Image Processing Using Python

Software Team

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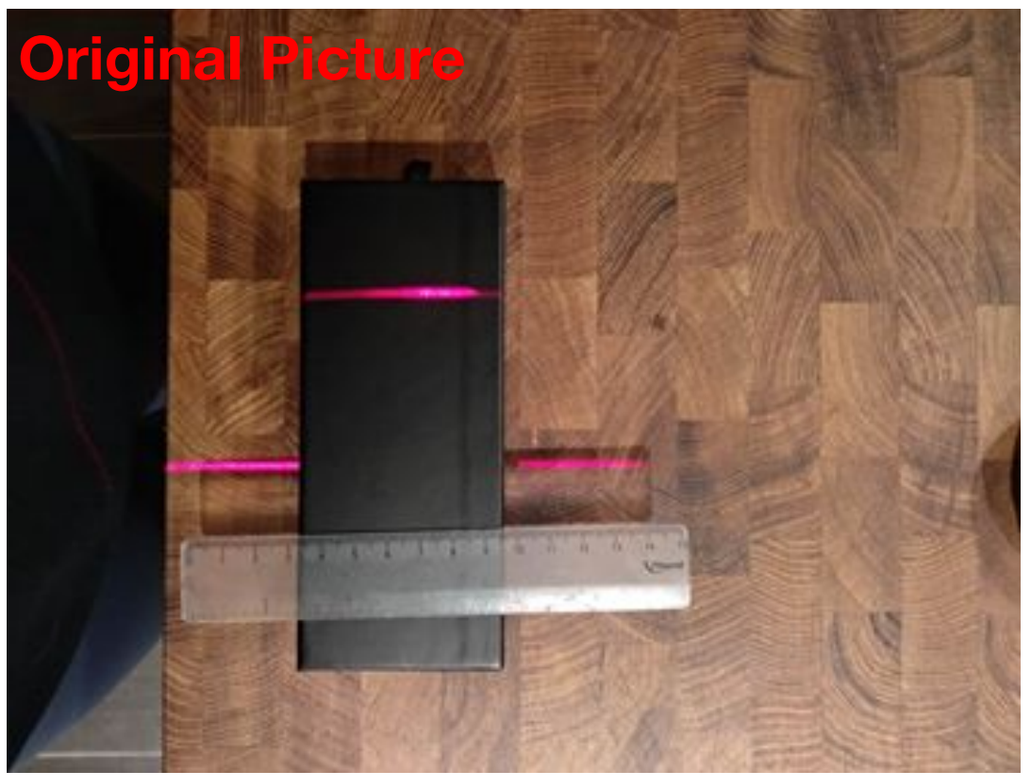
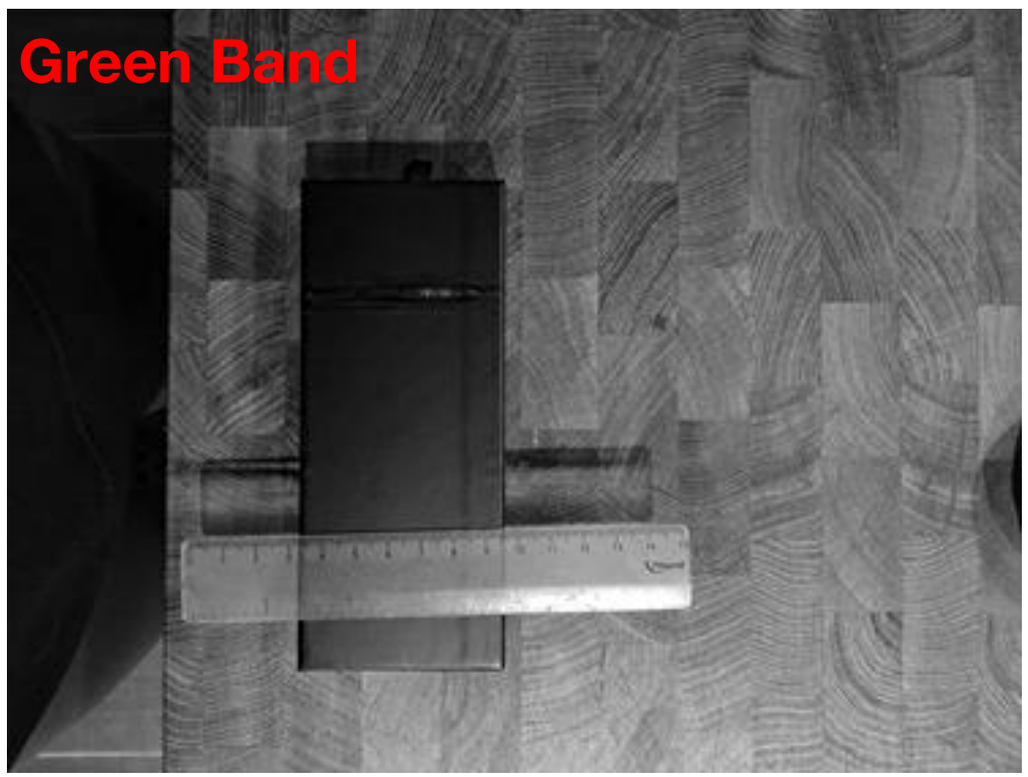
Python Code to Split Image Into R, G, and B Bands

