

Age Estimation of Adolescents and Adults Using Dimensions of the Eye and Pupil in “Selfie” Photographs

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Abstract

Investigating digital images and correlating an age with the photographed individual has become a challenge in digital forensics and criminal investigations. Individuals in the teenage age range, who often appear older in age due to the use of make-up, posing, and filter technologies, are often documenting themselves and their activities by taking a picture of themselves – otherwise known as a “selfie.” By analyzing features of the face, particularly the eye and pupil regions, the subject has less ability to hinder age estimation based solely on physical appearance. Institution Review Board (IRB) approval was obtained in order to use human subjects. The target age group of participants was between 11-19 years old. A series of pictures of each individual were taken with a Nikon® D3100 digital camera and Apple® iPad® iOS Version 7.1.1, along with a short video of the participant’s face in a room with controllable lighting conditions. The images were downloaded onto a computer for analysis using Photoshop®. Each image was calibrated so that the pupillary diameter and interpupillary distance could be determined and compared.

Introduction

Individuals in the teenage age range, who often appear older in age due to the use of make-up, posing, and filter technologies, are often documenting themselves and their activities by taking a picture of themselves – otherwise known as a “selfie.” These images can be forensically valuable in criminal investigations such as sexting, solicitation, and possession or distribution of child pornography.

It has been found, from studies in ophthalmology and optometry, that measuring the diameter and interpupillary distance of the eyes can aid in age estimation. This is a soft biometric technique, used to determine a specific characteristic of an individual, rather than one’s identity. By using similar techniques, these processes may be forensically valuable in establishing a technique to analyze these digital images.

The human eye and pupil have natural responses to many variables, but most importantly to light. By using the metadata of an image, the amount of light, or lux value, can be calculated to estimate the light in the image environment. With this information, the pupil response can be predicted and the measurements of the pupil can be used to estimate the age of an individual.

Methods & Materials

Participants were recruited through personal contacts and e-mail advertisements. Those willing to participate were required to have parental permission, if under the age of 18, and sign an informed consent form.

A brief survey was given to participants to record actual age, birthday, mood, medications taken, and eye problems. Using a Dr. Lux® light meter, the luminescence of the room was documented. Images were taken at Marshall University Forensic Science Center in the MISDE digital laboratory.

The first series of images were taken at a distance of 1.5 meters from the participant using a Nikon® D3100 digital camera. One image was taken while the participant looked directly at the camera; another was taken while the participant looked past the camera. If the participant wore glasses, this series was repeated again without the glasses. Figure 1 shows examples of images in this series.



Figure 1: Images taken of the eyes with a Nikon® D3100

Using an Apple® iPad®, participants took a “selfie” photograph and then a short, 10-second video capturing their face from different angles. Participants wearing glasses were not required to repeat this series without them. Figure 2 includes examples of images in this series.



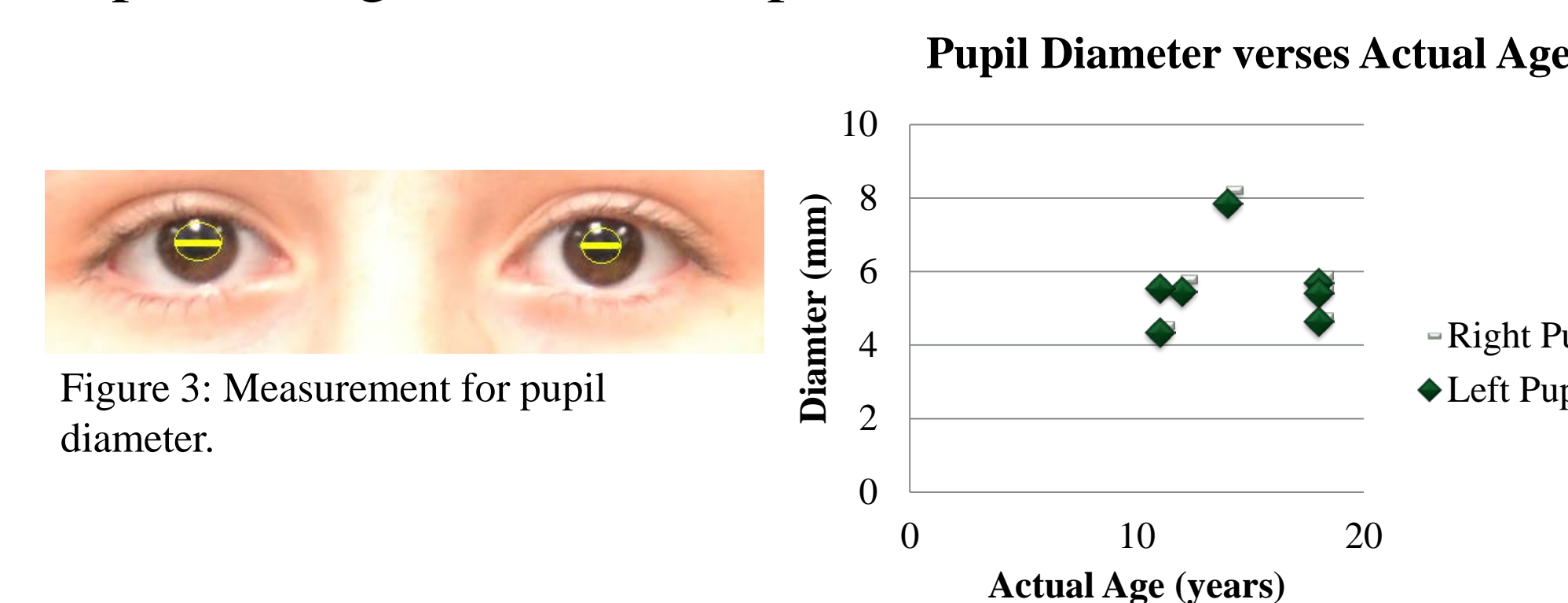
Figure 2: Images taken of the eyes with and Apple® iPad®

