Melanoma Detection Application

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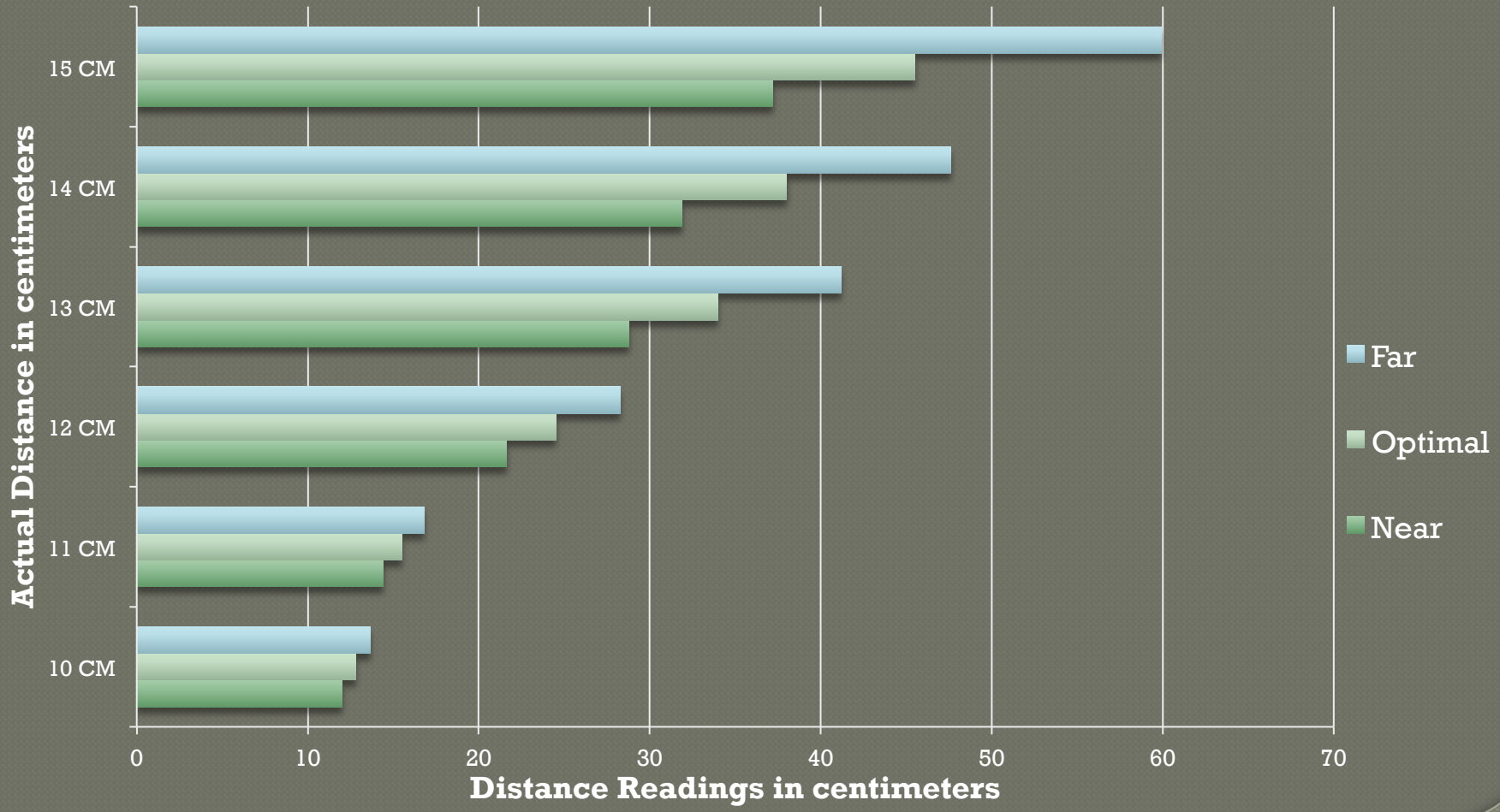
Overview

- Using built-in camera to locally determine whether a skin lesion is malignant or benign
- American Cancer Society ABCs
  - Asymmetry
  - Border Structure
  - Color
  - Diameter
  - Evolution

getFocusDistances()

- Determining distance between the camera and object in order to find lesion diameter
- To test the accuracy of the returned values, 10 pictures were taken of quarter and nickel coins at every 1 cm interval from 10 to 15 cm

