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The optimization of the low-resolution images and the sizes of tophat and open filters for the application of gaze estimation

***Abstract**. In this study, the effect of the size of filters on the use of tophat and open filters on the use of tophat and open filters that have a quite common application on the processes of images. The effect of the sizes of filters is tested on the gaze estimation application which is one of the popular subjects in the processing of image. The images recorded while looking at 9 different points are recorded, the results are compared by subjecting the images to the tophat and open filters with different sizes.*

***Streszczenie.** W artykule przedstawiono wyniki badań dotyczących filtra typu Top-hat w zastosowaniu do obróbki obrazu oraz jego porównania z filtrem erozyjnym. Określono wpływ rozmiaru filtra na estymację kierunku spojrzenia osoby na zdjęciu. Analizie poddano 9 zdjęć obrazujących 9 różnych kierunków patrzenia. (**Optymalizacja obrazów o niskiej rozdzielczości, rozmiarów filtra Top-hat oraz filtrów erozyjnych w estymacji kierunku patrzenia**).*

Keywords: Gaze estimation, Open, Morphology, Tophat.
Słowa kluczowe: estymacja kierunku patrzenia, erozja, morfologia, Top-hat.

Introduction

The estimation of head pose and eye gaze is important in applications such as virtual reality, video conferencing, and special human-machine interface/controls. Interacting with the computer through the head pose and eye gaze is natural for human-machine interaction since this involves passive sensing the human gestures of the face that can be recognized without any discomfort for the user [1, 2]. Eye-gaze tracking has been an important and interesting area of research for quite some time now. In laboratory experiments for psychological research, eye-gaze tracking constitutes a helpful tool to probe the perceptual or the cognitive processes of the subjects. In day-to-day applications, eye-gaze tracking can be used as a computer interface for both industrial and nonindustrial applications, which require hands-free installations.[3] An eye tracker is a system for analysing eye movements. As the eye scans the environment or focuses on particular objects in the scene, an eye tracker simultaneously localized the eye position and tracks its movement over time to determine the direction of gaze [4]. In general, eye positions provide important cues for detecting gazes on a monitor [5]. The design of robust and high-performance gaze tracking systems is one of the most important objectives of the eye tracking community. In general, a subject calibration procedure is needed to learn system parameters and be able to estimate the gaze direction accurately.[6] Stereo vision is best when the sizes of the images presented to the eyes are equal or nearly equal, and that remains true even when the eyes are in eccentric gaze where a size difference would naturally occur. A model of disparity estimation based on correlating the two eyes' images exhibits the same behavior [7]. For to detect the gaze position, it located the facial region and the facial features (both eyes, nostrils and lip corners) automatically in 2D camera images. From the movement of the feature points detected in starting images [8]. Bobin, J., et al, describes a new method for blind source separation, adapted to the case of sources having different morphologies. They show that such morphological diversity leads to a new and very efficient separation method, even in the presence of noise. The algorithm, coined multichannel morphological component analysis (MMCA), is an extension of the morphological component analysis (MCA) method.[9]. A different methods for image segmentation is contrast information, instead of the commonly used derivative information, as the gauge for color segmentation [10]. In another approach present a new model which consists of two termsthe length of the segmentation curve and the high-frequency component in the regions [11]. In addition to these are also used for the classification of hybrid applications [12].

Morphologic Process and Labeling

Binary conversion

One way to choose a threshold is by visual inspection of the image histogram

While choosing T, Threshold rate μ_1 and μ_2 rates, which dives the distribution of histogram, are being searched. The iterative method that Gonzales and Wood suggest for the selection of the rates is given in formula 1.