Results

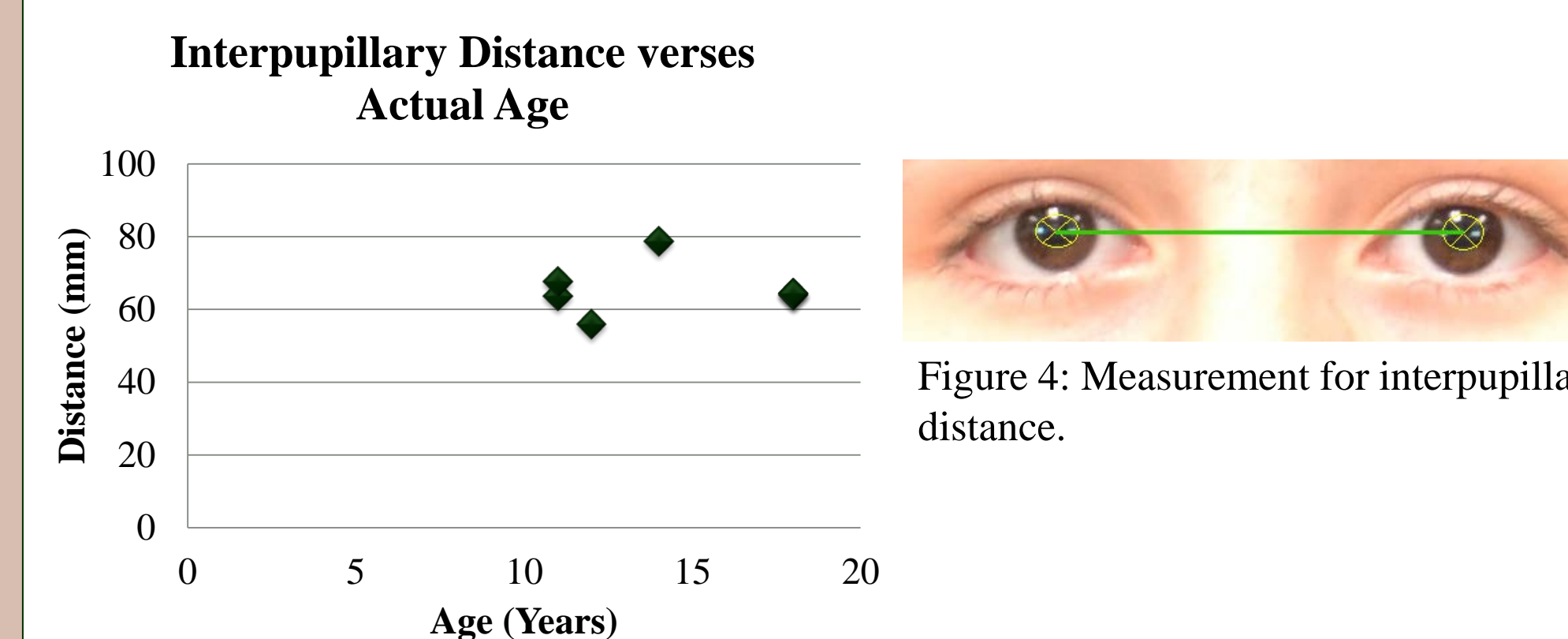
The age distribution of the participants are shown in Table 1. Only 10 participants were included in this study.

11	12	13	14	15	16	17	18	19
3	1	0	1	0	0	0	3	2

Diameter of the pupil was determined by measuring the boundary of the inside and outside of each pupil, as shown in Figure 3. Results of the measurements are representing in the scatter plot below.



Interpupillary distance was determined by measuring the distance from the outerpupillary boundary of each eye and subtracting the radius of each pupil as shown in Figure 4. Results of the measurements are shown in the scatter plot below.



Conclusions

Ultimately, the sample size was too small to find a significant age estimation process. Ideally, the sample size needs to include at least 50 individuals of each age in order to determine a range of the measurements that are unique to each age.

Nevertheless, the analysis is possible and simple to accomplish with digital images. Measurements of the left and right pupil diameter can be assumed to be the same, which is consistent with other studies.

It is also necessary to develop a sufficient methodology to differentiate pupils from darker colored irises. This would allow all ethnicities to be included and differentiated by these measurements.

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