

# Astro 331 Prelab 2: Camera Payload

## Report Instructions

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Documentation:

- Arducam datasheet
- DFAS writing guide (I used for writing these instructions—you don't need to reference it)
- Cite references as necessary, but don't include course notes, course text (SMAD), or these instructions as documentation
- Don't forget to update your own documentation statement when you write your prelab report!

### Overview

FlatSAT's payload is an ArduCAM-M-2MP visible-light camera. You will use this camera to capture images of a test chart at ranges from 0.5 to 5 m to validate prelab predictions and determine if the camera will satisfy mission requirements from its 500 km circular orbit. FlatSAT's objective is to monitor large areas over time for change detection. It should be able to resolve areas the size of a city block or smaller.

### Format

Include the sections required in a Short Summary Report from the USAFA/DFAS writing guide, with the addition of a Nomenclature section. Do not include a cover sheet for prelabs.

- Objectives
- Nomenclature
- Approach
- Assumptions
- Math Technique
- Theoretical Predictions
- Experimental Setup
- (Preliminary Results)
- (Experimental Results)
- Discussion
- Conclusions and Recommendations
- Appendices

Include preliminary results in an Experimental Results section only if you have performed preliminary testing—there is no preliminary testing for this prelab. Collect data during this lab for inclusion in your end-of-semester lab report.

This assignment will be no more than five typed pages. This assignment is individual effort, but you may use websites and textbooks provided that you cite all sources used (see the References section in the DFAS Writing Guide). A documentation statement is required.

### Content

For each distance in Table 1, calculate expected diffraction-limited resolution and pixel-limited resolution using the information provided in the ArduCAM-M-2MP datasheet. Excerpts from this datasheet are provided in Appendix A. Your prelab should also contain this information in an appendix.

Your prelab report will include a completed version of Table 1. Your final lab report will additionally include the experimental results of your resolution measurements.

Comment on whether the camera's resolution is diffraction-limited or pixel-limited. Comment on your results, including whether they system will meet mission requirements. Discuss design changes to improve system performance (even if

**Table 1 Predicted resolution**

distance	diffraction-limited	pixel-limited
50 cm		
1 m		
2 m		
5 m		
500 km		

the payload meets mission requirements as-is).

All variables and units will be defined (including units) in a nomenclature section at the beginning of your paper. In your math techniques section be sure to discuss every equation. If a term has a range of possible values, such as the value of wavelength in a resolution equation, explain which value you chose and why.

You must show all of your work in an Appendix. Ensure that equations and intermediate values are included. This may be by hand. If you use Matlab, use a livescript. Do not suppress output but display it alongside your equations.

This prelab should be a stand-alone document that any engineer without prior space experience could read and understand. At a minimum, you will need the following equations:

Diffraction-limited resolution (Equation 1):

$$X' = \frac{2.44\lambda h}{D} \quad (1)$$

Pixel-limited resolution, from SMAD Fig 9-8:

$$X = \frac{2R}{p} \quad (2)$$

Magnification:

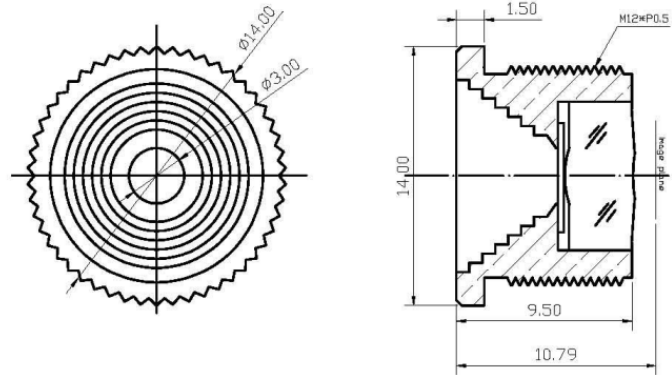
$$\text{magnification} = \frac{f}{h} = \frac{r_d}{R} \quad (3)$$

## A. Arducam specifications

- Power supply Normal: 5V/70mA
- Low power mode: 5V/20mA
- SPI speed: 8MHz
- Frame buffer: 384KB
- Size: 34 x 24 mm
- Weight: 20 g
- Temperature:  $-10^{\circ}\text{C}\sim 55^{\circ}\text{C}$
- Active array size: 1600x1200
- Shutter: rolling shutter
- Lens: 1/4 inch
- Resolution support: UXGA, SVGA, VGA, QVGA, CIF, QCIF
- Format support: RAW, YUV, RGB, JPEG
- Pixel Size:  $2.2\mu\text{m} \times 2.2\mu\text{m}$

### SPECIFICATION:

1.Sensor Format:	max $\phi$ 5.3mm
2.EFL:	3.96 mm
3.F-number:	2.6
4.Construction:	4P+1IR
5.TV Distortion:	<1.2%
6.FOV:	$56.8^{\circ}$
7.FBL:	1.29mm
8.IR:	645nm



**Fig. 1 ArduCAM S mount lens**

**Table 2 ArduCAM parameter summary**

Active array size *	1600 px $\times$ 1200 px
Pixel size	$2.2\mu\text{m} \times 2.2\mu\text{m}$
Focal length	3.96 mm
Aperture Diameter	3.00 mm
FOV	$56.8^{\circ}$

\*Use the larger number for pixel-limited resolution