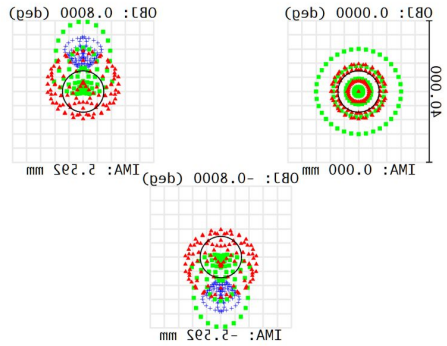

Object
Telephoto Lens
Depth map for ranging
Stereo image capture
L Camera
R Camera
Image Processing

Hardware

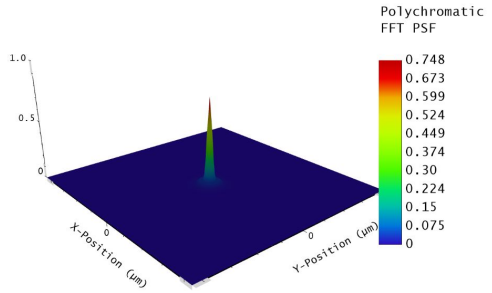
- Zemax 400mm EFL len design

- 3D CAD and print
  - Lens tubes
  - Camera housing and lens support

Spot Diagram



PSF



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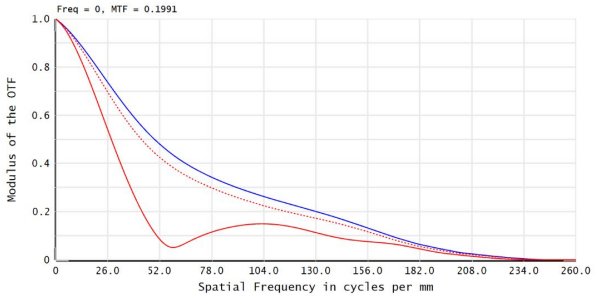
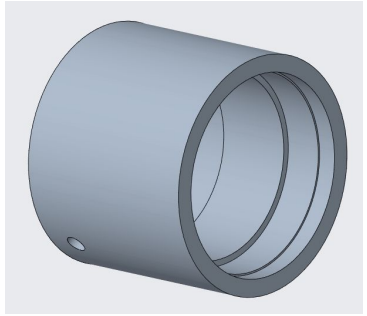
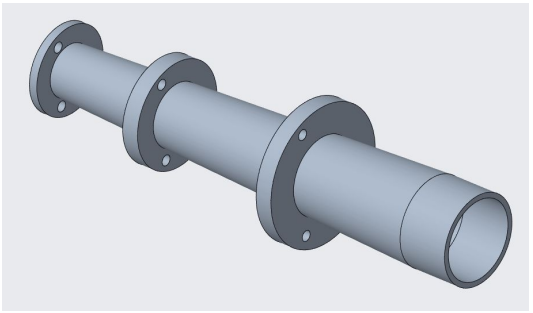
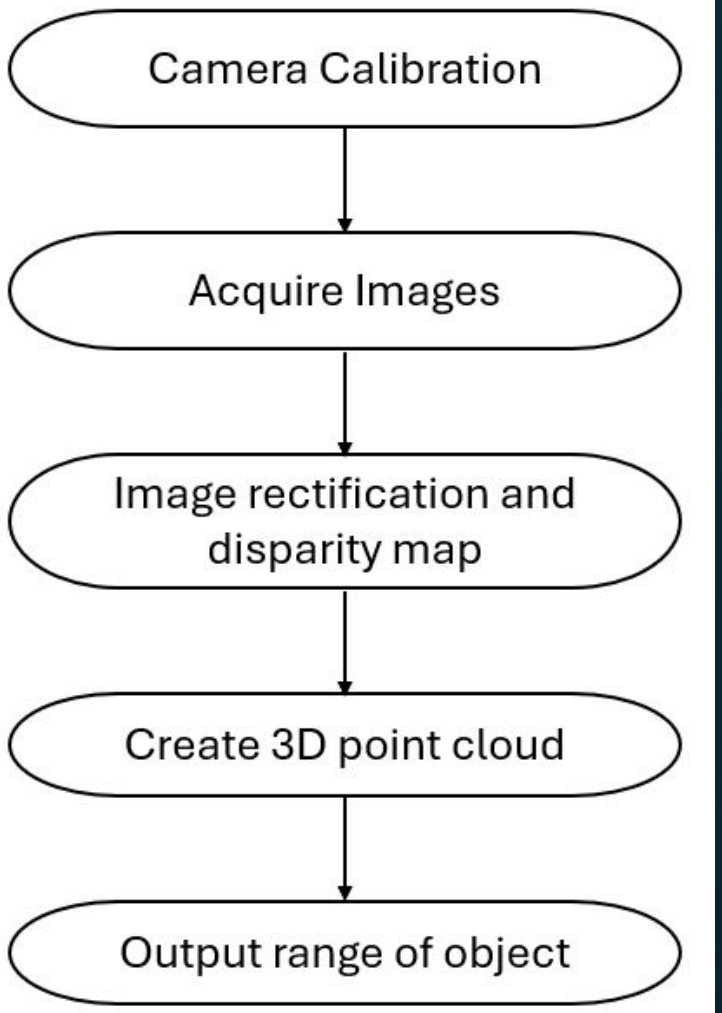






