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Eye Blinking Alarm System for Elderly Abuse Prevention

Ahmad Kweder*, Mastaneh Mokayef

Department of Electrical and Electronic Engineering, Faculty of Engineering, Technology and Built Environment, UCSI University, Kuala Lumpur 56000, MALAYSIA

*Corresponding Author Designation

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Abstract Elderly abuse is an act committed by entrusted person or family member toward elderly people. Elderly abuse is a very serious act and goes against all kind of human rights. Covid-19 era has shown huge increase of abuse committed against elderly people. In the last two years due to the pandemic and quarantined imposed by the government, elderly people had fewer chance to defend themselves against abuse, and less opportunities to alert someone to help, which resulted in increase of elderly abuse cases all over the world. This paper projects the impressive impact of utilizing technology on elderly abuse prevention. This is a potential solution for minimizing the risk of elderly abuse in a cost-effective base. The operation of this project is based on the Eye blinking detection technique with the aid of Eye Aspect Ratio. The detected blinks have been modified to distinguish between voluntary blinks and involuntary blinks and the alarm will be sent by SMS to the elderly's guardian. The project has been designed using several libraries such as OpenCV, NumPy and Dlib. The project focused on two criteria, distance and brightness. The system was put on trial for 120 times, and as result a detection accuracy of 78.33% has been achieved. The detection accuracy results can be improved by using a camera with higher resolution and fps.

Keywords: Elderly abuse, OpenCV, Eye blinking

1. Introduction

Elderly abuse is a very dangerous and serious problem elderly people are facing all over the world. Elderly abuse is an act committed by entrusted people and family members toward elderly people ranging from the age of 60 years old and above. These acts can cause physical and psychological harm to all people who are being abused but their effect on elderly people is higher because of their poor health and mental conditions. According to The National Center on Elder Abuse this type of actions violates all kinds of human rights [1]. For the past 2 years there was an enormous increase in elder abuse

*Corresponding author: ahmadkweder95@gmail.com

cases due to COVID-19 and the pandemic all over the world. During the pandemic everyone were under government order to stay at home, the chance of the elderly people to report their abuser or talk to someone about it became very low [2]. The aim of this project is to provide a platform for elderly citizens to request help once they are under a domestic violence and there is no one around to protect them. The project proposed is a computer vision system that detect eye blinking of elderly people. The system proposed should detect the face from live video feed, from the face detected it should locate the eyes then calculate the distance between the eye coordinates. The results calculated will be compared to the Eye Aspect Ratio (EAR) threshold to detect eye blinking. When signal conditions are met the system will send an alert via SMS to the elderly's guardian.

2. Materials and Methods

2.1 Materials

The system used for this project is an ASUS laptop's camera with 640x480 resolution at 24fps. The platform used to design the system is Visual studio code and the programming language used for coding is Python programming language and libraries such as OpenCV, NumPy, dlib, and VideoStream.