Initial AverageValues from getFocusDistances()



Finding Normalizing Functions

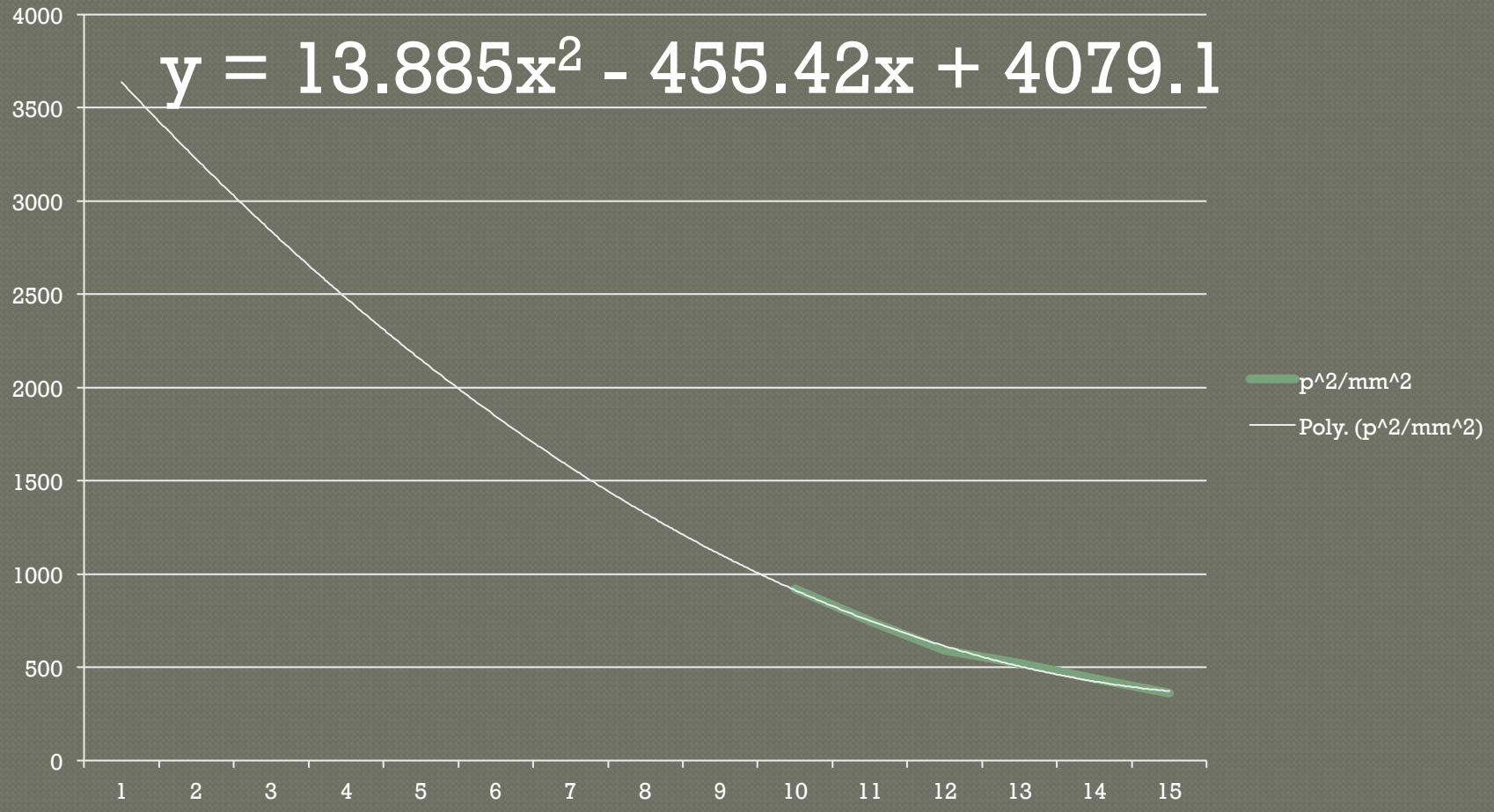
- Using the means of the near, optimal and far values, functions were found to make the values returned from the method more reliable
- Near: $x = (y+41.92)/5.3$
- Optimal: $x = (y+57.51)/6.8714$
- Far: $x = (y+85.591)/9.6131$
  - Where x is the real distance and y is the returned value