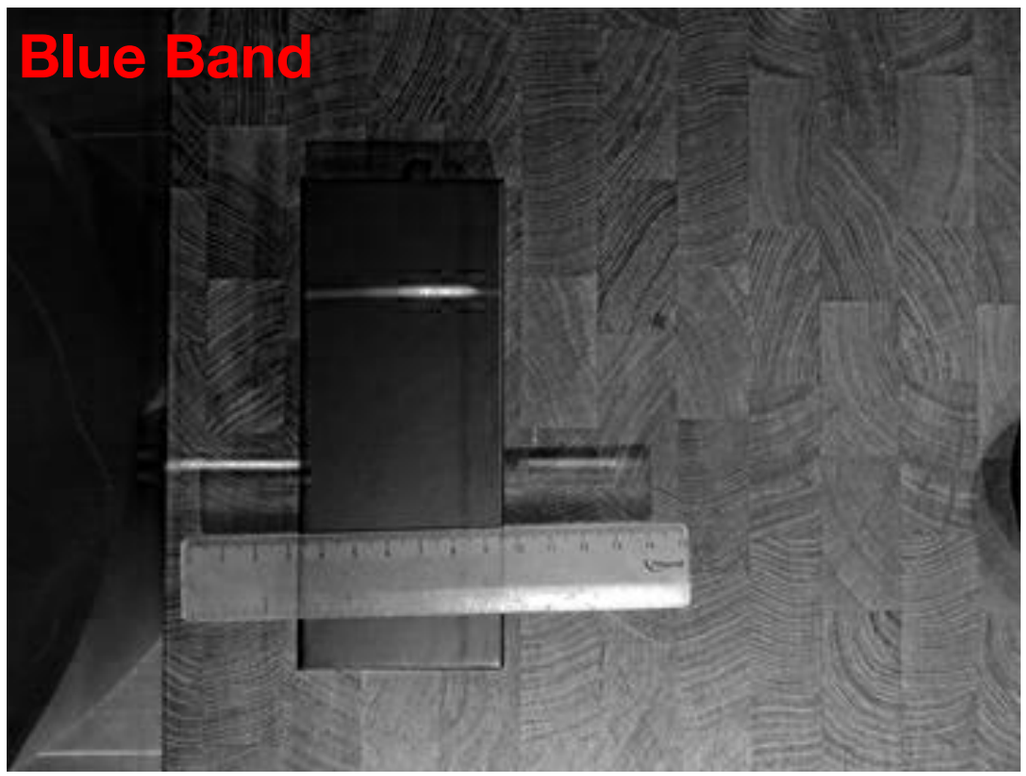
The code on the right was used to split the image above into the separate bands.

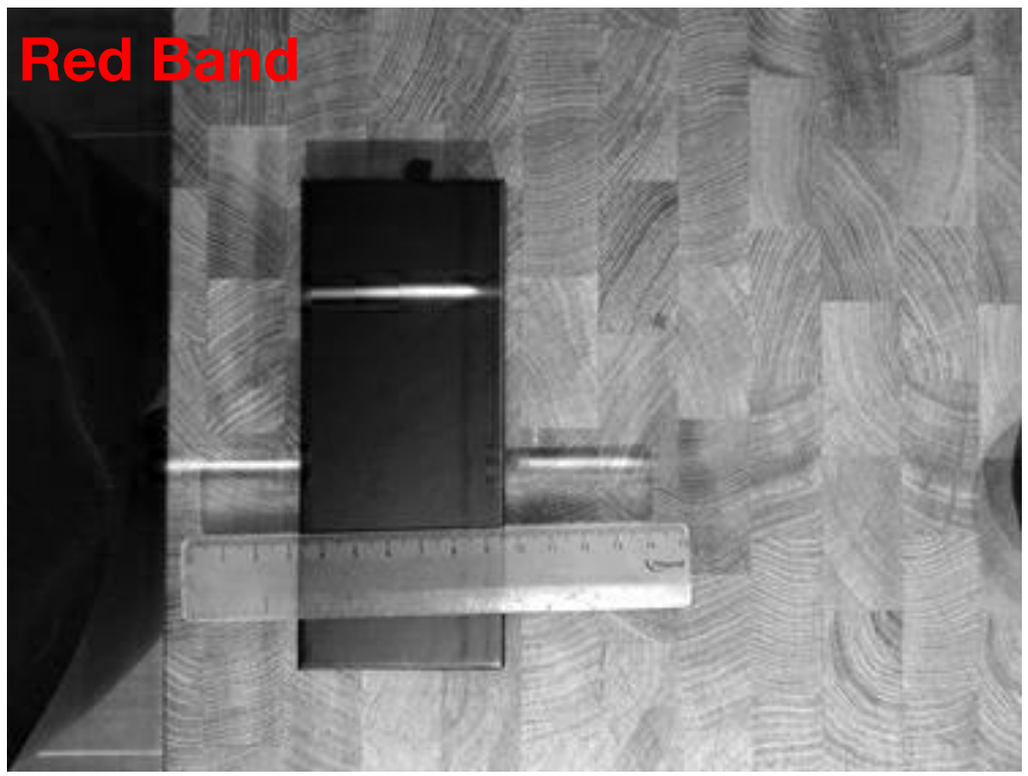
```python
from PIL import Image
def main():
    print("now in main")
    try:
        img = Image.open("/Users/isabela_taketa/Desktop/Capstone Test/pictureone.jpg")

        print(img.split())
        print("done printing the image")

        print("splitting image again and saving to variables")
        red, green, blue, alpha = img.split()

        print("saving individual images")

        red.save("/Users/isabela_taketa/Desktop/Capstone Test/red_line1.jpg")
        green.save("/Users/isabela_taketa/Desktop/Capstone Test/green_line1.jpg")
        blue.save("/Users/isabela_taketa/Desktop/Capstone Test/blue_line1.jpg")

        print("done saving individual images")

    except IOError as e:
        print("there was an error", e)
        pass

if __name__=="__main__":
    main()
```