(1) $$T = \left(\frac{\mu_1+\mu_2}{2}\right)$$

After specifying Threshold rate, each pixel in the picture is compared to specified T rate and loaded with 0 or 1 rate. Therefore, color information with 8 unit resolution is transformed into binary format.[13]

(2) $$g(x,y) = \begin{cases} 0, f(x,y) < T \\ 1, f(x,y) \nless T \end{cases}$$

Opening, Closing and Top-Hat

The opening of image f by structuring element b, denoted $f \circ b$, is defined as

(3) $$f \circ b = (f \ominus b) \oplus b$$

As before, this is simply the erosion of f by b, followed by the dilation of the result by b, Similarly the closing of *f* by *b* denoted $f \cdot b$, is dilation followed by erosion

(4) $$f \cdot b = (f \oplus b) \ominus b$$

Subtracting an opened image from the original is called a top-hat transformation.[13] The Strel structure in the program MATLAB R2007 is used in tophat and open filters.

Labeling

A pixel p at coordinates (x,y) has two horizontal, two vertical and four diagonal neighbors whose coordinates are (x+1,y), (x-1,y), (x,y+1), (x,y-1), (x+1,y+1), (x-1,y+1), (x-1,y+1), (x-1,y-1). This set of 8 neighbors of p denoted as $N_8(p)$ A path between pixels p1 and pn is a sequence of pixels p_1, p_2, …, p_n, such that p_k is adjacent to p_{k+1}, for 1≤k≤n. For any foreground pixel,p, the set of all foregroud pixels connected to it's called to the connected containing p. The term connected component was jusst defined in ters of path and the definition of a path and the definiton a path in turn depends on adjacency [13]

Results

The images in the study are recorded with a 320*240 Pixel resolution webcam. A sample Picture as a source can be seen in Fig 1, for the detection of the view, for the detailed detection of the eye area, source Picture is subjected to in the order of tophat transformation, binary transformation and open transactions. Probable area numbers that occurred in the picture, obtained in the binary format are recorded. The effect of the size of the tophat and open filters are compared in accordance with the regional numbers.

Tophat Filter Application

Fig. 1 A sample source picture

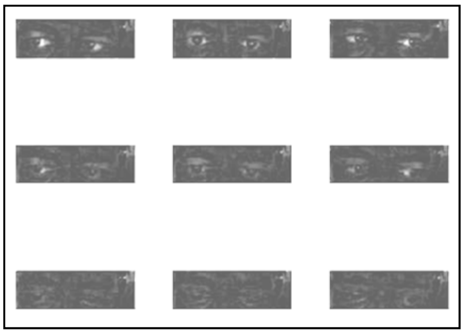
View pictures, which are manually taken out of the area of the eye and taken from one of the components of RGB can be seen in Fig. **2**

Fig. 2 Gray scale Pictures for different angle of views

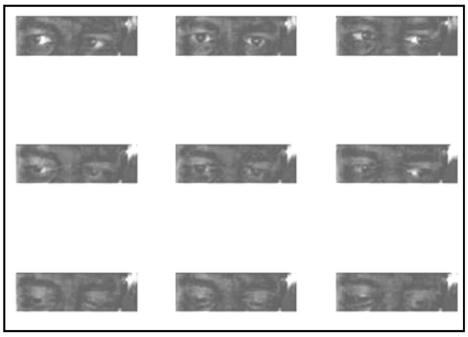
Each picture out of the 9 pictures seen in Fig. **2** is firstly subjected to tophat filter. In order to understand the effect of the size of tophat filter, filter size is increased starting from number 1 until number 25.

In the case of applying 8 unit tophat filter on the each picture seen in the Fig. **2**, the pictures seen in the Fig. **3**'(a) will be obtained as an output. In the case of applying 16 unit tophat filter on the each Picture, the pictures Fig. **3**'(b) will be obtained.

Picture converted into binary size in accordance with threshold. The Picture with 8 unit tophat filter and the last case of Picture converted into binary format can be seen in Figure 4 a, the Picture with 16 units tophat filter and the last case of Picture converted into binary format can be seen in Figure 4 b.when 2 images are compared, it is observed that if the tophat filter size is selected as 8 unit the details can be chosen; if we choose filter size 16 pixels , the eye area which is searched in the images out of the line ,is observed to disappear.