Normalized Average Readings from getFocusDistances()

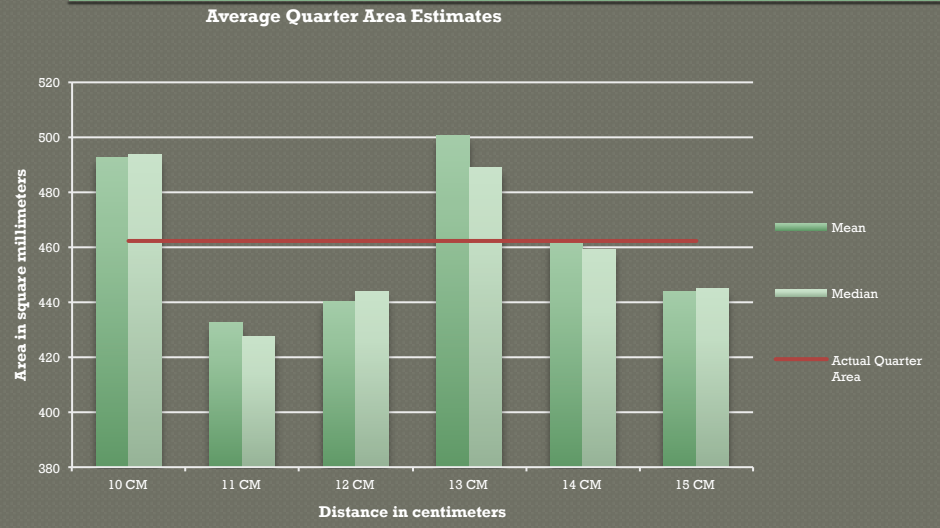
Determining Size from distance

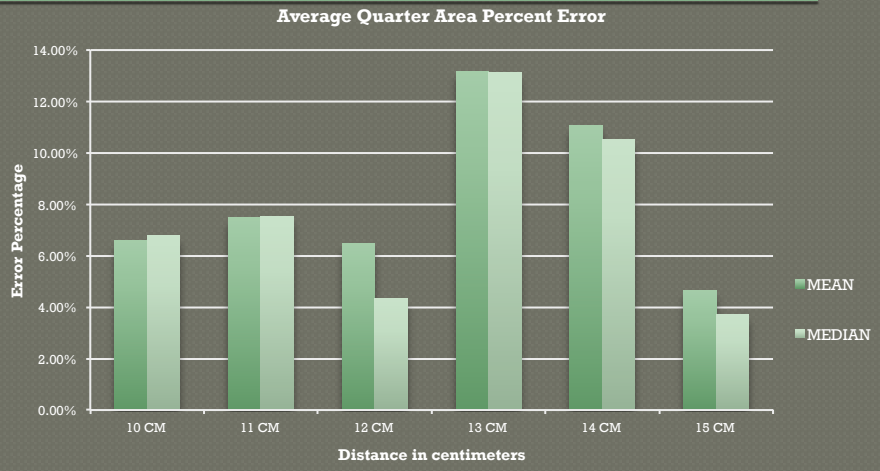
- Using OpenCV the area of the coins in pixels were found at every centimeter interval
- The mean number of pixels per square millimeter at every centimeter was used to derive a function for converting pixel area to area in square millimeters