Image Split Into Separate Bands





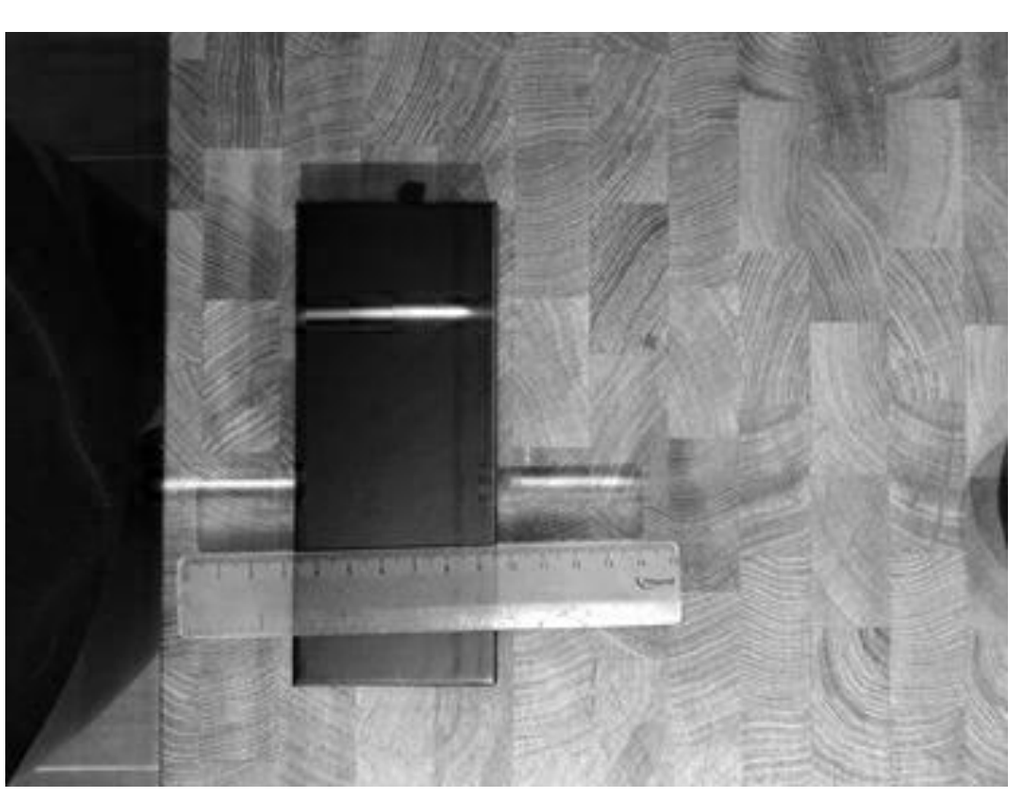




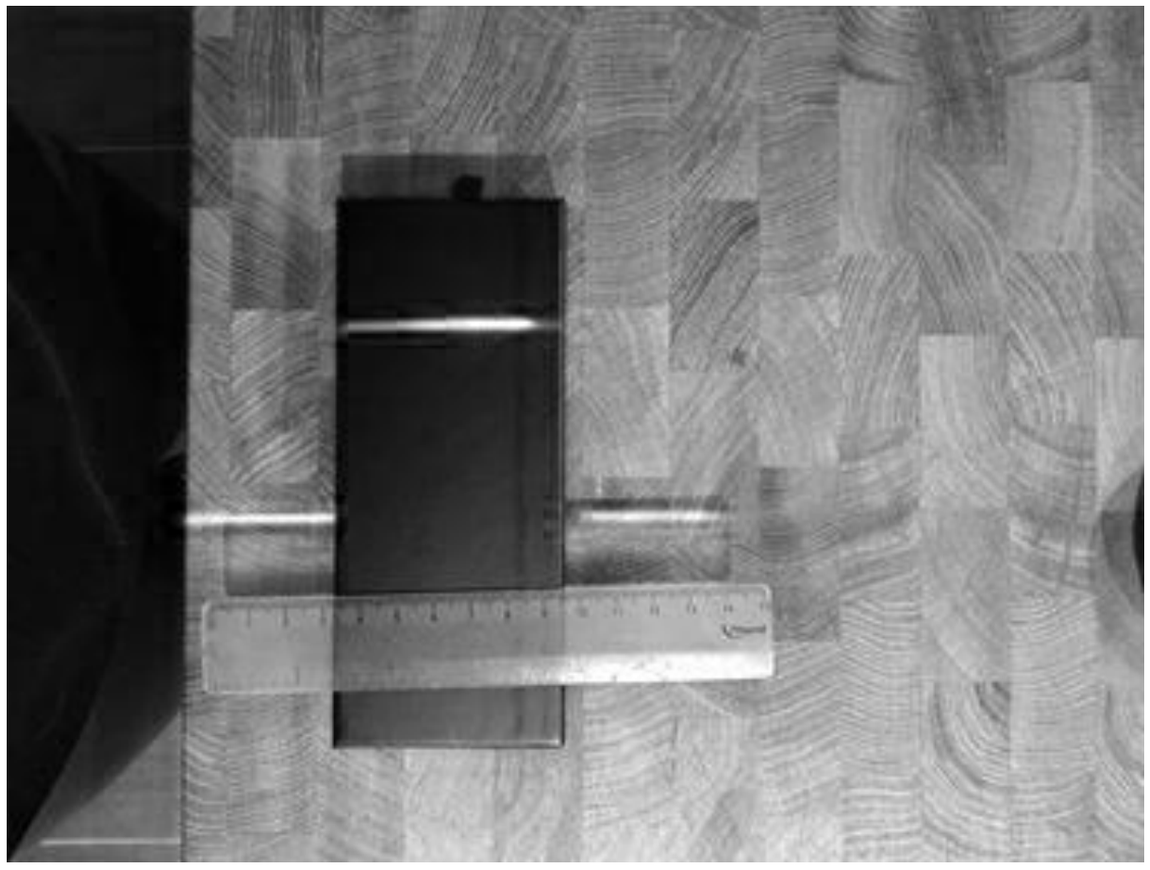
Python Code to Detect Edges

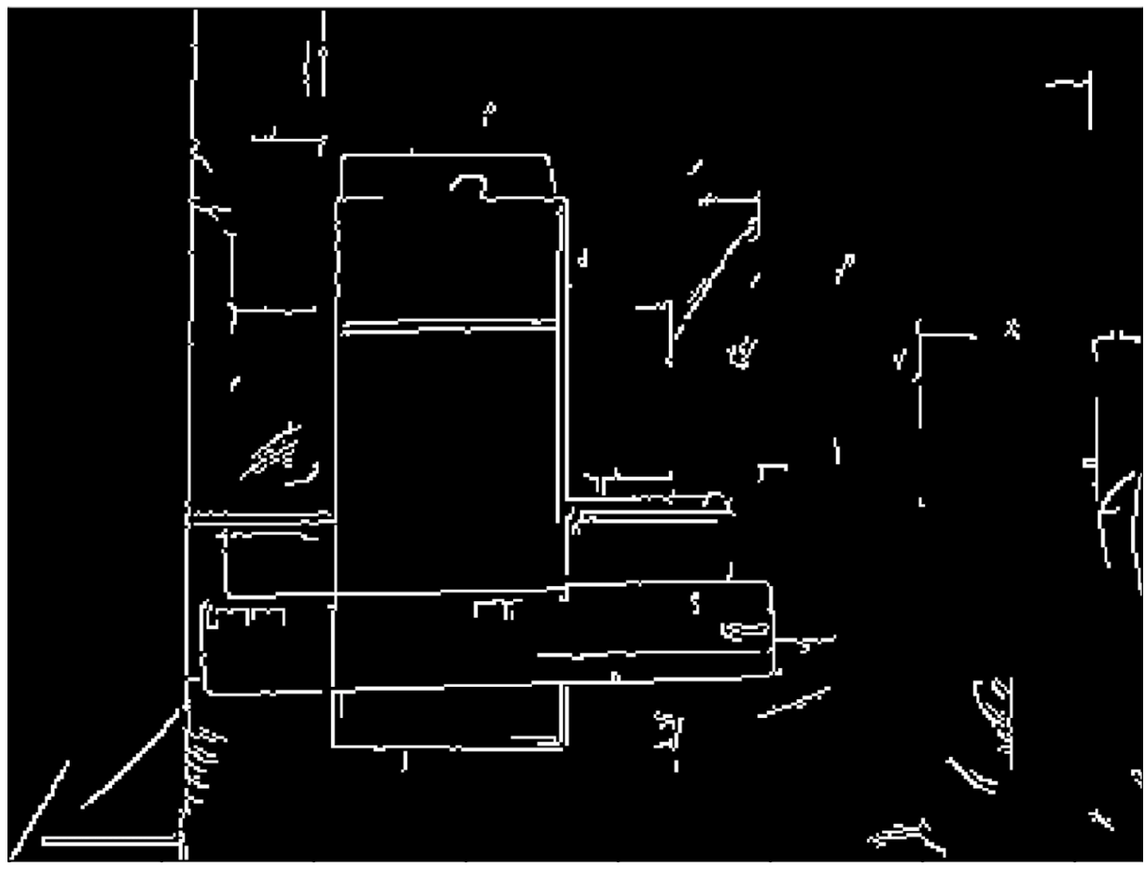
The code on the right was used to detect the edges in the red band image.

```python
import cv2
import matplotlib.pyplot as plt

# Open the image
img = cv2.imread('/Users/isabela_taketa/Desktop/Capstone Test/line_red.jpg')

# Apply Canny
edges = cv2.Canny(img, 100, 200, 3, L2gradient=True)

plt.figure()
plt.title('Red Line')
plt.imsave('line-red-canny.png', edges, cmap='gray', format='png')
plt.imshow(edges, cmap='gray')
plt.show()
```



Original Image X Output





Problem

- The code detects a lot more than the laser line

Next Steps

- Add a minimum intensity value to the code to limit the area where the edges are detected

Environmental Impact of 3D-Printing

LCA Team

Aleisha Reese Cerny

Old Approach

- LCA of solution vs. How much material is saved by using solution

- Material waste from failure is not a good selling point for an LCA comparison

    - Electricity use has the biggest impact

New Approach

- 3D printing manufacturing vs. Commercial manufacturing
    - Energy demand of polymer products reduced by 41-64%
        - Conduct systematic analysis of enviro impact of FDM
- Compare variations in FDM
    - Material (filament choice ABS vs PLA)
        - Does this make a difference? (ie. in energy consumption)

Conclusion

- “But if energy consumption is the biggest problem, then shouldn’t reducing waste reduce (wasted) energy consumption?” – Chad

- Justify that reducing waste in FDM is a viable way to reduce impact

OR

- By justifying that FDM printers in general have less environmental impact compared to traditional manufacturing, we can justify that our failure prevention solution is necessary