2.2 Methods

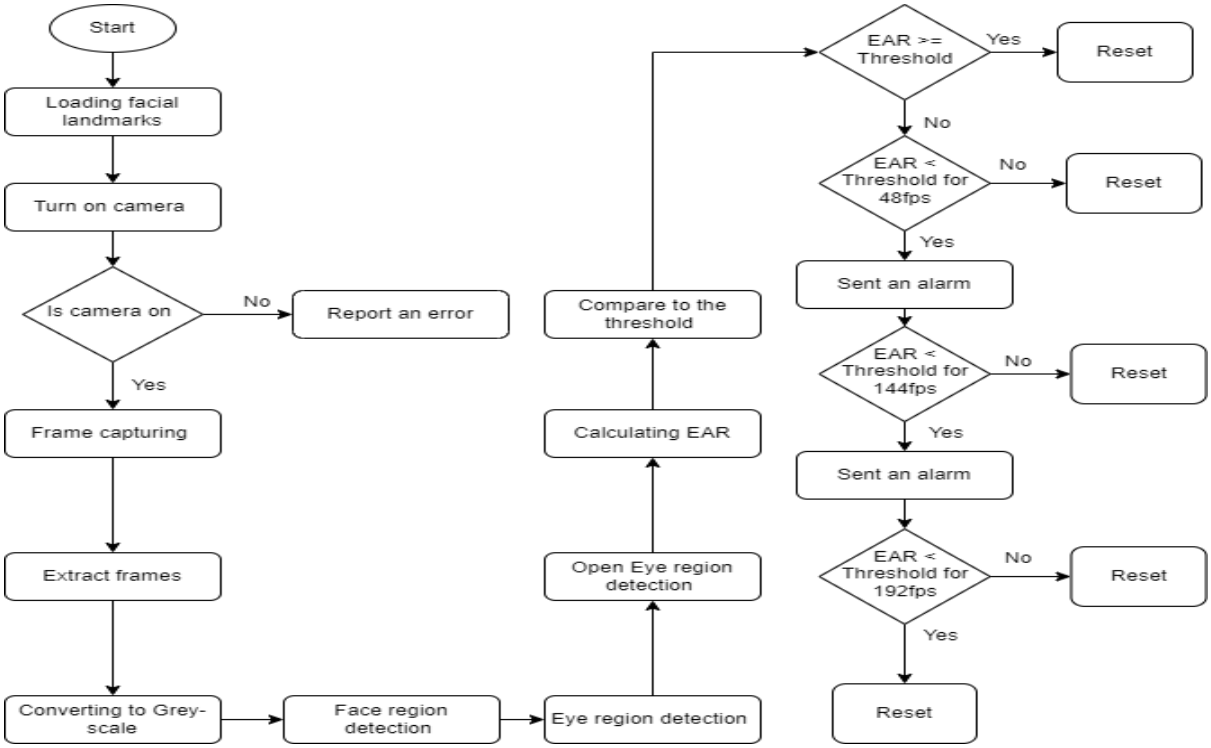

Figure 1: System Flowchart

Figure 1 describes the system steps and flow to achieve the expected outcome. Once the system is initialized it will turn on the laptop's camera and used it to capture frames from the live video feed. The collected frames are converted from RGB color to gray-scale using the luminosity formula (**Eq.1**) [3]:

$$L = 0.21R + 0.72G + 0.07B \qquad \textbf{Eq. 1}$$

The facial landmark is detected using the 68-point system used in Dlib library [4]. Face detection is accomplished through the use of a facial landmark algorithm by Dlib, which leads to the identification of a face inside a frame. Once the face is detected we can extract the eyes coordinates based on the 68-point system, the eyes coordinates will help calculating the EAR (**Eq.2**), then compare it to the EAR threshold which set to 0.30.

$$EAR = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|} \qquad \textbf{Eq. 2}$$

Where p1 to p6 are 2D facial landmark locations. The numerator of this equation computes the distance between the vertical eye landmarks while the denominator computes the distance between horizontal eye landmarks. If the EAR calculated is less than 0.30 the system will detect a blink [5].

The criteria are chosen to help determine the accuracy of eye blinking detection are distance and brightness. The distances between the laptop camera and the subject are measured using measuring tape and set from 50cm to 200cm. The brightness is determined by the illuminance of the room using LUX meter application. The room lux values chosen were when lx > 300lux, 300 > lx > 100lux and lx < 100lux.

Because we are dealing with elderly people we are basing our signal on the eye reaction when being abused or under distress, meaning when an abuse occur the elderly person will involuntarily close his/her eyes reacting to the abuse. The length of the eye closure will be considered as signal so the system can send the alert to the elderly's guardian. Three alerts are set. First alert is when the eye closing detected is more than 48fps and the alert will be a "Check in alert" and another alert will be sent when the eye closing exceeds 144fps and the alert will be "SOS I am being abused". The third alert will be a sleeping alert this will be activated when the eye closing detected is more the 192fps, this will not be sent to the user but it will stop sending the abuse alert. The method used to send the alerts is SMS using Twilio service. Twilio is a programmable SMS service that allows users to send and receive text messages with the help of programming languages [6].

