Determining the Size of a Skin Lesion Using Smartphones

Trevor Ash — University of Mary Hardin-Baylor
Jae Won Shin — University of Missouri
Yi Shang — University of Missouri

Introduction

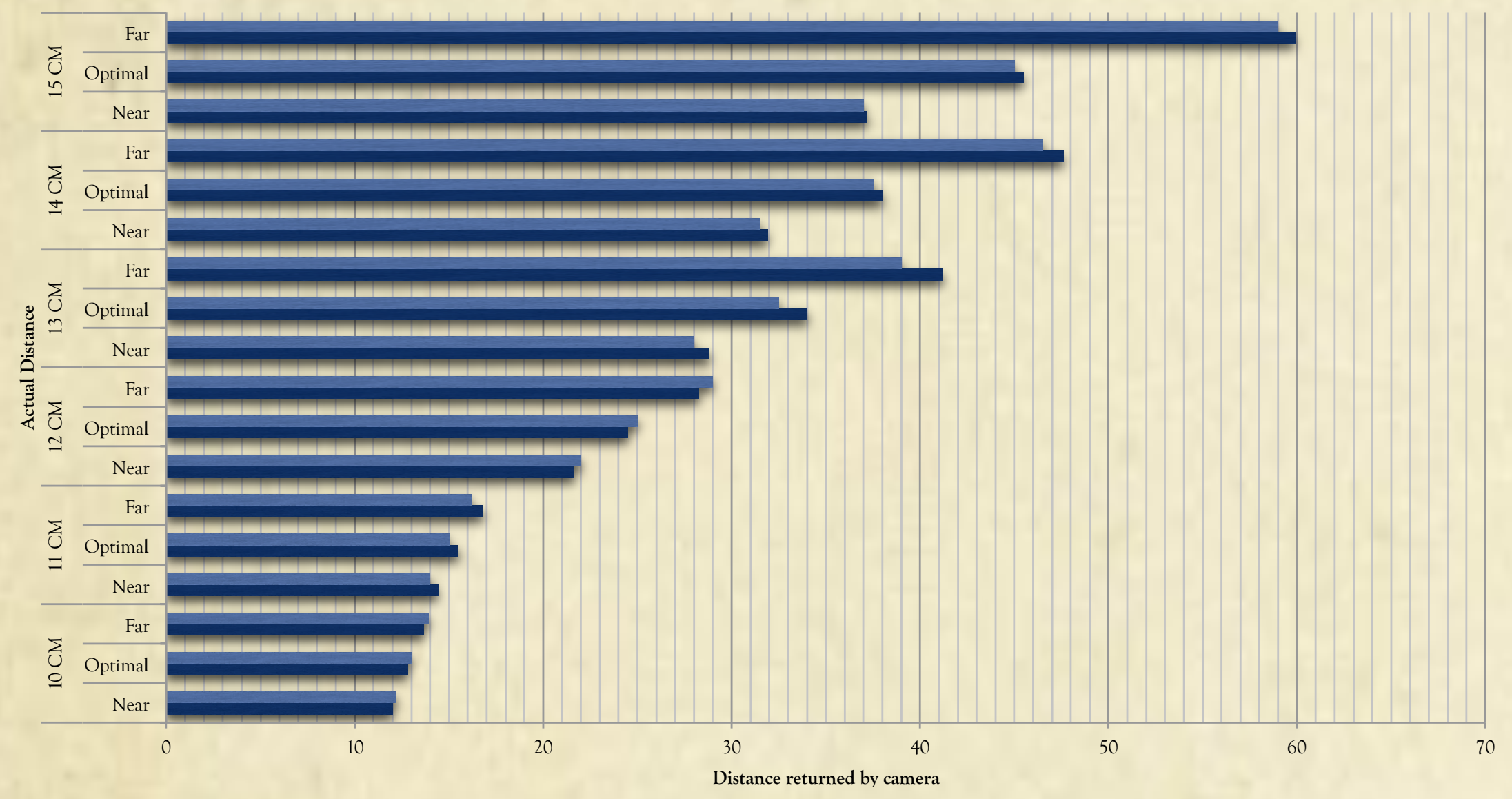
The objective of this project is to determine the area of a skin lesion from a photo and calculate the lesion diameter to help automatically diagnose melanoma. The American Cancer Society recognizes the guidelines of *asymmetry, border irregularity, color irregularity* and *diameter* as markers for possible melanomas; lesions with a diameter greater than 6 mm may need to be examined by a doctor. Not all lesions are circular, therefore the size will be determined by pixel area rather than diameter. Because of variable distances between the phone camera and the lesion in question, the area of the lesion changes in comparison to the picture. Two methods have been developed for determining the area of a lesion within a close proximity to the camera.

Focus-distance-based Method

This method uses the focus distance returned by the getFocusDistances() method from Android API level 9 to determine the distance from the camera to the lesion. Then from the pixel area of the lesion image, found through the image processing capabilities of the OpenCV library, and the distance from the camera, the real area of the lesion is found.

Experiment

- Multiple pictures taken of Nickel and Quarter coins at each 1 cm interval from 10 to 15 cm
- Output from getFocusDistances(): Near, Optimal, and far were recorded

