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ScienceDirect

Procedia Computer Science 120 (2017) 417–421

Procedia Computer Science

www.elsevier.com/locate/procedia

9th International Conference on Theory and Application of Soft Computing, Computing with Words and Perception, ICSCCW 2017, 24-25 August 2017, Budapest, Hungary

Lie detection on pupil size by back propagation neural network

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Abstract

A pupillometry is a device that measures diameter of pupil. Measuring diameter can be done for different reasons. However, if person is not fixed to the pupillometry, diameter value could vary depending on distance between subject and device. To overcome this problem radius of iris was taken as reference to pupil as output will be ratio of pupil diameter to iris diameter. In this paper one of cues of deception, pupil dilation was studied, the dilated and non-dilated iris images were image pre-processed and segmentation of pupil and iris was achieved. Images were chosen from MMU Iris database and images with big pupils are assumed to be dilated pupils that are indication of lying and small ones were assumed to be neutral. After pre-processing that follows segmentation of pupil and iris, pupil to iris ratios as 60 samples of 1 element with 10 hidden neurons were fed into neural network for classification by neural network pattern recognition tool. All images were correctly classified.

Peer-review under responsibility of the scientific committee of the 9th International Conference on Theory and application of Soft Computing, Computing with Words and Perception.

*Keywords:*Pupillometry; cues of deception; artificial neural network; image processing; image segmentation.

1. Introduction

Granholm and Stuart (2004) explains that change in pupil size occurs due many reasons, it's know fact that pupil react to the low light condition as dilation and bright light condition as constriction. However, changes in pupil size is also known as indicators of emotional arousal as well as medical state. Sympathetic system is responsible with pupil dilation by controlling the radial dilator muscle of pupil due activation of sympathetic system stimulation

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1877-0509
Peer-review under responsibility of the scientific committee of the 9th International Conference on Theory and application of Soft Computing, Computing with Words and Perception.
10.1016/j.procs.2017.11.258

and as activation decreases diameter decreases. Parasympathetic system controls constriction of pupil with sphincter muscle of iris as reflex reaction to light via activation of parasympathetic system stimulation with efferent pathway originating in the edinger-westphal complex of oculomotor nucleus.

Pupil size is very important parameter in psychophysiology. In psychophysiology, Goldwater (1972) indicated that, it can be used to catch unconscious behaviours of individuals, which can work as one of the lie detection parameters.

Zuckerman et al. (1981) suggested that no single or set of behaviours would always occur during lying never occurs any other time which became widely accepted premise of him. Instead, feelings, psychological processes and kind of thoughts are more or less often during lying compared with truth telling. Then, they came up with four factors theory, where they explained generalized arousal, the specific affects experienced during deception, cognitive aspects of deception, and attempts to control behaviour.

Zuckerman et al. (1981) proposed that liars experience greater undifferentiated arousal compared to truth tellers. Which can be observed as greater pupil dilation, more frequent speech disturbances, higher pitch and blinking. However, he generally accepted that characteristic of deception may be explained by looking at different aspects experienced during lying.Liars felt guilt about lying or fear of getting caught more often than truth tellers. Zuckerman et al. (1981) conceived that lying requires more complicated tasks than truth telling. The liars should maintain his answer logical according to their claims that others have been informed already, which can result as greater cognitive challenges and that can be predicted with greater pupil dilation, longer response times, more speech hesitations, and few illustrations.Liars tend to control their own behaviour in order to maintain their deception, which paradoxically result in cues. Liars' behaviour seems less spontaneous compared to truth tellers. Controlling each type of impression is not easy task to do which eventually result in inconsistencies. Zuckerman et al. (1981) called all of these four factor theory of deception and reflected on subjects as lying requires greater cognitive load than truth telling, which can result as more pupil dilation, longer response times, and in other signs of load.

Our work in this paper is about segmentation of pupil and iris radius from images which are taken from MMU iris database. We searched for dilated pupils and non-dilated pupils within the database. Therefore, all the images which were segmented and classified by back propagation neural network are not real images which are acquired during a crime investigation or so. We assumed bigger pupils to be lying ones and small pupils to neutral ones. Our algorithm depends on segmentation of iris and pupil radius and then training neural network to classify high pupil to iris radius ratio and low pupil to iris radius ratio.

2. Method

In this part, process of iris and pupil segmentation along with neural neural network classification is explained step by step. In first step, pupil is pre-processed and segmented. That followed by determination of iris radius. In Second step, different pre-processing iris segmentation is used and iris is segmented and radius of iris determined These two values which are in radius are used to compare pupil to iris ratio to later feed this information into neural network.

2.1 Pupil Segmentation

Images are read from the folder and converted into grayscale from RGB initially. Opening and closing with disk shape is applied in loop for smoother image, where we get rid of small dots and reduce effect of eye lashes at a degree. Disk shape with size from 2 to 5 applied to images in a loop(Gonzales et al., 2009, p. 526). Image sharpening is applied in next part to increase success of pupil segmentation(Gonzales et al., 2009, p. 194), where pupil little bit more differentiable with its surrounding. In the next stage segmentation is done by thresholding with Otsu's method (Otsu, 1979). The thresholding value is determined by trial and error technique as a result 0.15 was determined for MMU iris images. In next stage. In final stage of segmenting, we apply circle detection to measure radius of the segmented circle. Hough transform is applied to detect thresholded pupil (Atherton and Kerbyson, 1999). Our work in segmentation is illustrated in the Fig. 1. below.