Understanding Laser Line Projection

Hardware Team

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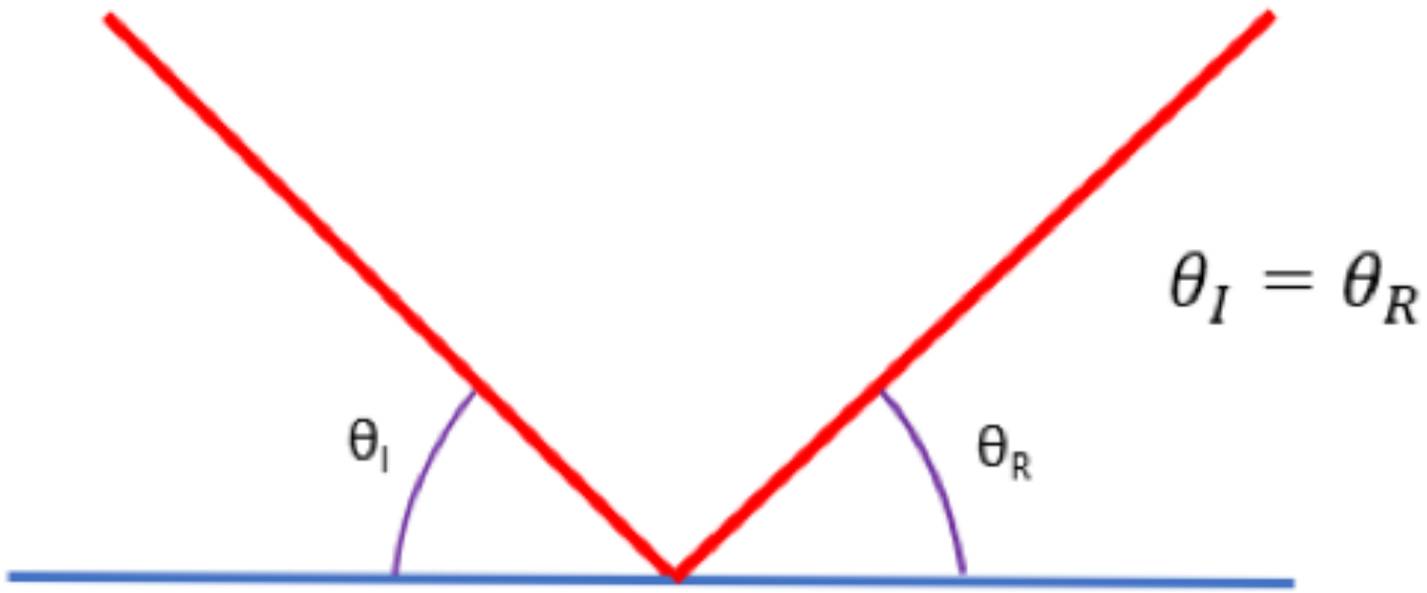
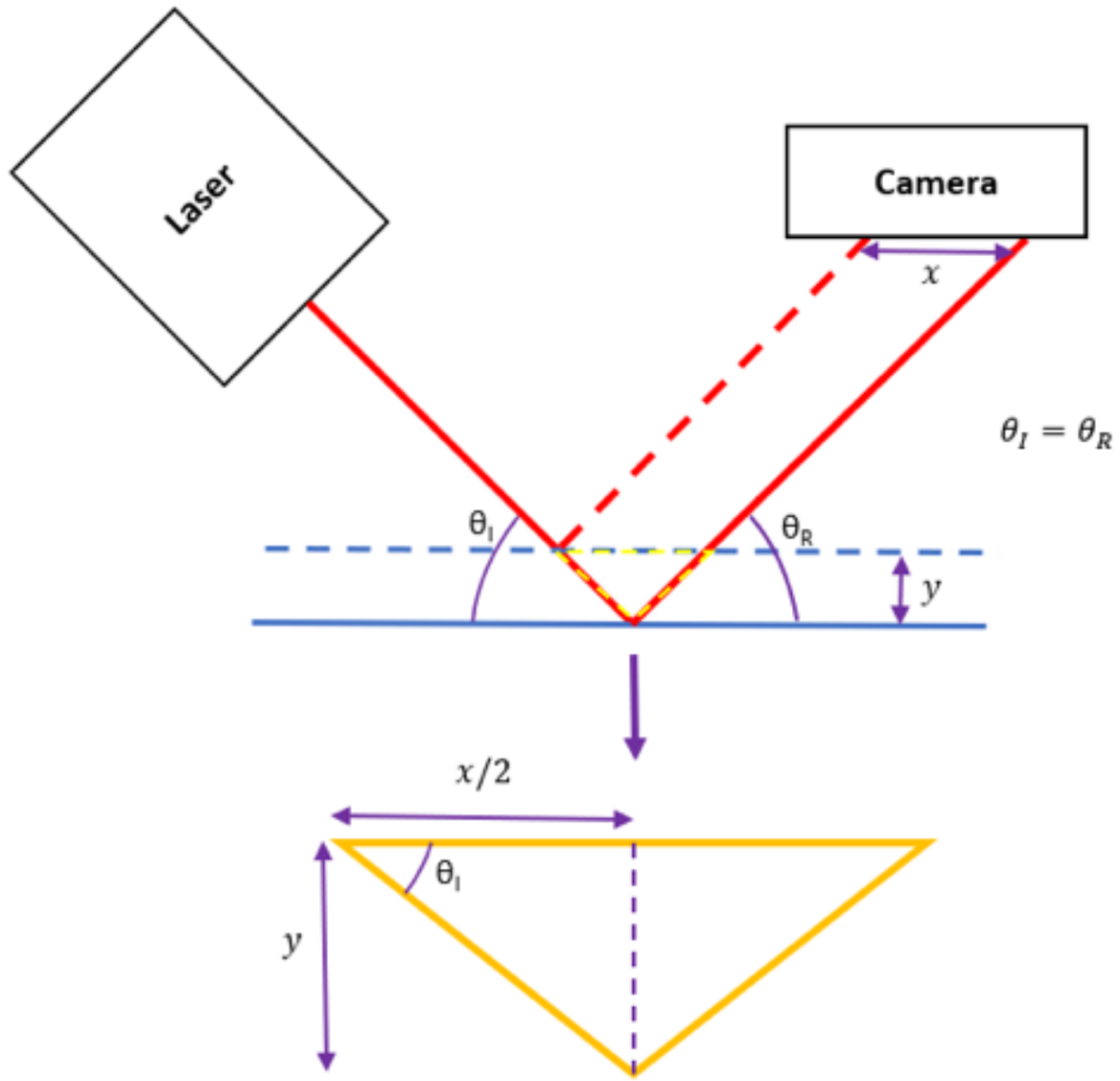
Euclid's Law of Reflection