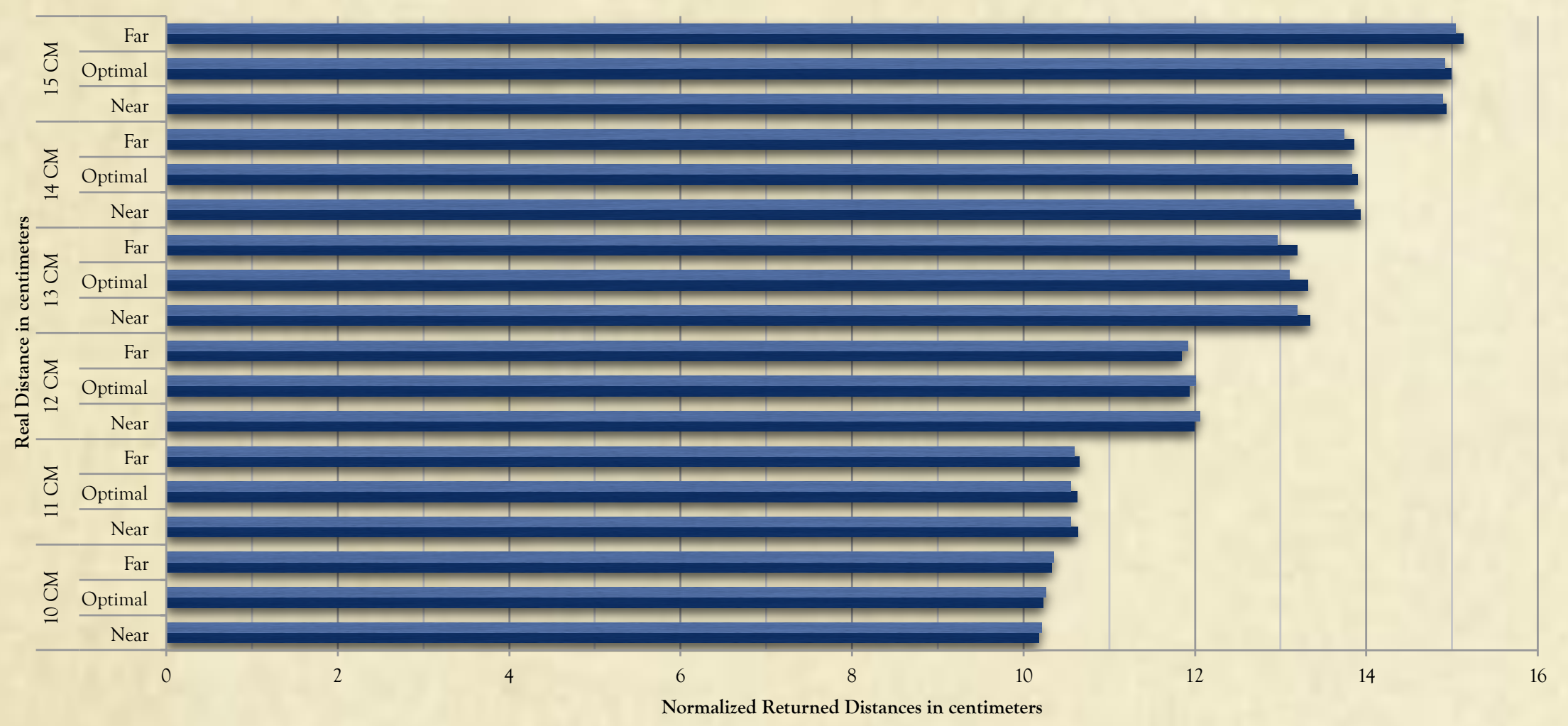


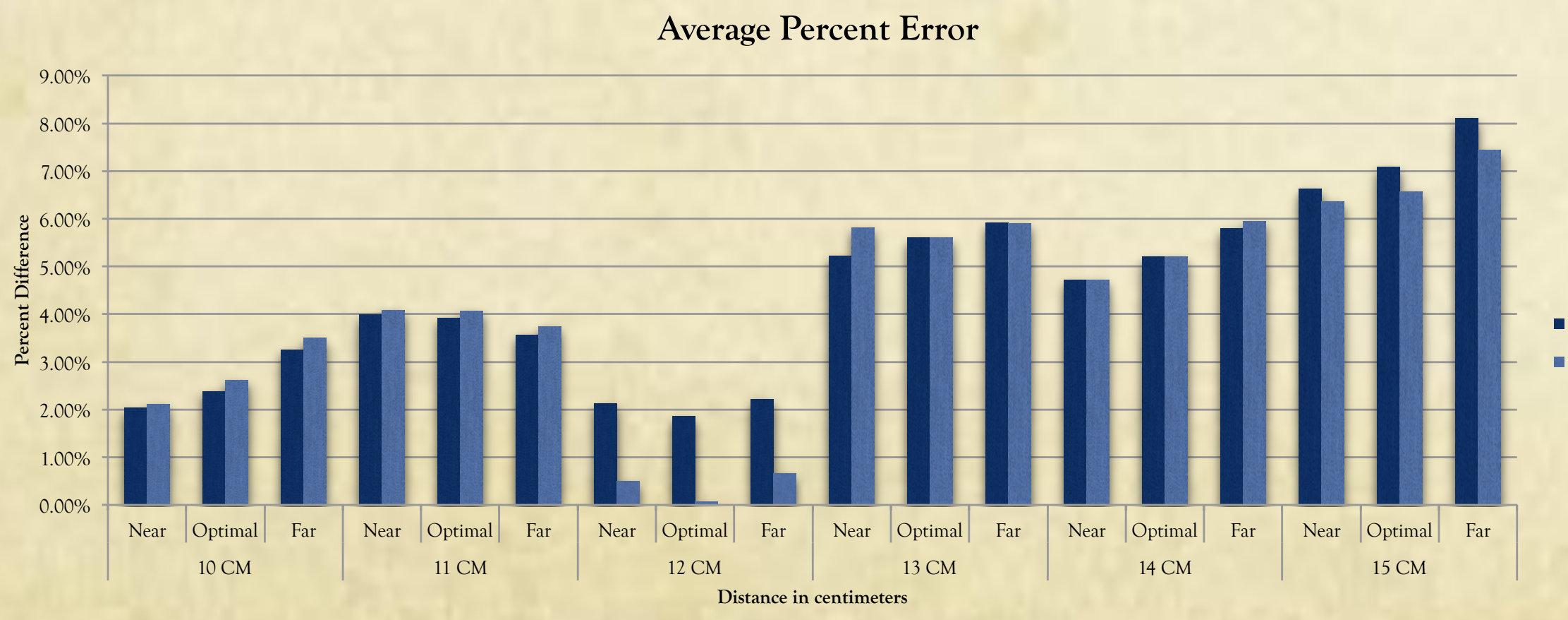
Focus-distance Normalizing Functions

Using the means of the near, optimal and far values between 10 and 15 cm 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)