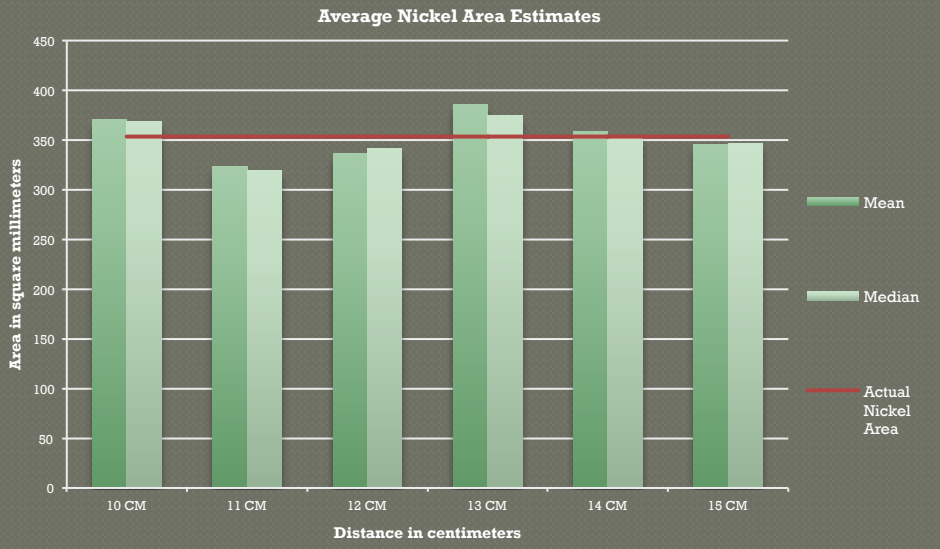
Pixels per Square Millimeter Function

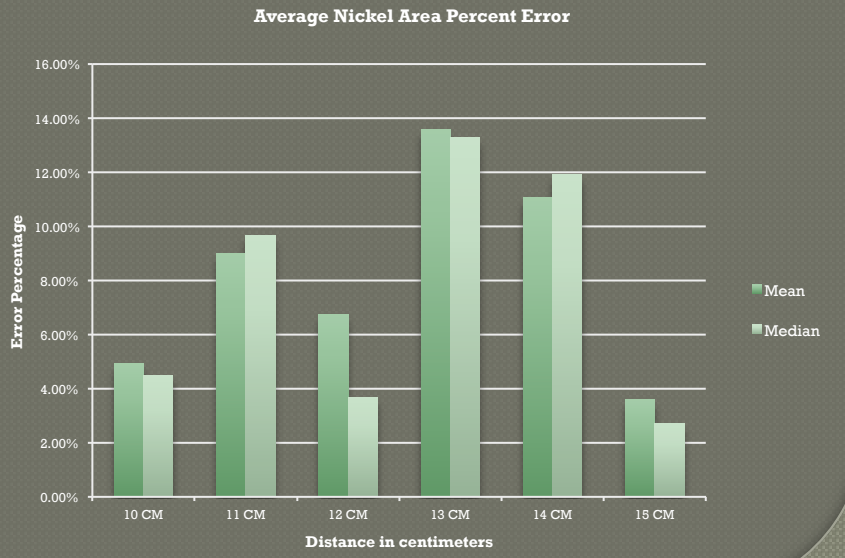


Area from Focus-Distance-based Method









Area to Diameter

- The standard deviation of estimated areas was over 37mm^2
- Since the problem threshold is 28.27mm^2, the error had to be reduced
- It was found that the error rate could be reduced by converting area to diameter

Let A be area and D be diameter and let the percent errors of area and diameter be represented by $\frac{\Delta A}{A}$ *and* $\frac{\Delta D}{D}$*, respectively.*