(a)Filter size 8 unit



(b) Fiter size 16 unit

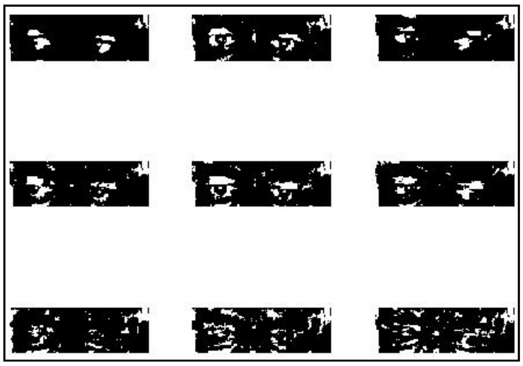
Fig. 3 The Topat Filter applied pictures

Open Filter Results

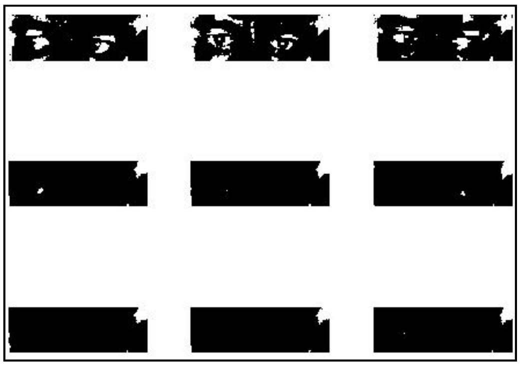
The pictures, as seen the samples in the Figure 4 4a and b, which are subjected to tophat filters then converted into binary format are later subjected to open process. Thus, after researching the relationship among pixels and other pixels surrounding them, it is aimed to disappear the details. In that phase, in order to understand the size of the filter to be applied, the filter size is raised from 1 unit to 15 unit and it is applied on the pictures that are converted into binary Picture. Below, there are some examples of pictures which are first subjected to tophat and then open filters

The white areas seen in the pictures are labeled. So, how many regions left are defected after each gate is subjected to tophat and open filters. In an ideal case, there must be two regions, labeled considering the numbers of the rates of filter, many differentiations are observed. On the one and , for instants, there a lot of postulant areas as seen in Figure 5 ,in the case of selecting tophat filter 2 and opened filter 1, on the other hand as seen in Figure 5 (f), only one area is labeled in the case selecting filter 16, and open filters.

$$r(x) = \begin{cases} 1 \quad (succesfull),\ x \geq 3 \\ 0 (unsuccesfull),\ x < 3 \end{cases} \tag{5}$$

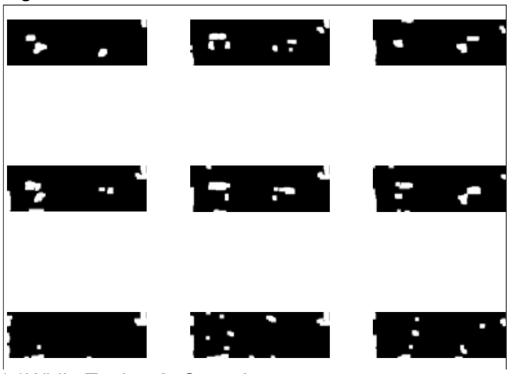


(a)Filter size 8 unit

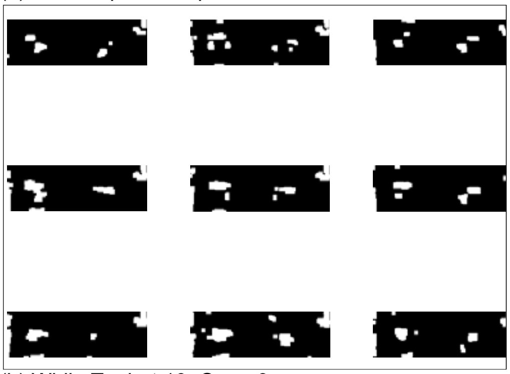


(b) Filter size 16 unit
Figure 4 Transformed into a binary image according to the threshold level