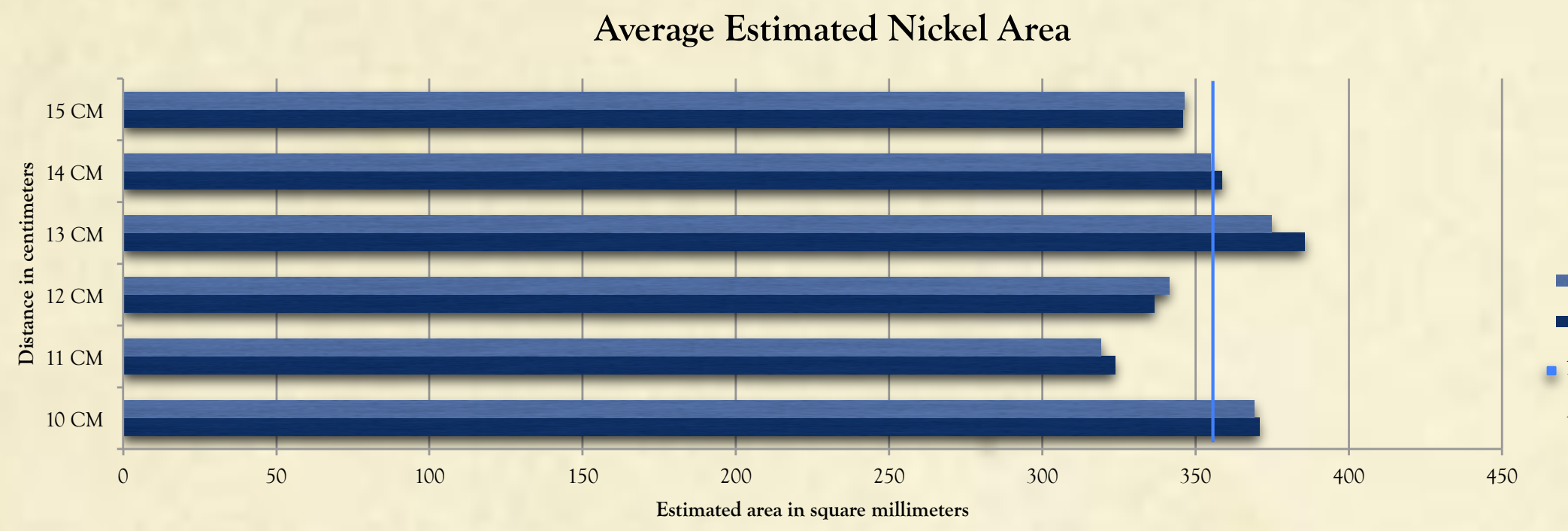


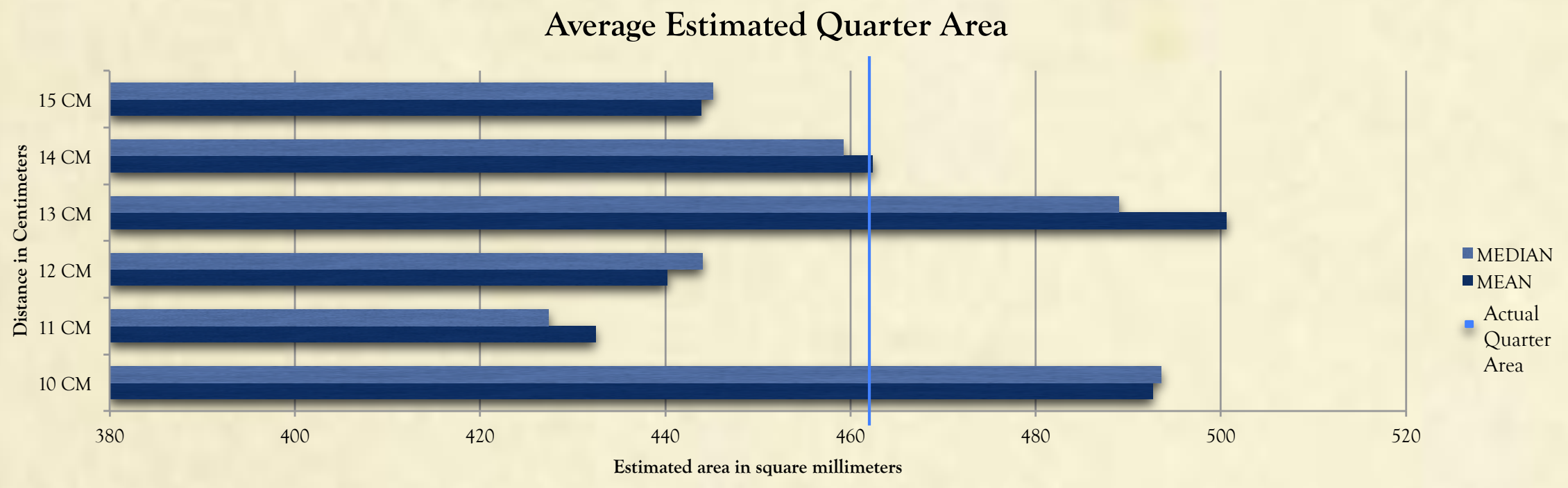
Area from Focus-distance

Using the average distance, that is (Near*Optimal*Far)/3, from every trial and the pixel area of the coins found from those trials a function was found to relate area in pixels^2 to area in millimeters^2.

$$y = 13.885x^2 - 455.42x + 4079.1$$

(where there are y pixels in a square millimeter at distance *x*)

