Abstract: Temperature distribution on the eyes of sober and drunk persons is studied and preliminary results are given regarding temperature changes. It is observed using simple image processing algorithms and histogram modification techniques that the temperature difference between the sclera and the iris increases when somebody consumes alcohol. Iris becomes darker, which means that its temperature decreases compared to sclera temperature.

1 Introduction

Biometrics is a research area with numerous publications in recognition or identification of persons. Applications are met in medicine, financial transactions, face identification and mainly in security issues. Research is carried out [DeM11][Ch10][Be10][JBP99] in several biometric problems such as face and fingerprint recognition, facial expression classification and iris identification (Fig. 1.1) with high rate of success.

Due to the availability of low cost cameras in the visible spectrum and the fact that face recognition is one of the primary activities of the human visual system, research in face recognition [Zh03] has been biased towards the visible spectrum. However, machine recognition using visible light is complicated due to the fact that the acquired images change with the conditions of illumination.

Recently, emphasis has been given to acquiring information from faces in thermal infrared spectrum [SS02][Bu07][ZG05]. The main reason for this is that the temperature of the face depends mainly on the physiological condition of the person [KIW06]. The human face being in a mean temperature around 300° Kelvin, radiates, according to the Wien Law, as a perfect black body [DB08], with maximum at 10 μm wavelength. Thus, this region of electromagnetic spectrum (7 μm – 13 μm) is the most appropriate to acquire information from the face.

Drunkenness is a challenging physiological condition to be investigated using infrared imagery. This is because arteries and vessels on the face of a drunk person, increase
activity with the consumption of alcohol. However, most of the publications refer only to automotive anti-drunk driving systems, which utilize electrical signals from the heart or brain [Wu09].

Figure 1.1 The parts of the eye. Sclera is surrounding iris which is actually a muscle controlled part of the eye to adjust the size of the pupil. Sclera lies on a net of blood vessels.

Iris identification has been extensively used in the past, and research results are on the market in robust and high performance commercial products. In [Pi11] a unified framework based on random projections and sparse representations, is presented in relation to iris biometrics. The work in [Mi06] presents an implementation of iris recognition algorithm using phase-based image matching — an image matching technique using phase components in 2D Discrete Fourier Transforms (DFTs) of given images. The authors in [Da07] present four advances in iris recognition: 1) more disciplined methods for detecting and faithfully modeling the iris inner and outer boundaries with active contours, leading to more flexible embedded coordinate systems; 2) Fourier-based methods for solving problems in iris trigonometry and projective geometry; 3) statistical inference methods for detecting and excluding eyelashes; and 4) exploration of score normalizations, depending on the amount of iris data that is available in images and the required scale of database search. In [Da04] algorithms suitable for recognizing persons by their iris patterns have been tested in many field and laboratory trials, producing no false matches in several million comparison tests. Finally, in [Ar12] matching iris images captured before and after alcohol consumption is investigated. Due to alcohol consumption, the pupil dilates/constricts which causes deformation in iris pattern, possibly affecting iris recognition performance. Near infrared technology is used for image capturing.

In this paper a preliminary study is provided regarding the temperature distribution on the whole eye before and after alcohol consumption. Experimentation is based on thermal infrared acquisitions in the range of 7-13 microns, by means of a passive thermal infrared camera. Half a litre of red wine was given to 40 volunteers in order to create our data base. It is observed using simple image processing algorithms and histogram modification
techniques that the temperature difference between the sclera and the iris increases when somebody consumes alcohol. Iris becomes darker, which means that its temperature compared to sclera temperature decreases.

The work layout is as follows. In section 2 is explained the way, the infrared images used in the experiment were acquired. In section 3 are described the histogram modification algorithms used and the experimental results obtained. The conclusions are drawn in section 4.

2 Infrared Data Used

The infrared images used in this work were acquired by means of the Thermo Vision Micron/A10 Model infrared camera (18 mm, f/1.6) of FLIR Company. The operating wavelengths are from 7.5 to 13.0 microns, which means that the obtained information is in the thermal infrared where we have the maximum of the Wien curve at 9.5 microns for 300o Kelvin. Actually, the human skin emits electromagnetic radiation as an almost black body in this exact region of wavelengths [DB08].

In this experimental procedure forty-one people were involved, 31 males and 10 females. Each person consumed four glasses of red wine, 120 ml each (13% vol.), in one hour time period (total of 480 ml wine i.e. 62.4 ml alcohol). In our experiment, wine was used for alcohol consumption compared to the experimental procedures in [KA12] and [KA11]. In those cases a number of twenty people had been employed and all persons participated in that experiment consumed beer. The quantity of beer required in order to consume the same amount of alcohol is almost three times larger (330x4=1320 ml) compared to that of wine. This is the reason why wine was used for drunk identification.