3. Results and Discussion

Figures 2, Figure 3 and Figure 4 show the detection accuracy results for the 3 brightness levels selected. The accuracy results are based on 10 trials for each distance. They also show high detection accuracy for distances 50cm and 100cm at all the brightness levels, then the accuracy decreases for distances 150cm and 200cm. The average detecting accuracy when the room brightness is lx > 300lux is 85%. For brightness 300 > lx > 100lux the average detection accuracy was 77.5%. The least average accuracy found at the lowest brightness level lx < 100lux which is 72.5%. Based on the average of the results acquired the overall detection accuracy for the system is 78.33%.

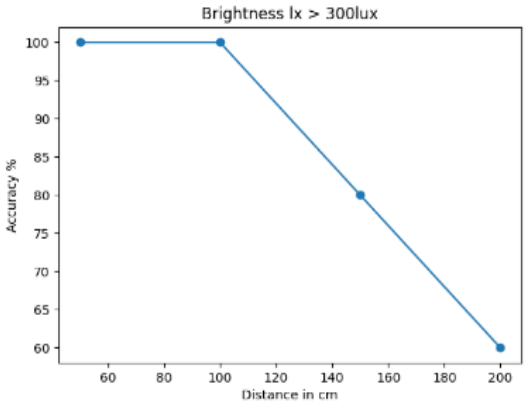

Figure 2: Detection accuracy when lx > 300lux

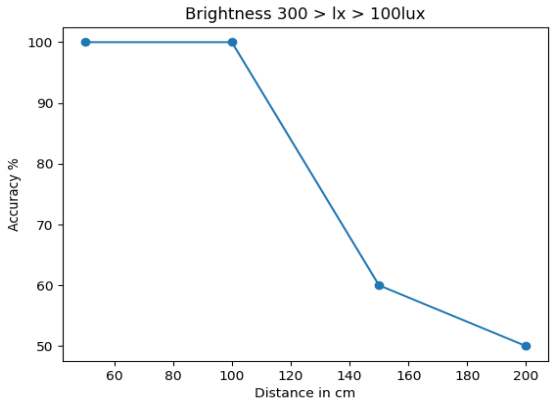

Figure 3: Detection accuracy when 300 > lx > 100lux

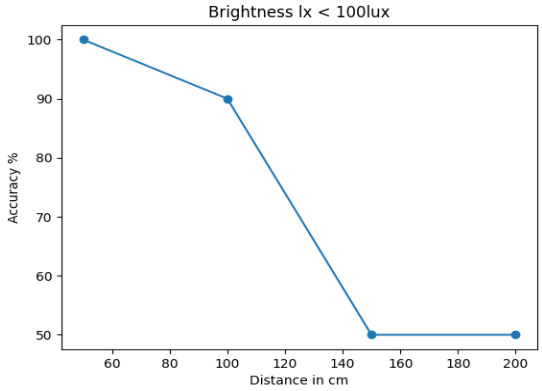

Figure 4: Detection accuracy when lx < 100lux.

Figure 5 shows the alerts sent by the system when closure of the eye is more than 48fps, 144fps and 192fps respectively.

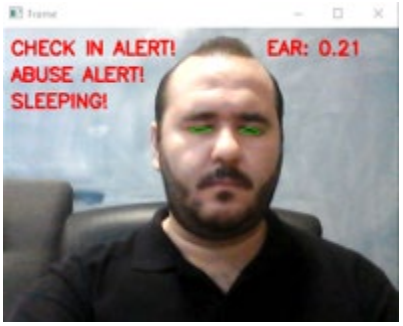

Figure 5: System alerts when the eyes closure conditions are met.

4. Conclusion

An eye blinking detection system is designed using OpenCV. The purpose of the system is to give elderly people a platform to communication with their loved ones when in distress. The system operation is based on the facial detection using 68-point system and eye blinking detection using Eye Aspect Ratio. Once the conditions of the eye closure are satisfied the system will send alarm SMS to the elderly's guardian using Twilio service. The system was put on trial for almost 120 times. Two criteria of distance and brightness have been focused. The results during high brightness and near distance were more accurate than low brightness and further distance. The average detection accuracy of 78.33% is achieved for 120 time runs tests. This percentage can be improved by utilizing a camera with better resolution and higher frame rates.

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