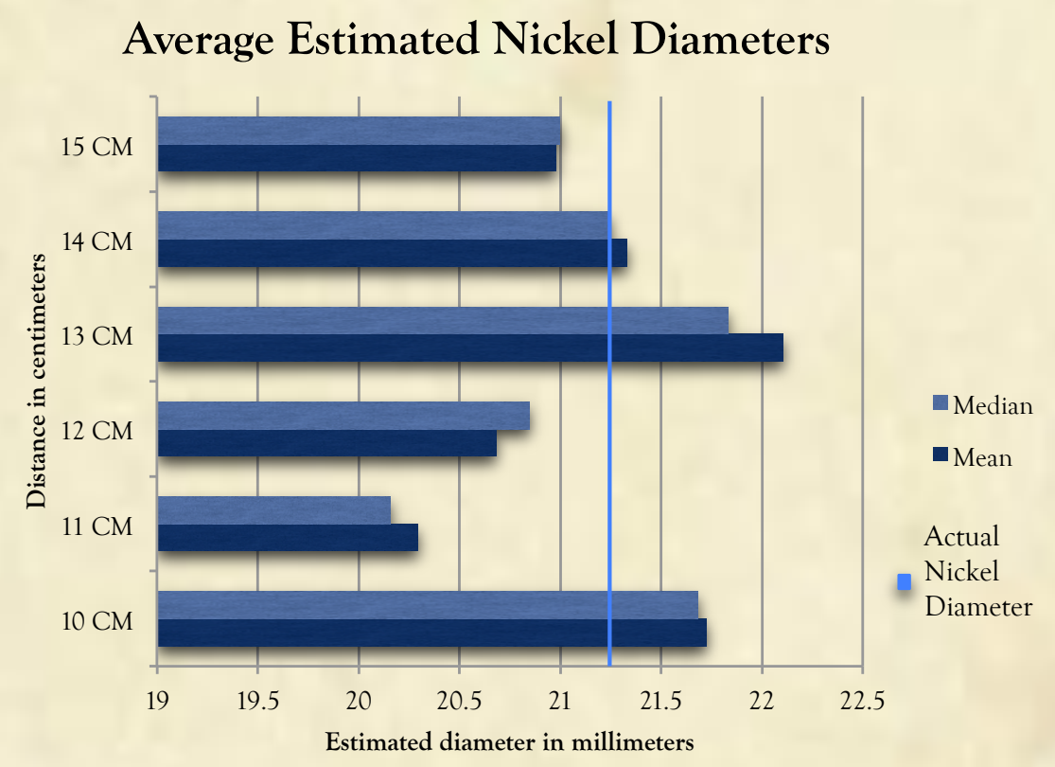


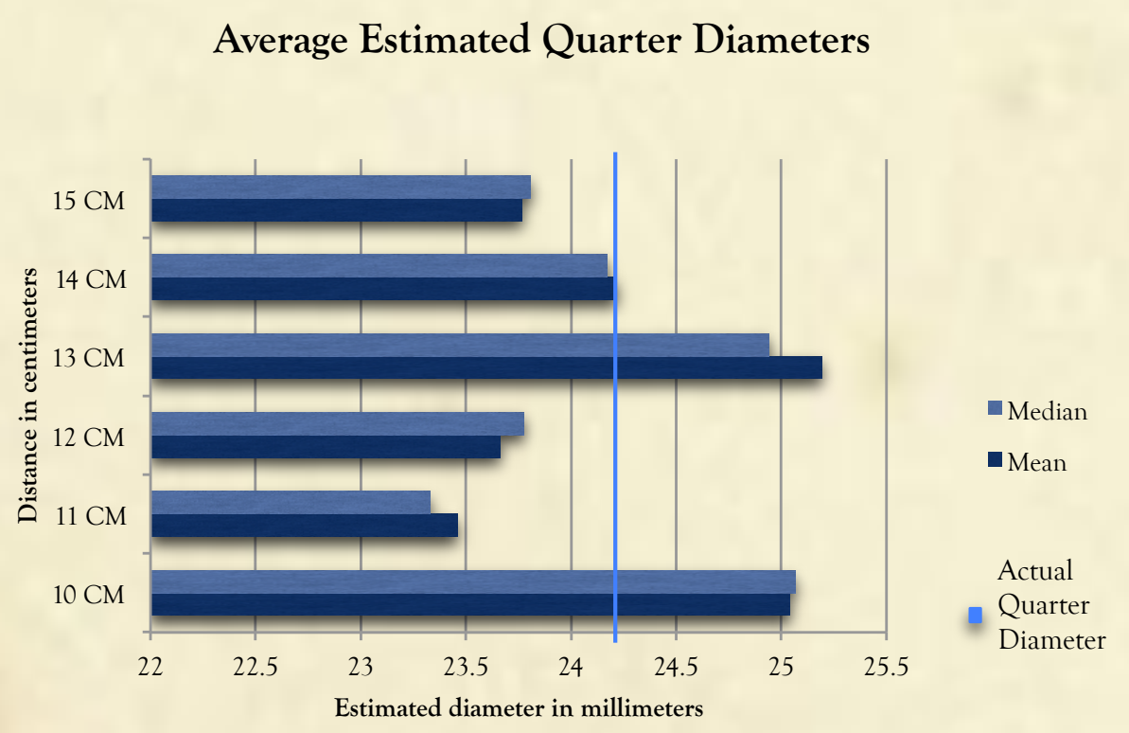


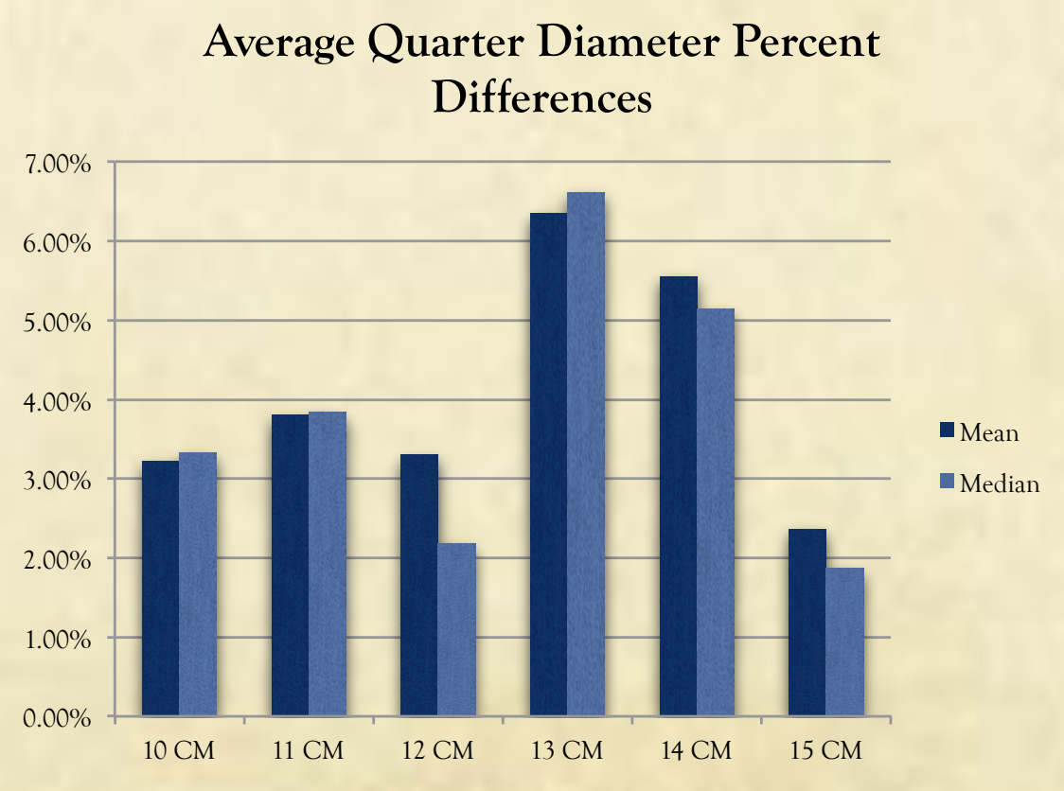
The "red flag" area for a lesion is around 28 mm^2. Because most of the area estimations were off by over 28 mm^2, a better estimator needed to be found.

