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EC OPHTHALMOLOGY
Research Article

Signage Recognition System for Blind People

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Received: March 07, 2018; **Published:** May 22, 2018

Abstract

The present paper describes the development of a system that detects and recognizes signage in closed and open environment. An application has been developed able to detect and recognize signage as: emergency exit, bathroom for man or bathroom for woman, etc., through an artificial intelligence and image processing that allow blind people to perceive and identify them. The communication through the system and the user is a synthetic speech. The system is implemented in a pair of sun glasses designed based on the human face ergonomics, a micro camera as an environment acquisition system, a processing system that have the dimensions of a credit card and bone conduction headphones. The system has a 97,5% of accuracy.

***Keywords:** Image Processing; Artificial Intelligence; Signage Recognition; Blind People*

Abbreviations

OCR: Optical Character Recognition; GPS: Global Positioning System; SURF: Speeded-Up Robust Features; BRISK: Binary Robust Invariant Scalable Keypoints; FLANN: Fast Library for Approximate Nearest Neighbors

Introduction

Artificial Intelligence is one of the most used science in all areas of the science. The usage of the new technologies makes this subject be presented in all electronic technology. The use of the artificial intelligence is also involved in the development of technologies for blind and people with low vision, people with different limitations or disabilities [1], applications for elderly people [2] etc. Actually the development of applications for blind people and people with low vision based on artificial vision are more used, applications for euro banknote recognition [3], dollars banknote recognition [4], Mexican banknotes [5], the currency of Saudi Arabia [6], face detection and recognition applications [7], navigation [8].

Signal detection and recognition systems are mostly used on development of systems for traffic signs detection and recognition [6,9]. Nerveless, there are no applications for signage detection and recognition for indoor and outdoor environment for people with visual disability. Knowing that in the world are over 285 million of people with visual disability, a system that will help them to recognize the signage in indoor and outdoor environment an important for their security and independence. There are many mobile applications for reading, based on OCR (Optical Character Recognition) [10], navigation by using GPS (Global Positioning System), and maps, but there are no applications that will inform the user about the obstacles or objects in front of them by using artificial speech or acoustic sounds.

The present paper treat about the development of a system for signage detection and recognition by using a high resolution camera, a credit card processing unit and Android application for communication between the system and the user. The pervasiveness of the usage of the new technology in the human daily life makes possible the implementation of new interactive signage detection and recognition.

The algorithms uses the Viola and Jones algorithms for the detection [11] and the algorithms for the signage recognition based on SURF and BRISK.

Materials and Methods

The proposed system consist of a credit card electronics as a processing unit dotted with a high resolution video card, a No-infrared high resolution camera and an Android Smartphone. The system processing unit communicate with the Smartphone by Bluetooth. The Smartphone is used as a communication system between the user and the processing unit. Through voice command and or tactile bottoms of the Smartphone, the recognition system is activated and controlled.

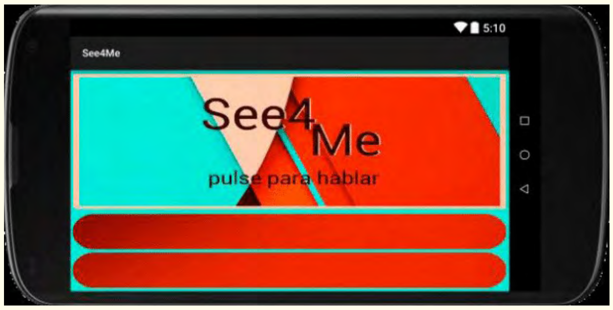


Figure 1: *User interface.*

The processing system consist of the Data acquisition algorithms, Training algorithms, Feature extraction algorithms, object detection algorithms, training algorithms and signage recognition algorithms.

The Data Acquisition algorithms are in charge of the image capture from the environment. The captured images are processed in order to filter the noises, blur and to define the image for a specific dimensions.

The processed images are then used for the training algorithms. The proposed algorithm create a Haar Classifier. 60 images of the most common indoor signage have been captured and processed. That images have been processed in order to create over 1500 negative images with by combining the original images with negative images that contains exterior and interior images without signage.

Once the images are ready, through Gentle Adaboosting, the images are processed in order to create the main features of the images. The Gentleboost algorithm look for small numbers of positive features that does not have significant variation. To each sample the algorithm give a weight and create a feature for each weight. Initially the classifier have the respective threshold:

$$\theta = \frac{1}{2} \sum_{t-1}^{T} \alpha_1 \quad (1)$$

Where T are the wished features and the α is the weight for each feature T.