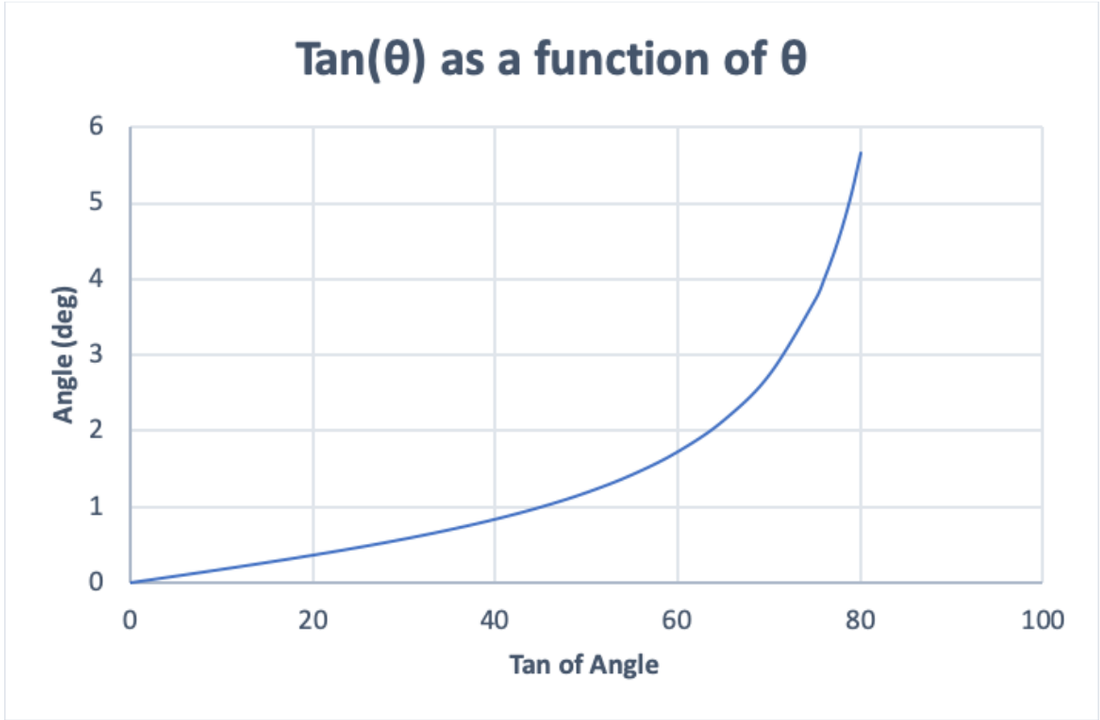
Applying the Law of Reflection to Find Changes in Height



$$Tan(\theta) = \frac{2y}{x}$$

Variables: Minimize Theta

- X and Y are related by θ
- For a given y (defect size); goal is to maximize x
- X and tan(θ) are inversely proportional
- To maximize x, minimize tan(θ) by minimizing theta