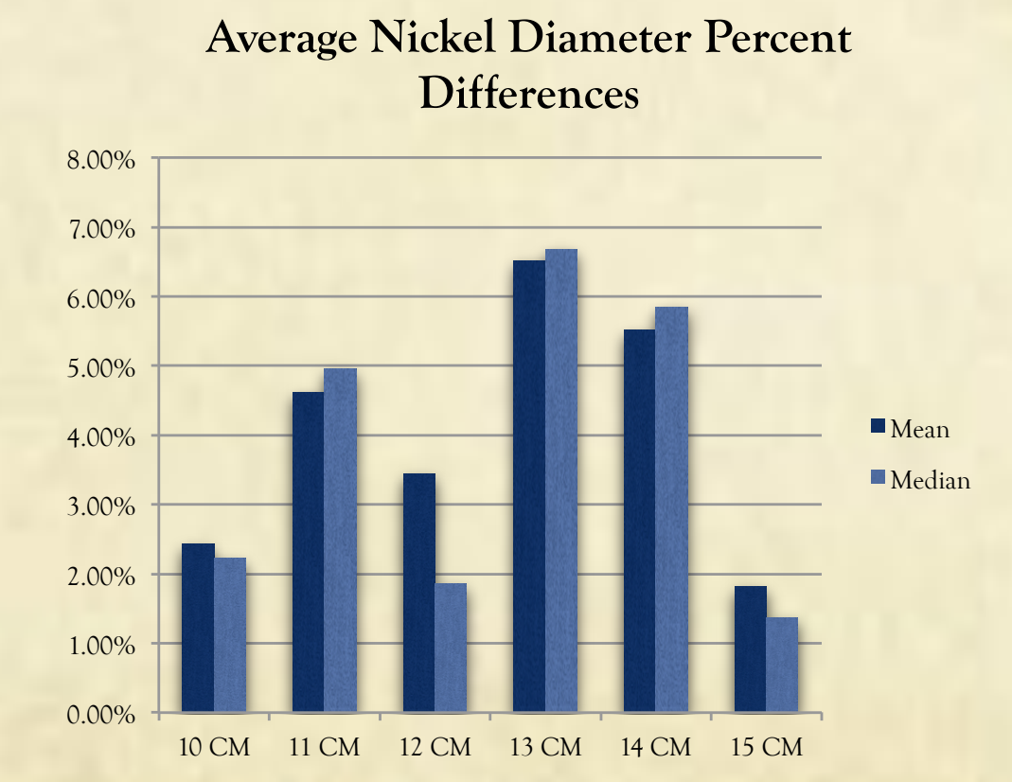
Finding Diameter from Area Estimates

It was found that the error was reduced greatly by calculating diameter from estimated area.







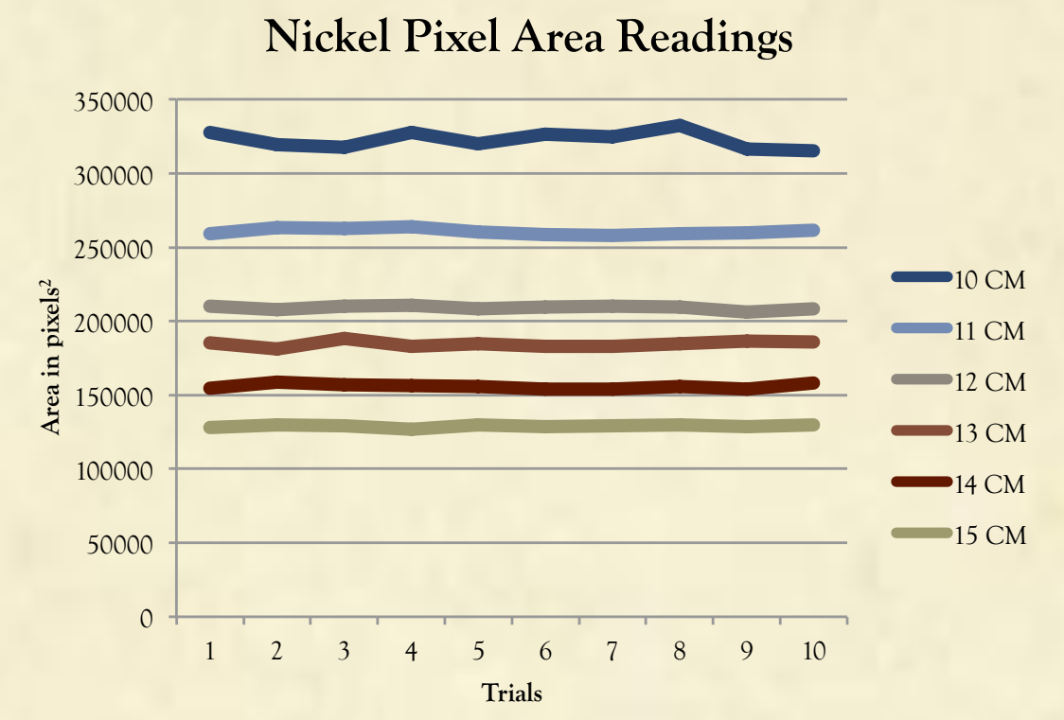


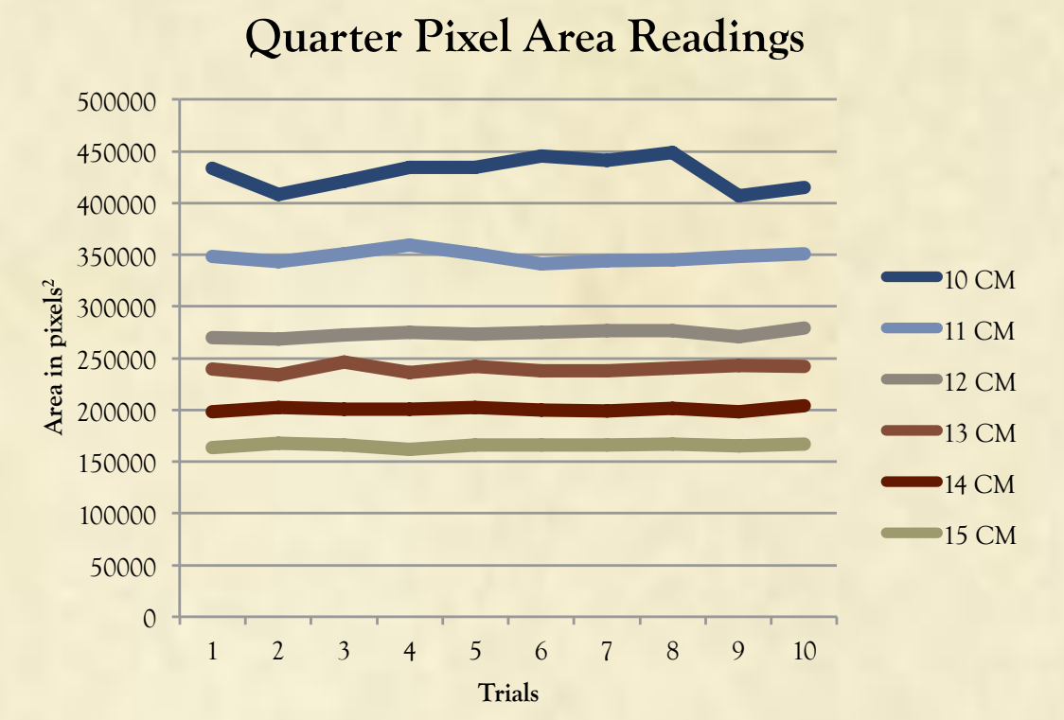
Reference-based Method

This method uses uses a coin of known size as a reference and utilizes the automatic image segmentation and recognition capabilities of OpenCV on Android to calculate the area of a lesion.