The hit rate of the training algorithm is over 99.9% and hit rate of false positive is over 50%. It have to mention that the training algorithm is required to train the system and in case the user upload new signage.

With the trained classifier, the system realize the detection algorithm. The detection algorithm is based on the Multiscale Cascade Classifier proposed by Viola and Jones and Lienhart [12]. The proposed algorithm detect the main features of the new images and the trained images, looking for common features.

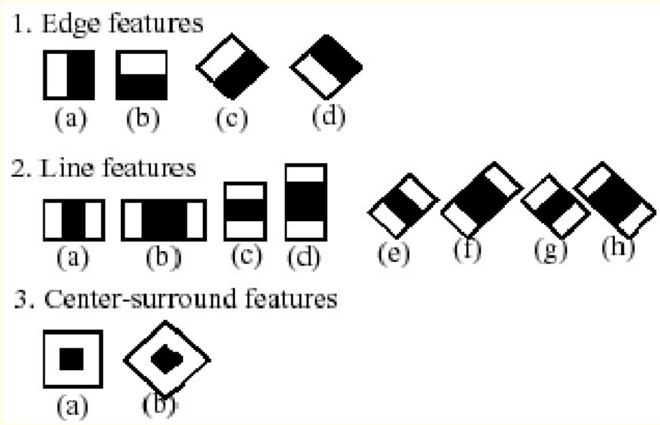


Figure 2: *Haar features [12].*

With the proposed modification over the Viola and Jones algorithms, Lienhart increased with 10% the hit rate.

The recognition system implement the SURF and BRISK algorithms. This algorithms compare in real time the new images with the processed ones defining the match points between them. From each image the points of interest and descriptors are extracted, that afterwards are used on the matching process. In order to obtain the points of interest the algorithm uses the blobs detection based on the Hessian matrix. The Hessian matrix are based on the evaluation of the second degree Gaussian partial derivate. The rotation invariants are obtained through Wavelet filters.

When the points of interest are detected, the luminance of the neighbors are defined. Finally, the recognition system define the points of coincidence between the stored image and the new one by using the Fast Library for Approximate Nearest Neighbors (FLANN) [13].

Results and Discussion

In order to test the system, 15 images that represent the EXIT signage have been taken. For the negative images a set of images were downloaded from internet, images that does not have the EXIT signage on. Then a file with 2000 images have been created by convolving the original ones and the negatives.

Figure 3: *Examples of images.*

The true positive hit rate is calculated as:

$$TPR = \left(\frac{N^{o}\ correct\ signage}{N^{o}\ of\ signage} \right) * 100\% \quad (2)$$

Once the images have been convolved, were involved on the training algorithm in order to define the recognition features.

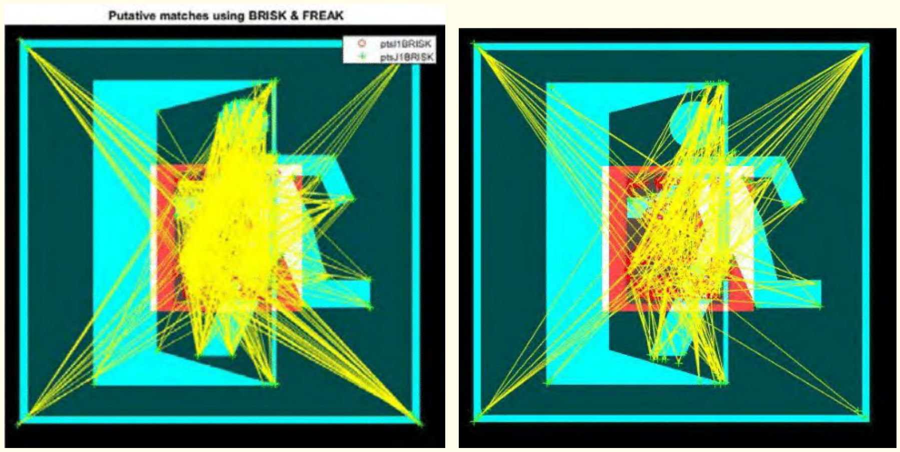
Once the camera take the image process it and segment it as presented in figure 4a.