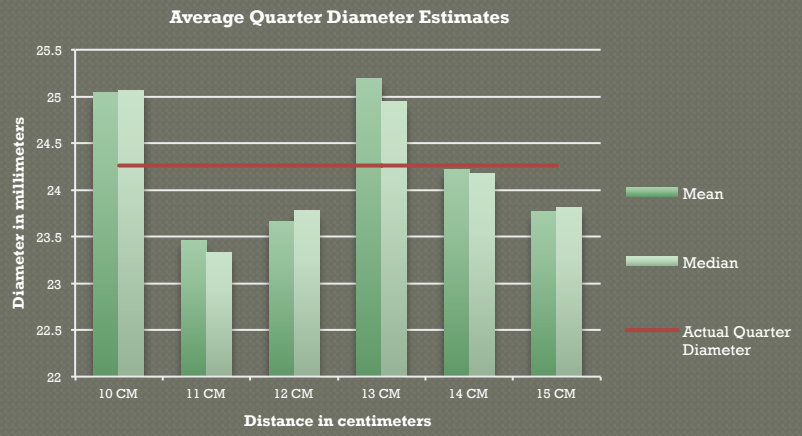
$$Note: A = \frac{\pi D^2}{4}$$

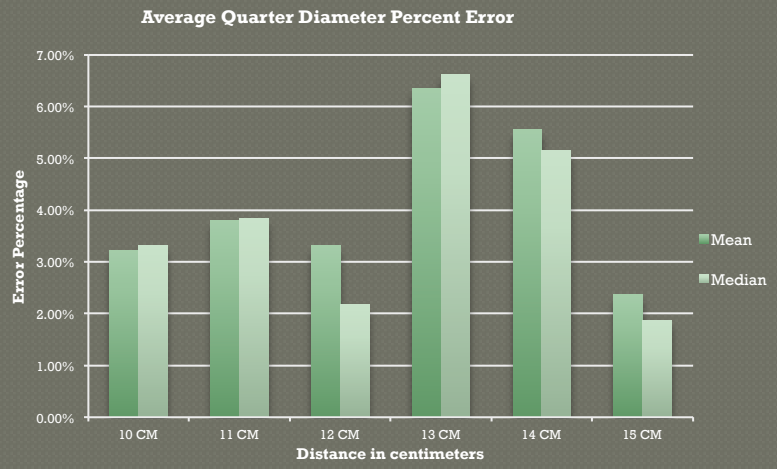
Then,

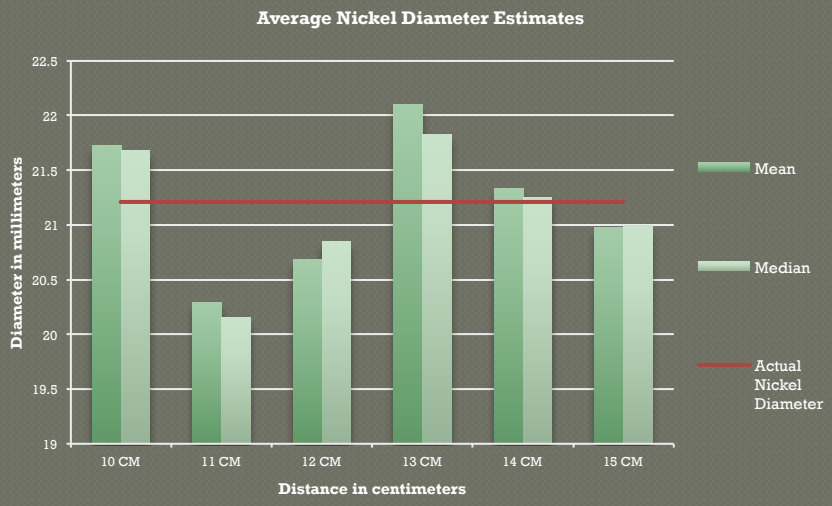
$$\Delta A = \frac{\pi D \Delta D}{2} \Rightarrow \frac{\Delta A}{A} = \frac{\frac{\pi D \Delta D}{2}}{A} \Rightarrow \frac{\Delta A}{A} = \frac{\frac{\pi D \Delta D}{2}}{\frac{\pi D^2}{4}}$$

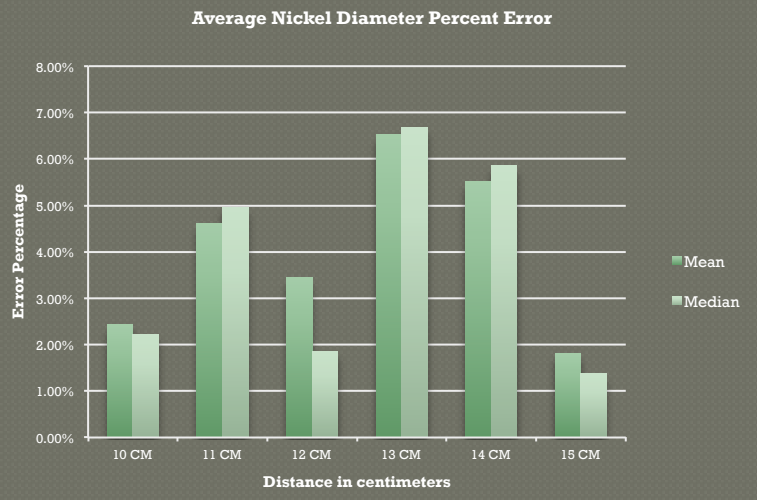
$$\Rightarrow \frac{\Delta A}{A} = 2\frac{\Delta D}{D}$$