Experiment

Multiple pictures taken of Quarter and Nickel coins in intervals of 1 cm from 10 cm to 15 cm





Analysis

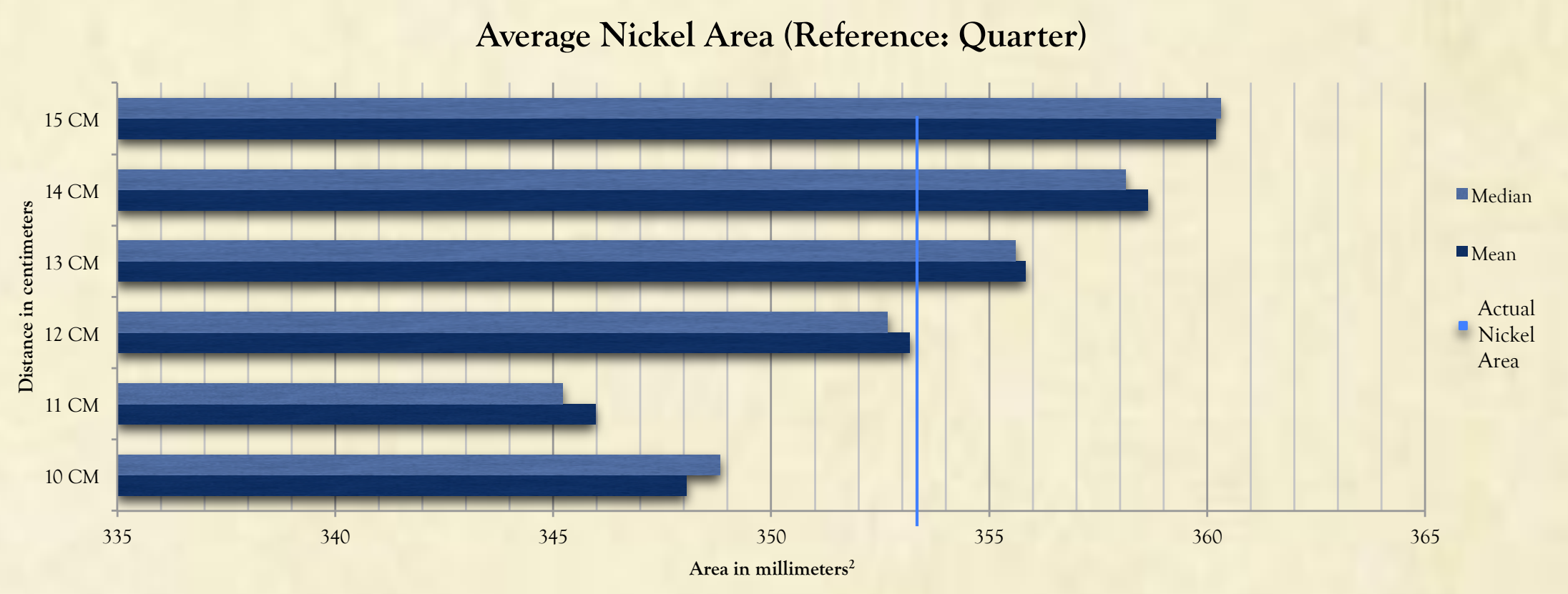
Finding unknown area from known area

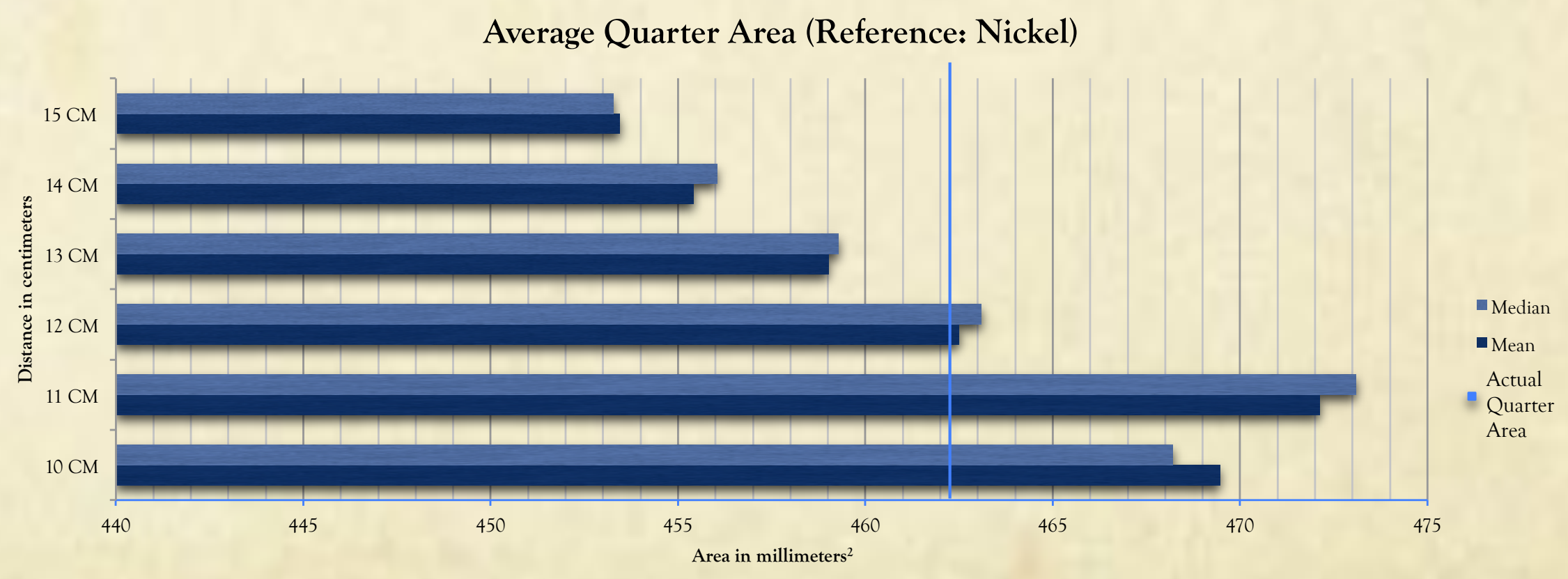
- Found pixels per millimeter(ppm) by dividing the known region area in pixels by its area in millimeters

$$\frac{KR_{pix}}{KR_{mm}} = ppm$$

- Then dividing the unknown region area in pixels by ppm value to return unknown region area in millimeters