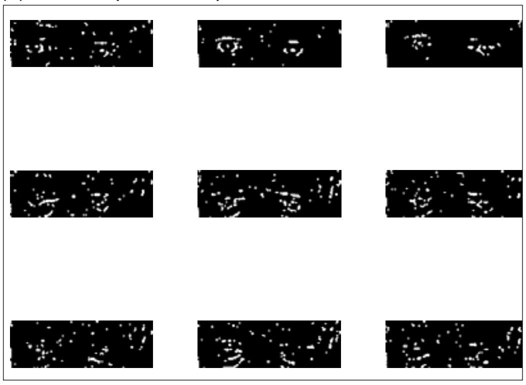
After applying tophat and open filter on each gaze, the number of areas left in the image is reorder. Successful and unsuccessful coefficients were obtained from formula 5. The left areas after filter application is a denoted as x. If the numbers of the left areas are 3 or less than 3, the filter co-efficient showing this result are recorded as unsuccessful co-efficient. When the activity mentioned is applied in each gaze and the entire filter co-efficient, the result seen in the Fig. 6 is obtained.



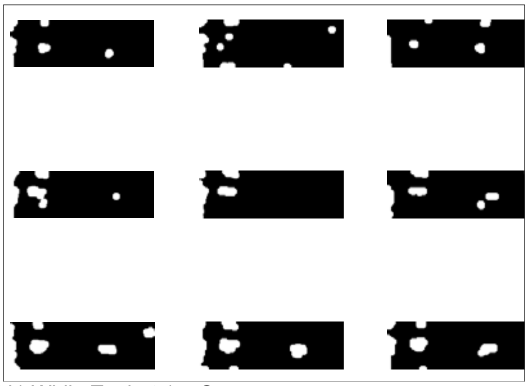
(a)While Tophat 8, Open 3



(b) While Tophat 10, Open 3

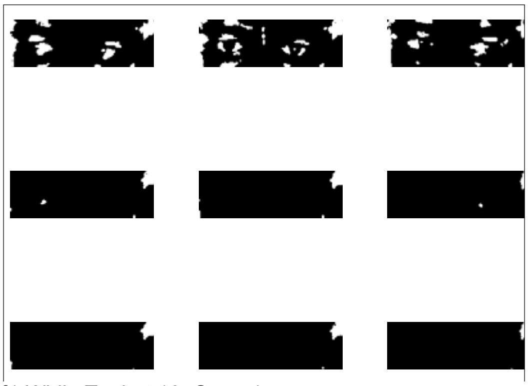


(c)While Tophat 2, Open 1



(d) While Tophat 14, Open 5

(e)While Tophat 15, Open 1



(f) While Tophat 16, Open 1
Figure 5 Differans Tophat and Open filters output

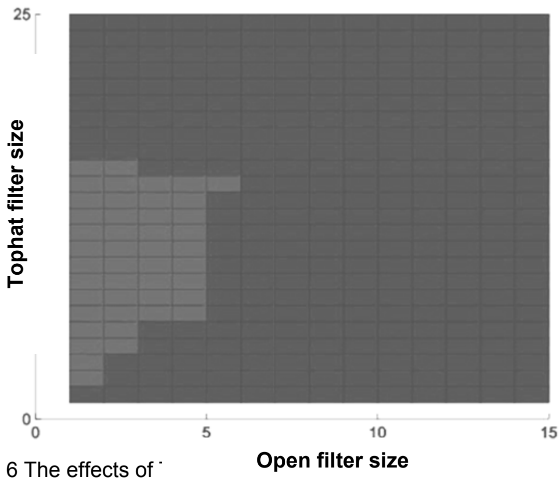


Fig. 6 The effects of

Conclusion

In this study the images recorded while gazing at different points, the tophat and open filters with different sizes applied with the aim of detection of eye areas. As understood by examine the Figure 5, while in some areas only area of the eye is in a good shape, in many other cases either many postulant areas are detected or even the area of the eye is not detected. This demonstrates that, we need to be selective when using tophat and open filters. For the sizes of tophat and open filters as in many other applications, the algorithms making the adoptive magnitude can be improved

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