Diameter from Focus-Distance-based Method









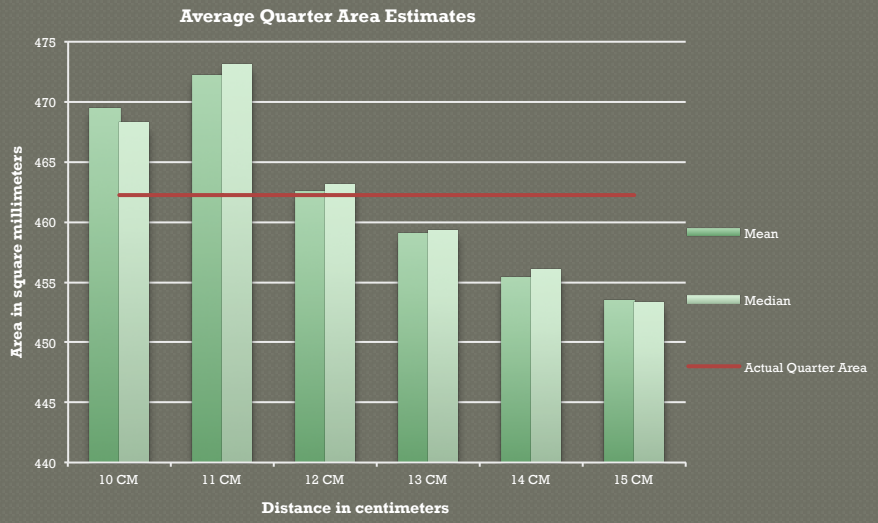
Reference Object Experiment

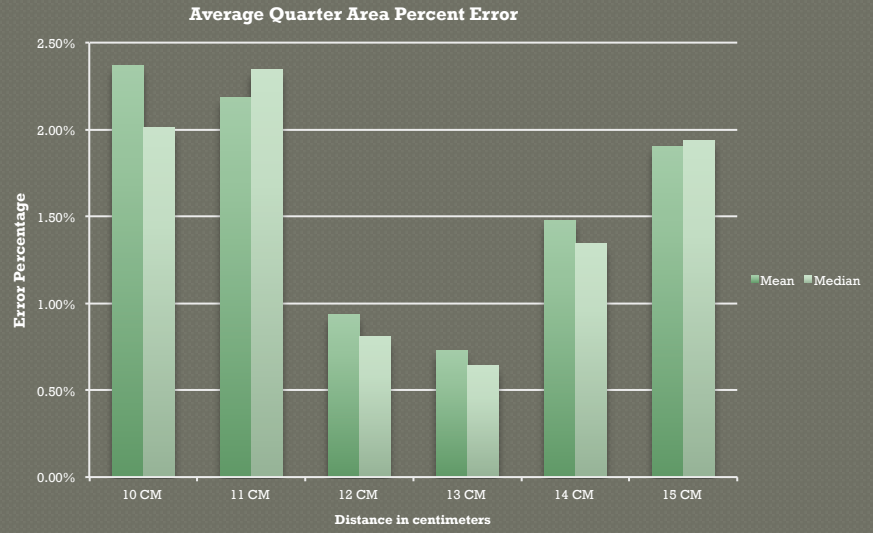
- To determine the relationship between area and diameter in pixels versus real area and diameter
- Experiment
  - Multiple pictures of Quarter and Nickel coins in intervals of 1 cm from 10 to 15 cm