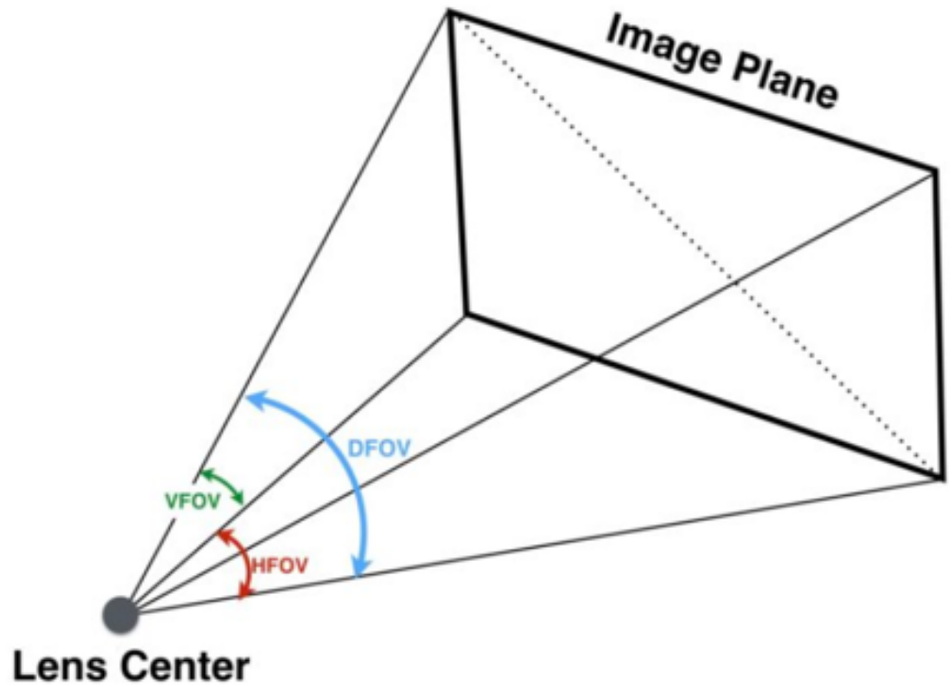


Variables - Distance from Object

- Camera view is shaped like a pyramid - with isosceles sides

- Can assume the number of pixels is constant

- Vertical, horizontal and diagonal field of view angles are also constant



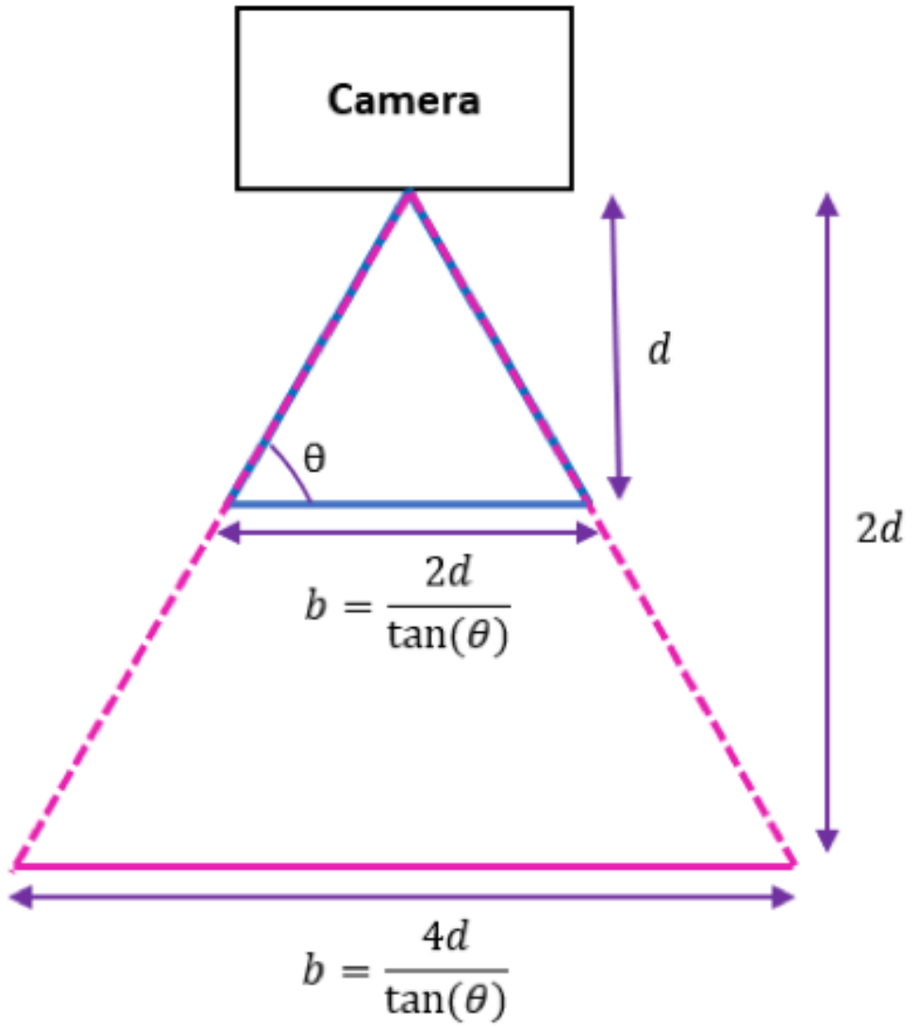
Variables - Distance from Object

- Using a 2D diagram we can calculate the effect of distance between the camera and surface on the resolution

- Base is proportional to distance; therefore image plane area is proportional to square of the distance

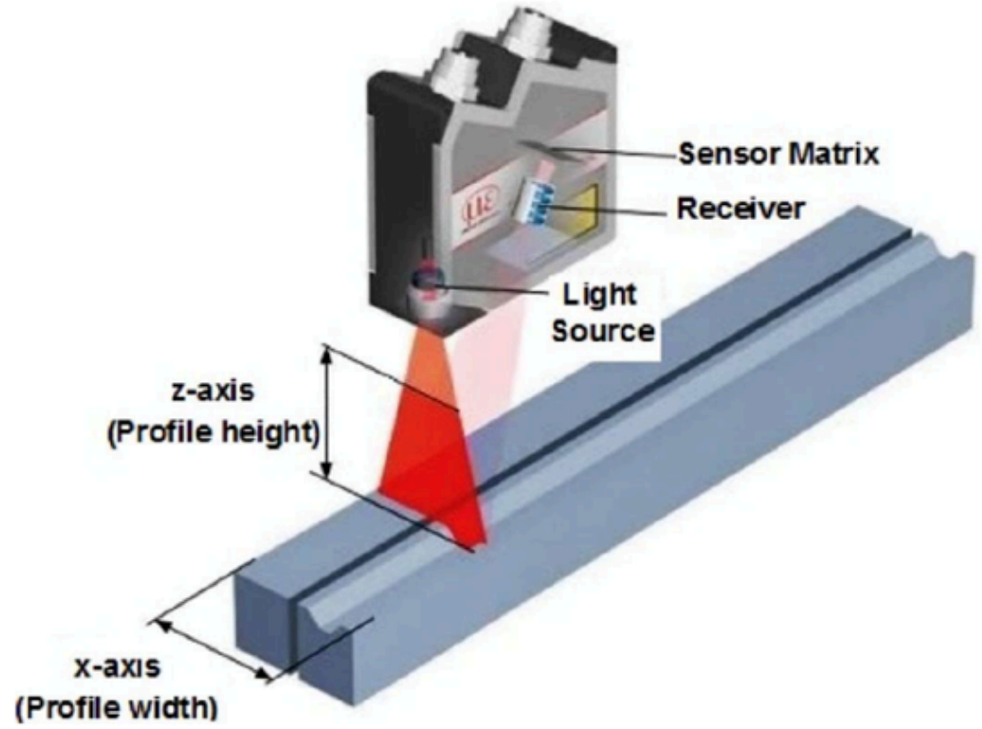
- With constant number of pixels, the area represented by each pixel is also proportional to the distance squared

- Minimum visible defect size is the image plane area of a pixel



Line Laser

- Single points have been shown in the simplified diagrams
- Our solution will be implemented with a line laser