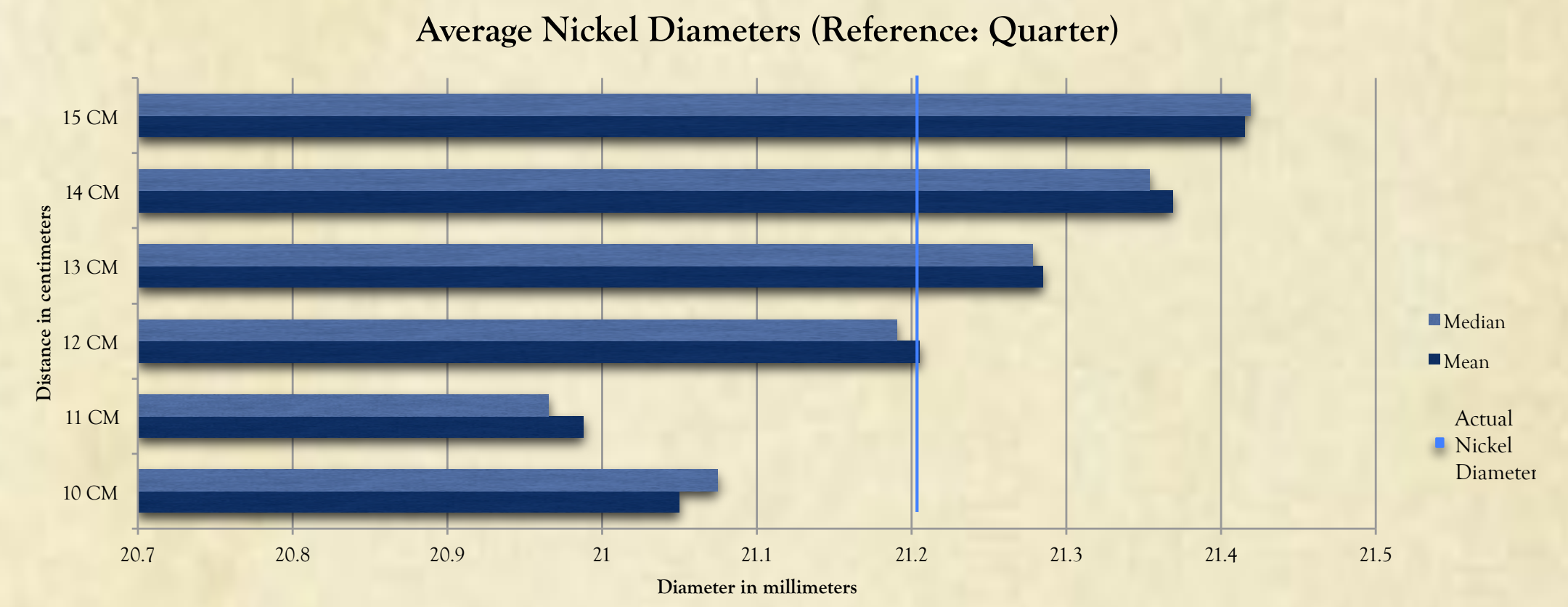
$$\frac{UR_{pix}}{ppm} = UR_{mm}$$

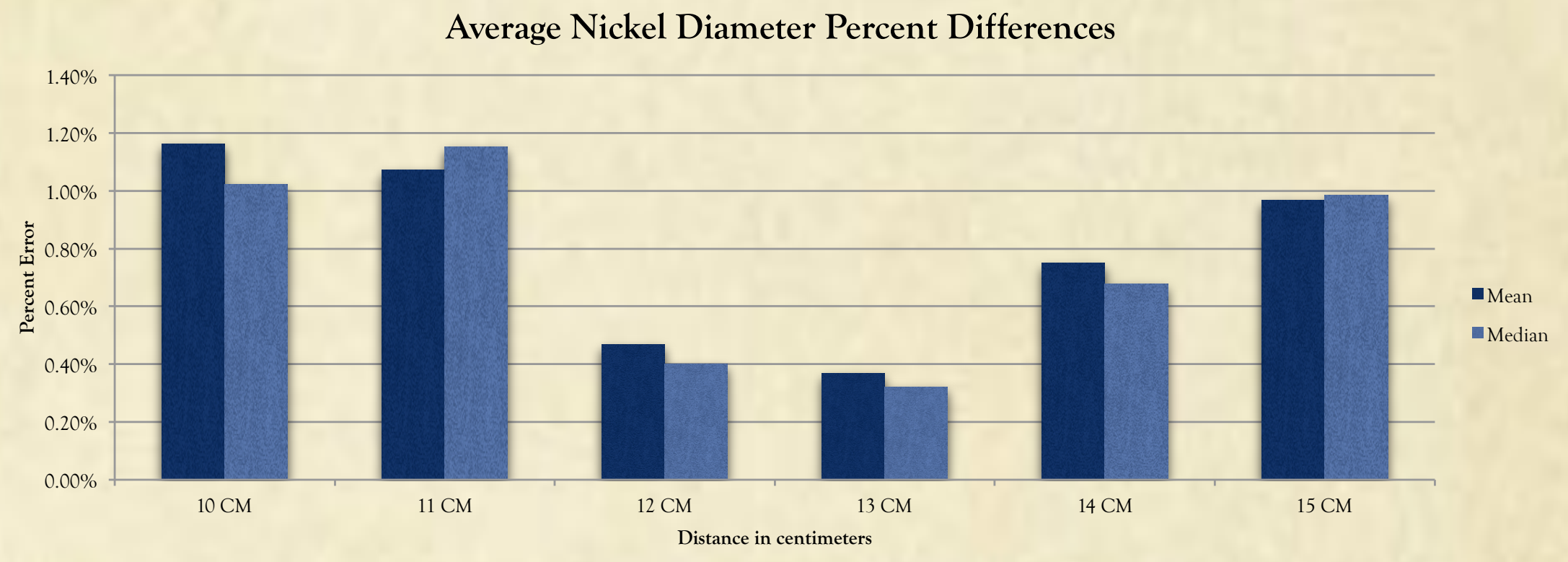


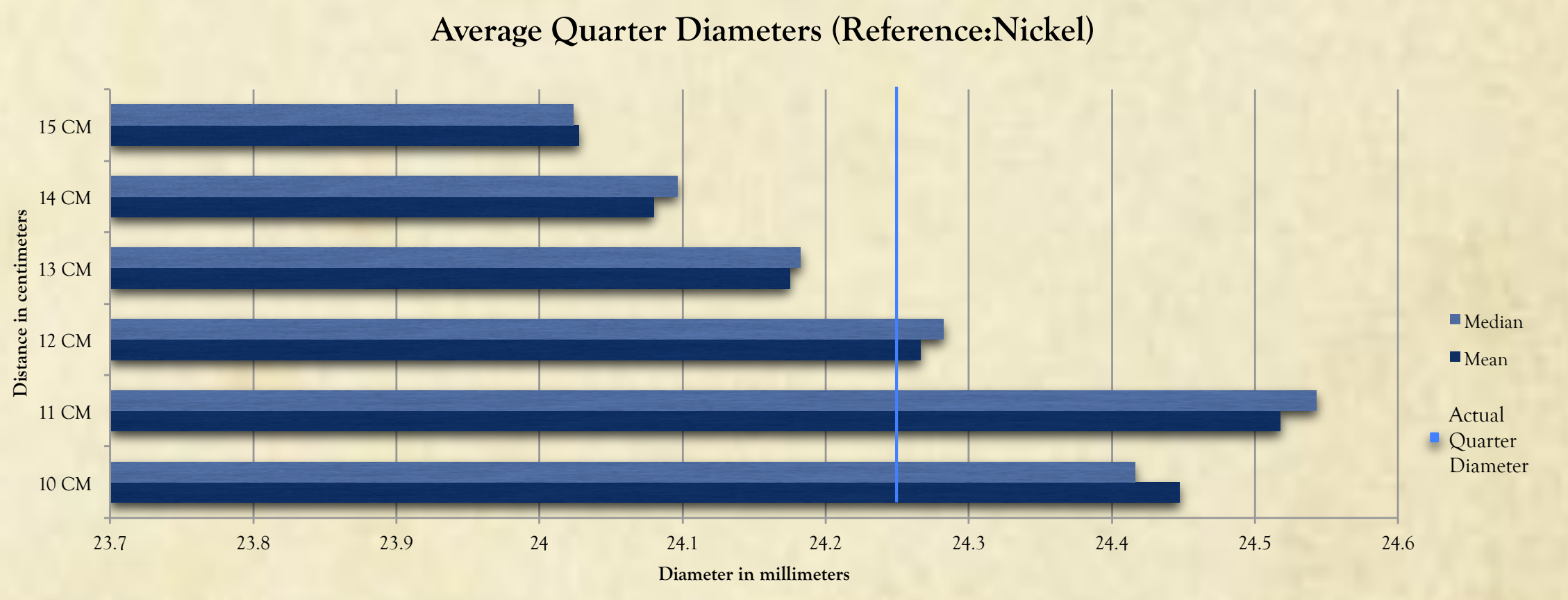


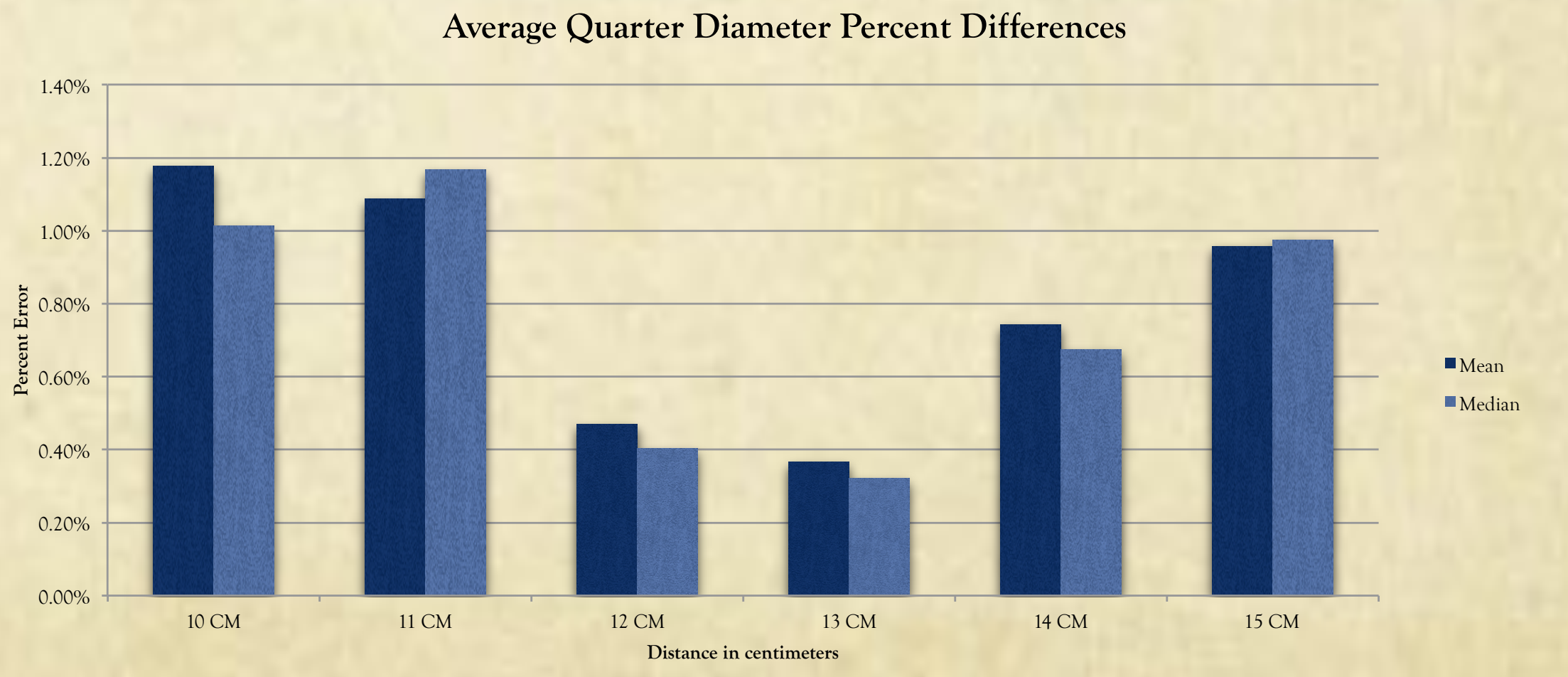
Finding the diameter from area

In order to compare results between the two methods, the findings must be of the same type. Because of this, the areas found from the reference-based method were converted into diameters despite the relatively small error rates found using a reference.









Conclusions

Experimental results show that the reference-based method produces diameter estimations with errors typically less than 3% and an average error of 0.96%. The errors of the focus-distance-based method are less than 13% with an average error of less than 5%. Though more accurate, the reference-based method requires the user to have a coin with them when they use the app. Both methods are successful and are being incorporated into our automatic melanoma detection app on Android smartphones. Further work can be done in determining the symmetry or lack there of present in the lesion as another criterion for classification.

Acknowledgements

MU Computer Science Department
NSF REU Program