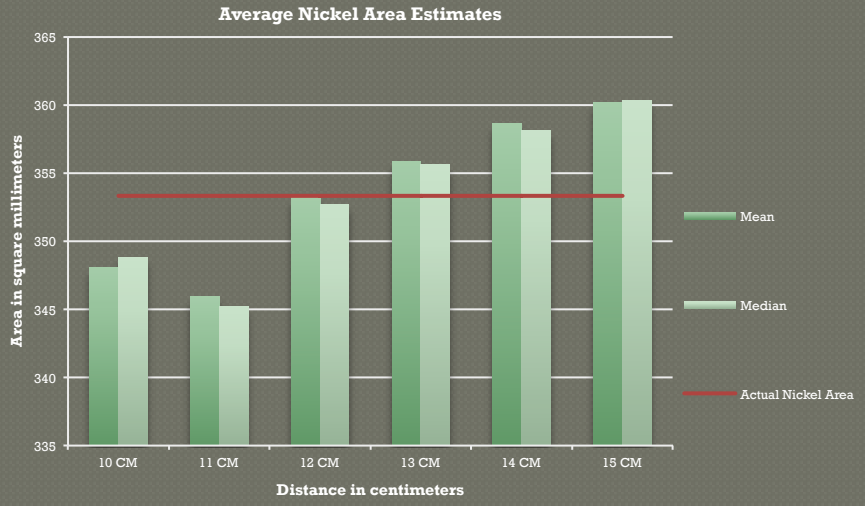
Reference Object Analysis

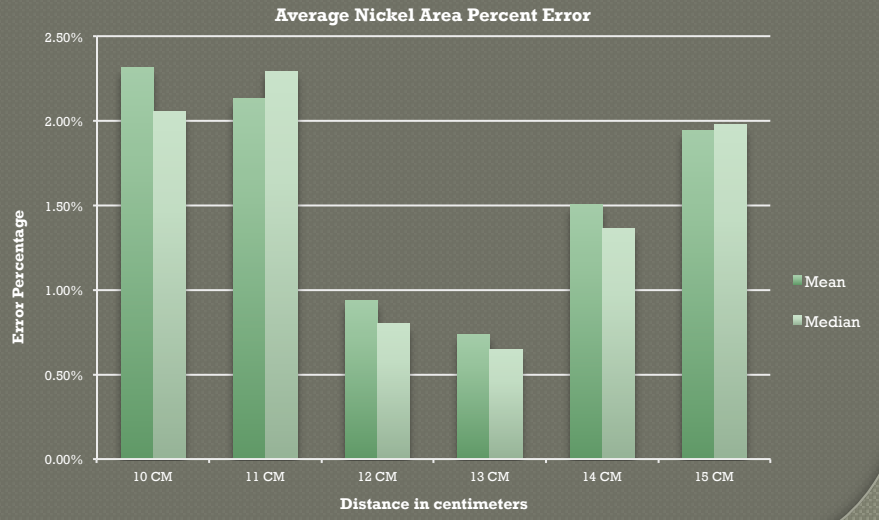
- Finding unknown diameter from known diameter
  - Found pixels per millimeter(ppm) by dividing the known region diameter in pixels by its diameter in millimeters $$\frac{KR_{pix}}{KR_{mm}} = ppm$$
  - Then dividing the unknown region diameter in pixels by ppm value to return unknown region diameter in millimeters $$UR_{mm} = \frac{UR_{pix}}{ppm}$$