The first acquisition of 50 frames for each specific person was obtained just before starting alcohol consumption. The second acquisition of 50 frames was obtained 30 minutes after drinking the fourth glass of wine. Similar acquisitions were obtained one hour as well as one hour and a half after finishing alcohol consumption. Thus a total of four acquisitions were obtained for each person. In each acquisition, a sequence of 50 frames was acquired from each person with a sampling period of 100 msec between the frames. The mean value of the 50 frames of each acquisition was evaluated using MATLAB. This mean value of the eyes of a specific drunk person is demonstrated in Figure 2.1. The resolution of the infrared images is 128x160 pixels. The images were acquired in such a way so that all the image is occupied by the eyes of the specific person.
The term “drunk” is attributed to the person that has consumed four glasses of red wine or a total of 62.4 ml of alcohol. We consider that the number of forty people employed for this experiment is the maximum we could gather, so that infrared images in both cases, sober and drunk, are acquired. Furthermore, we consider this quantity of alcohol the maximum that our researchers could consume and participate in our experiment. No blood tests were conducted in order the blood alcohol content be known. According to various tests available to the web, only three glasses of wine are enough for any person to go beyond the limit of 0.5 gr/(litre of blood), a quantity set for secure driving [Wi13].

We noticed that, with the same quality of alcohol the participants are affected differently. This was realized by the measurements carried out by the police using an alcoholimeter. With the quality of 62.4 ml alcohol given to all persons the breath alcohol content was between 0.25 and 0.9 mgr/lit. It was found that this was the maximum concentration and was reached half an hour after the consumption of the last glass of wine. This is why in our experimental procedure we used only the corresponding acquisition as far as the data regarding the drunk persons are concerned. After that, the breath alcohol content started to decrease. The females were affected more than the males. The heaviest participants were also affected less that the thinner ones.

All persons participated in the experiment were aware about the risk they were undertaking. However, all of them were healthy without any problem that could brink them in difficult position. All persons accepted their personal data to be available in the Internet for use by the scientific community. In the specific data base all data such as age, weight and sex are recorded.

Finally, it is worth mentioning that the people employed in our experiment were calm and in normal physical and psychological condition during the experiment. No illness, no psychological stress or any kind of body exercises were recorded for any one of the participants. They were asked to be present in the room of the experiment half an hour earlier and to keep calm till the first acquisition of frames.

During the acquisition procedure, the temperature and the lights in the room were kept unchanged. Actually, a very dim light was available from a neighboring room for the researchers to be able to work. This light did not affect the operation of the infrared camera or the acquired infrared images. The distance of each face from the camera was around 30 cm and was kept constant from acquisition to acquisition. This results in a face which occupies the whole area of the frame and simultaneously it gives the images of the same person the capability of been easily compared.

3 Experimental Results

Among the forty persons participated in our experiment, it was evident for 28 of them that the sclera becomes hotter than the iris when the person consumes alcohol. In all these cases, in the original thermal image of the eye corresponding to the sober person the sclera
and the iris are almost of the same temperature appearing with almost the same gray level as shown on the left image of Figure 3.1. When these persons consumed alcohol, the sclera becomes hotter and brighter compared to the iris, as shown in the right image of Figure 3.1 (images are shown in their original form without any kind of preprocessing).

![Figure 3.1 Thermal Infrared images of the same eye of a person sober (left) and drunk (right) (person 5). The images are shown in their original form without any kind of preprocessing. The sclera is evidently hotter (brighter) than the iris for the drunk person.](image)

In all these cases the iris was darker than the sclera for the drunk person or this difference simply became prominent by means of a histogram equalization algorithm. Such cases are shown in Figure 3.2 (right images).

Moreover, another 8 persons presented significant temperature difference between the sclera and the iris for the drunk person using other histogram modification algorithms. These cases are depicted in Figures 3.3, 3.4 and 3.5 respectively. Particularly, in Figure 3.3 is shown the original images of the eye of person 21, for the sober and drunk cases respectively. This images have been modified using a histogram modification algorithm which clips all values lower than 0.5 and higher than 0.75, and stretches the rest to occupy the whole histogram range (MATLAB imadjust ([0.5 0.75],[0 1])).

![Figure 3.2 Using a histogram equalization algorithm the eyes of two different persons (persons 11 and 13) present an iris with lower temperature after alcohol consumption. The algorithm was applied in the thermal images of the eye for the sober persons (left) as well as for the corresponding images in the case of the drunk persons (right).](image)

In Figure 3.4, the results for the same person 21 are obtained from a contrast stretching algorithm which was applied in the original images. In Figure 7, results are shown when a logarithmic transformation is applied to the original data of person 37. In all these cases the sclera becomes hotter after consuming alcohol and this is evident from all images on
the right of Figures 3.3, 3.4 and 3.5.

Figure 3.3 (a) The original images of the eye of person 21, for the sober (left) and drunk (right) cases respectively. A histogram modification algorithm which clips all values lower than 0.5 and higher than 0.75 and stretches the rest to occupy the whole histogram range (MATLAB imadjust([0.5
0.75],[0 1])) gives the images in (b).

Figure 3.4 The results obtained from a contrast stretching algorithm which was applied in the original images of person 21.

Figure 3.5 The results obtained from the logarithmic transformation applied to the original data of person 37.

Finally, we have to mention that for 5 persons no algorithm applied to both sober and drunk data succeeded to show off increased temperature for the sclera in the case of drunk persons.
4 Conclusions

In this work preliminary experimental results are presented which describe the temperature changes on the human eyes when somebody consumes alcohol. Thermal images are used for this purpose. The basic evidence is that the iris remains in the same temperature while the sclera increases its temperature with alcohol consumption. Consequently the iris appears darker in the thermal imagery. A physical explanation is that the sclera is full of blood vessels which increase the temperature of sclera with alcohol consumption. In our experiments 36 among forty-one persons which consumed alcohol presented darker iris in their thermal imagery.

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6 References