Provisional Setup

- Accurate to 0.05cm of height deviation

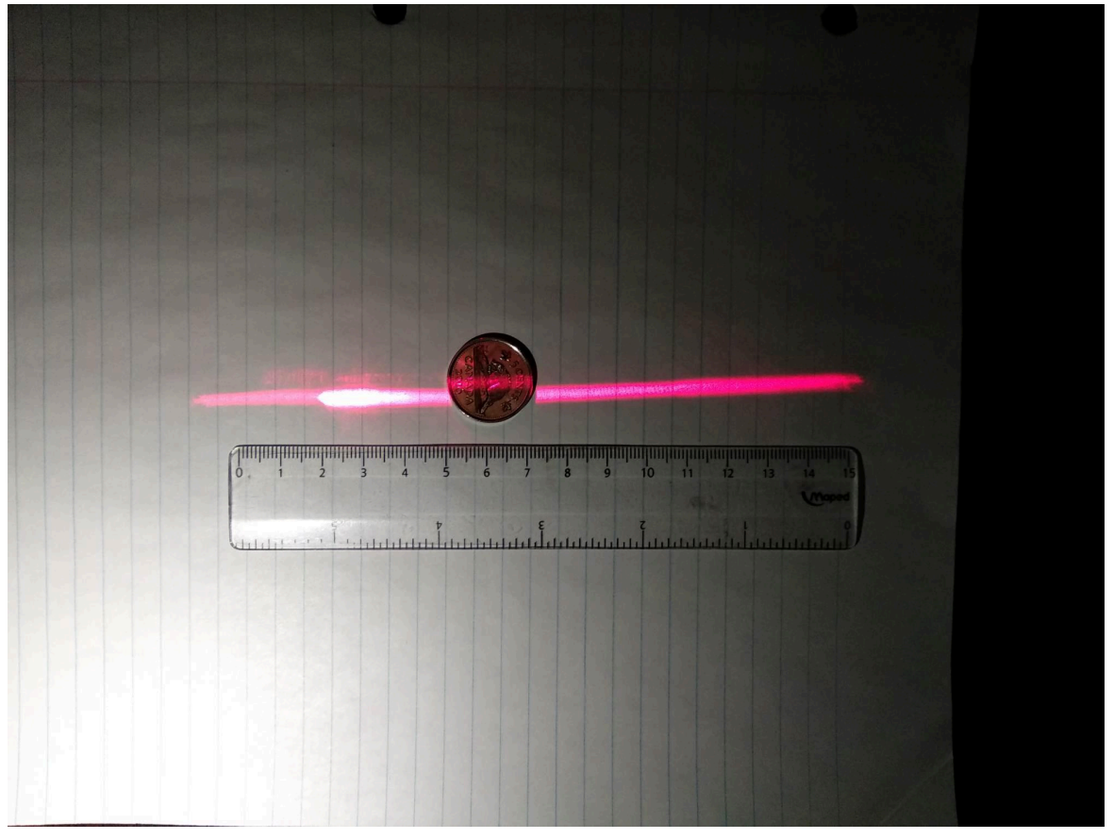
Provisional Set up Steps 2.0

- Took photo of set up – measured the angle with shapes on word (word calculated the angle).
- Took photo of the coin with the laser shining on it.
- Zoomed in the photo so that the scale on the ruler in the picture was equal to the scale on the ruler itself.
- Measured (with the ruler) the distance from the left edge of the laser on the coin to the left edge of the laser on the paper (value of x/2).
- Using Euclid’s law of reflection calculate the thickness of the coin.

Provisional Set Up 2.0

- Thickness of a nickel from the royal Canadian mint: 1.76 mm

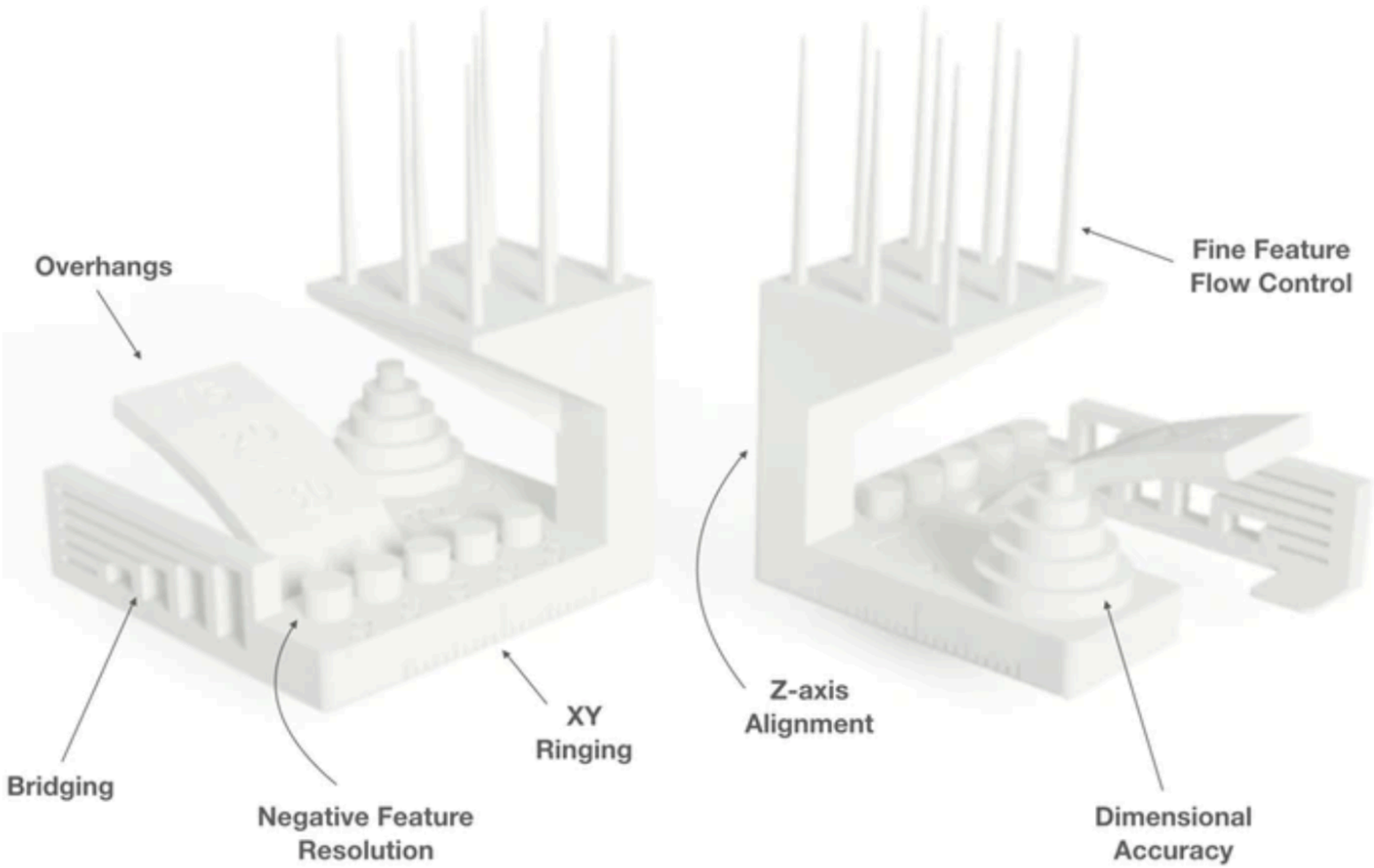
- Calculated Thickness: 1.73 mm



Error Calculation

- Systematic error:
  - Ruler (used twice): ½ the resolution is 0.5mm assuming uniform distribution, uncertainty = 0.5mm/$\sqrt{3}$ = 0.29mm
- Error from angle estimation??

Failure Tests in FDM



Next Steps

- See if software team can analyze our image to clarify edges (reduce error).
- Move onto identifying detects.
- Improved setup with retort stands.

Expected Challenges (Keep in Mind)

- Distance between the surface (print) and the camera will change throughout the print run
- The camera position will have to change unless the image plane area is large enough
- Printer nozzle may get in the way of the reflected laser and the camera
- Location and angular accuracy when setting up the laser and camera will be difficult to achieve