Reference Object Area Estimations

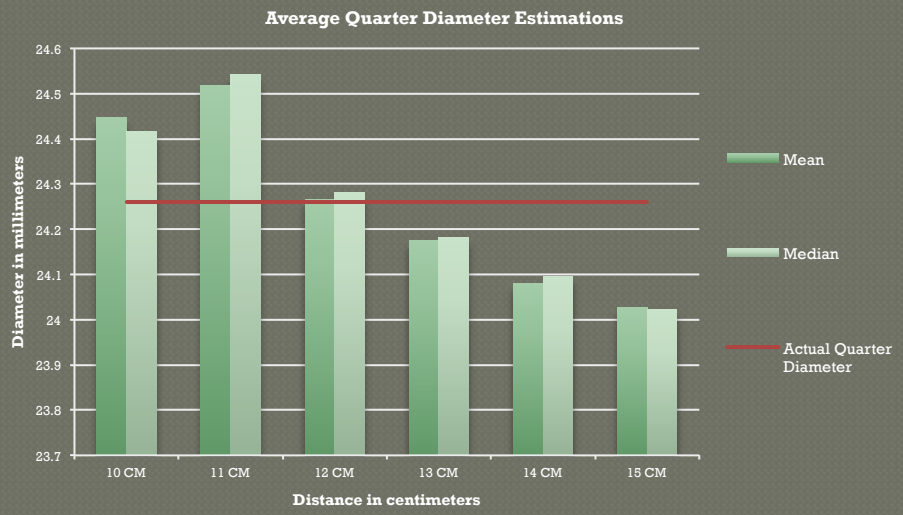


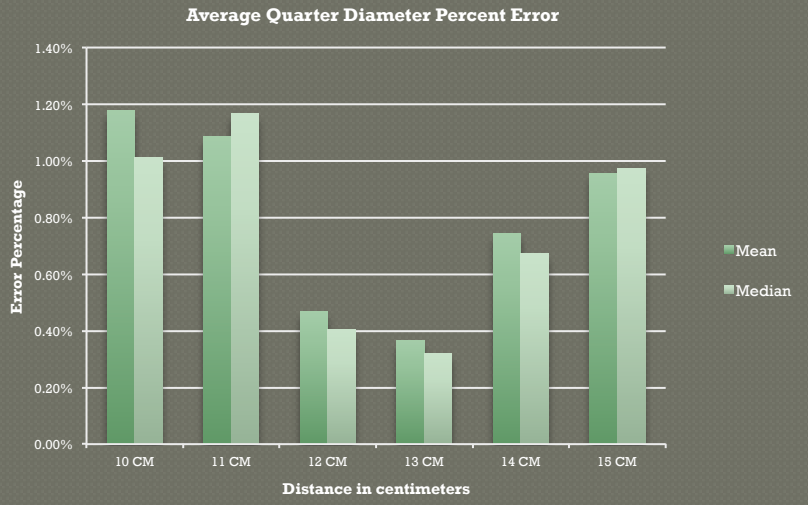


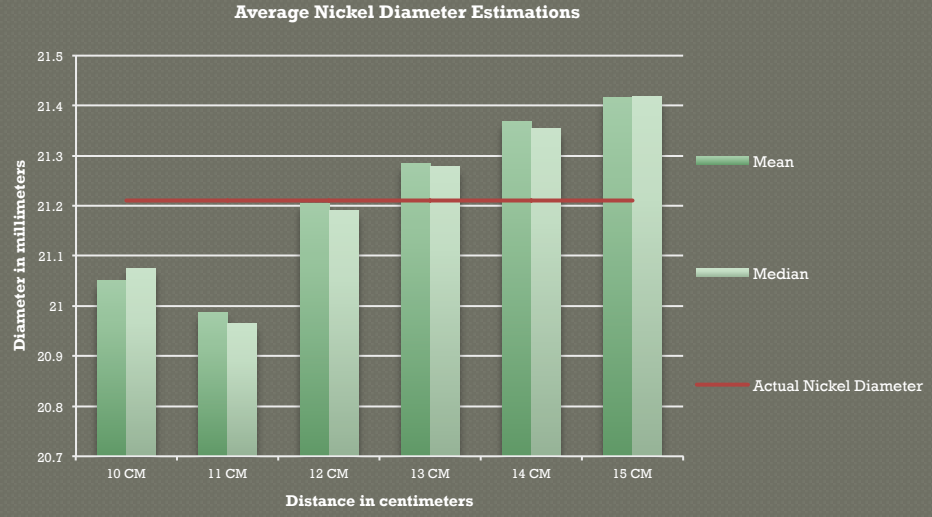


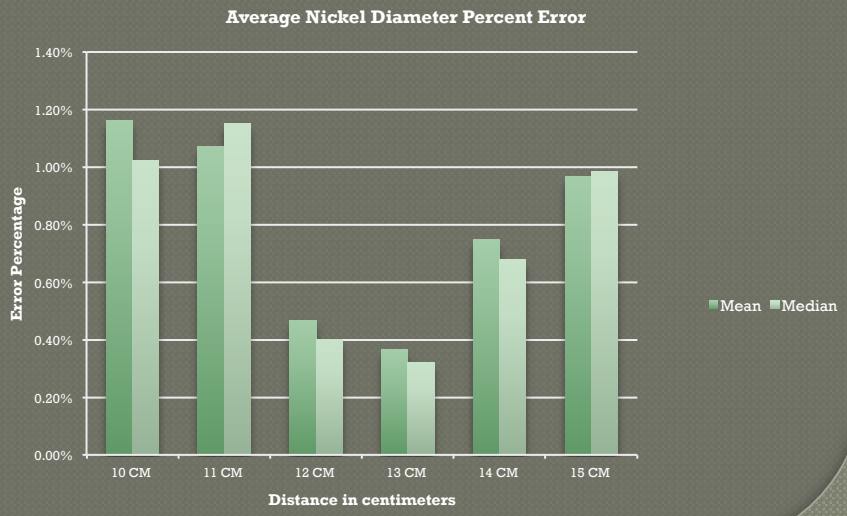


Reference Object Diameter Calculations









Conclusion

- Both methods prove to be successful in determining an object's diameter
- While the focus-distance method is more convenient, the reference-based method provides greater accuracy