On figure 4b are presented the two different images of the EXIT signage and the matching points by using SURF and BRISK algorithms. In the figure 4b, are presented the results of the matching points that are common for both algorithms.

a) b)

Figure 4: *a) Image segmentation. b) Matching points using SURF and BREAK algorithms between two images of the EXIT signage.*

The results of the test shown in the figure 5, which involves two recognition algorithms BRISK in the a) and SURF in b), demonstrate that BRISK algorithm determine more points of interests than SURF. The BRISK algorithm obtained a 99% of the hit rate when SURF obtained 95% of hit rate.



a) b)

Figure 5: *Results of the match points by using BRISK algorithms for the EXIT signage.*

After the image has been recognized, the system return to the user by writing a message on the Smartphone screen “EXIT” and with synthetic voice communicate “EXIT”. In case there the image is not recognized, the system response is “SIGNAGE NOT RECOGNIZEDED”. Actually the system hit rate are: 73.6% hit rate for classification, 84% for detection algorithms with the scale Factor = 1.25 and min neighbors = 6 and 97.5% of the recognition hit rate.

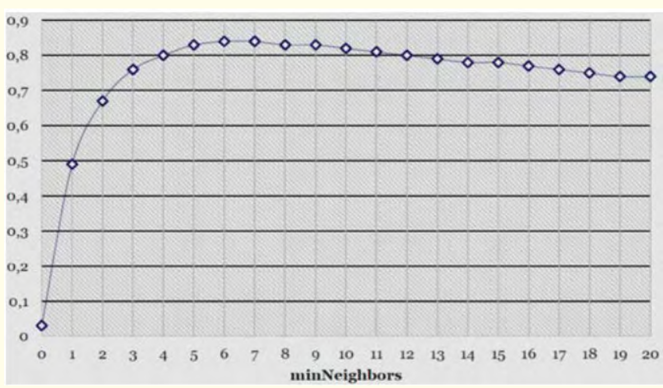


Figure 6: *Graphical interpretation of the Hit rate varying the min Neighbors from 0 to 20.*

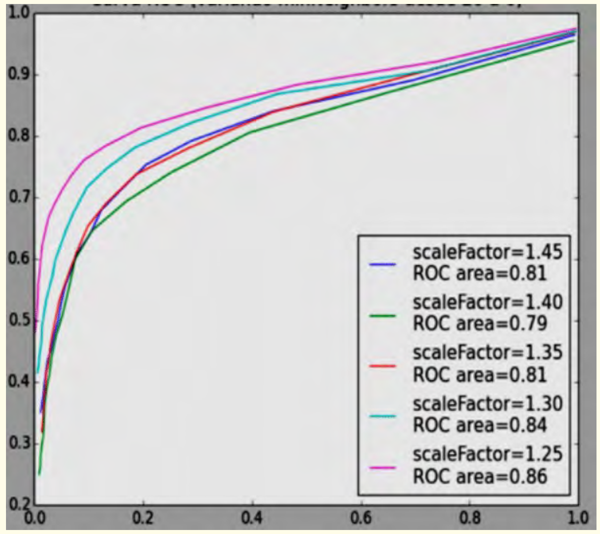


Figure 7: *Graphical representation of the ROC curve, the definition of the optimal scale factor varying min neighbors from 20 to 0.*

The Oi-Mean, Abdullah Khalid Ahmed [14,15] develop a signage recognition system for blind people, which treat the public signage that consist of English alphabet. In another work [16], the authors treat about text recognition processing by a synthetic speech. In comparison with their system our system detect and recognize all indoor and outdoor signage composed by text and image. Shuihua Wang [17], developed a signage recognition system based on the SIFT descriptors. The authors obtained 89.2% on signage detection and 84.3% in recognition, while our system with only SURF descriptors obtain 84% in detection and 97,5% on recognition. The final recognition was improved with BRISK descriptors, which increase the recognition to 99%. Our system contain a huge database of the universal most common signage for emergency, exit, bathrooms, stop, etc.

Conclusion

The proposed work describes the development of a signage detection and recognition system for blind people. The training algorithm by using Gentle Adaboost, the detection algorithm by using modified Viola and Jones algorithms and the algorithms of the signage recognition by using SURF and BRISK algorithms were developed. The results of the actual system are: the hit rate 73.6% for classification, 84% for detection algorithms with the scale Factor = 1.25 and min neighbors = 6 and 97.5% for the recognition.

Conflict of Interest

Not financial interest or any conflict of interest exists.

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Volume 9 Issue 6 June 2018