Software

- MATLAB Stereo Camera Calibrator App
  - Provides necessary intrinsic properties of stereo camera system
  - Allows for use of stereo vision-based functions in MATLAB for desired image processing
- MATLAB stereo image acquisition
- MATLAB Image processing using stereo camera intrinsic parameters



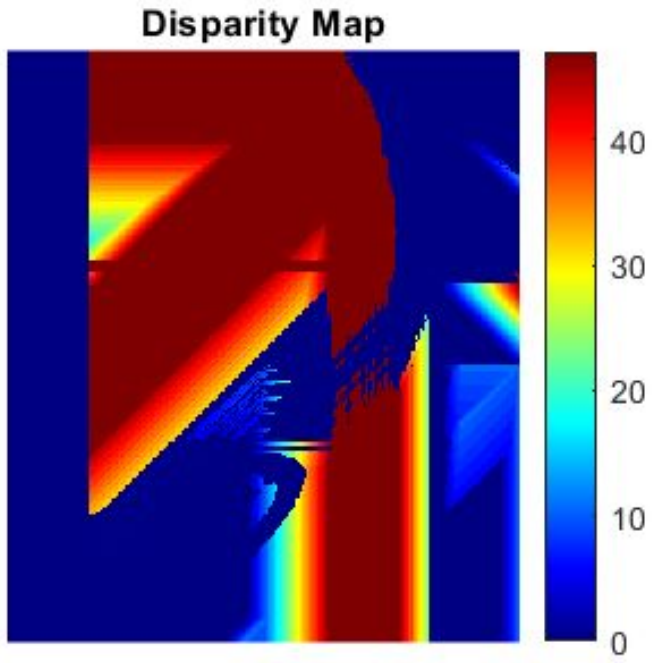
Prototyping and Testing

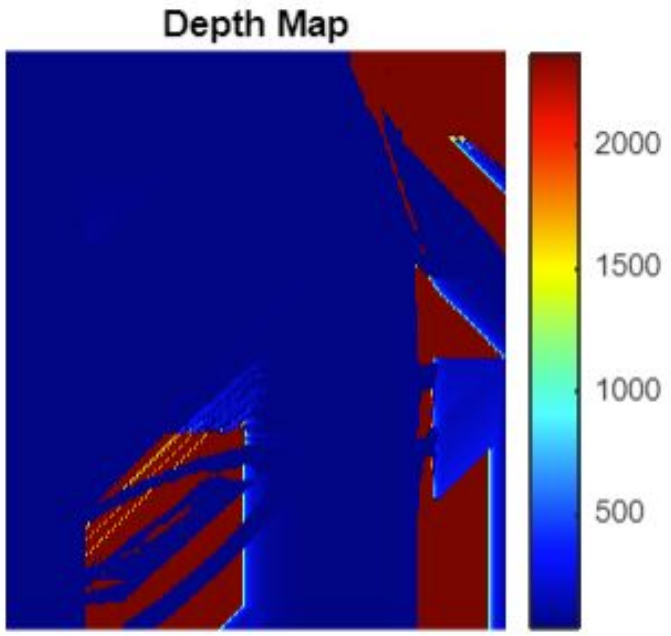
- Current testing and prototyping performed with 50mm EFL lenses stock with ELP cameras
- Baseline set at 50cm
- MATLAB Stereo Camera Calibrator App

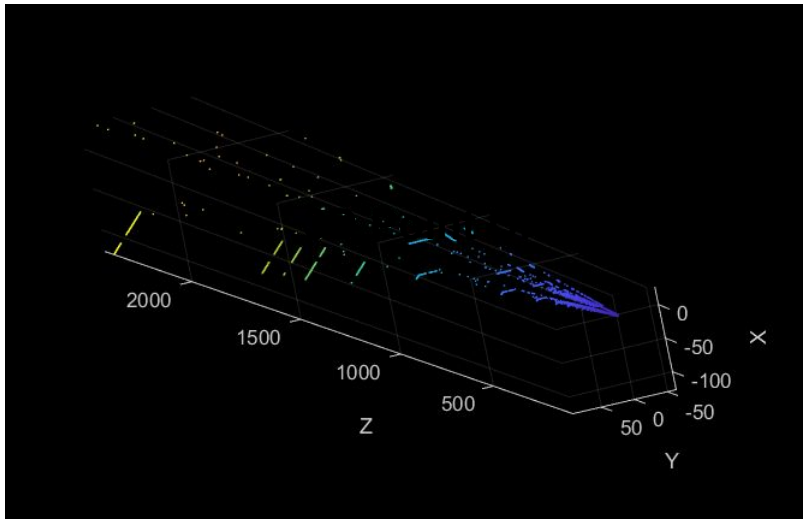
Stereo Image set for testing

Prototyping and Testing

Testing output







Progress

- Progress
  - Able to use Stereo Calibrator App to create stereo camera intrinsic parameters for testing
  - Code is producing disparity map and depth map

Plan for Completion

- Finalize Lens Tube design for adequate imaging
- Determine optimal baseline for stereo camera system
- Build camera and lens support
- Use MATLAB Stereo Camera Calibration APP to find camera intrinsics for final system
- Test code to get usable data for depth/range of objects in stereo image scene