Towards the Development of a System for the Support of People with Visual Disabilities Using Computer Vision

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Abstract. The visual impaired people requires being as much independent as possible to navigate indoor environments. The mobility of this kind of people is difficult and several times requires a companion. Therefore there are several methods for object detection and recognition based on computer vision techniques. This work proposes the use of these methods in the context of accessibility for people with vision problems.

Keywords: Accessibility · Blind navigation · Artificial vision

1 Introduction

According to WHO (World Health Organization) [1], in 2010, 39.365 million of people suffered blindness and there were 264,024 million people with low vision in area of the Americas (Central and South America) 3,211 million (8%) were blind and 23,401 million (9.5%) with low vision. Vision is one of the main ways humans develop most of their daily activities, due to that, people with affected eyesight suffer various difficulties dealing with everyday activities. Although governments and public agencies in different cities have implemented systems that include Braille and RFID (Radio Frequency Identification) labels in main sites to orient blind people, these methods are not widespread and not effective in all cases. As a result in most cases blind people depend on a companion to move towards their work, home or any indoor environment. Relying other methods in many cases is not feasible or practicable, for lack of time or resources. For this reason these people seek to be as independent as possible in order to integrate and become part of society. There are several applications that help navigation and mobility of people with visual disabilities [2–5], that can be divided into navigation support indoor and outdoor spaces.

Additionally, there are other methods based on the generation of mental maps for navigation using step to step actions in a virtual environment using portable devices [6].

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2 Developed Process

A system for support of people with visual disabilities must consider a set of different kinds of sensors, which provides as much as possible information about the environment. Such as a unit of processing (i.e. a companion computer), a method for feedback (tactile or auditory) and a correctly developed interface that receives the user commands and manage the inputs of sensors to return the required information to the user. In this work, a part of the whole system is presented, this part is composed of a visual system based on computer vision techniques. The computer vision techniques are in charge of detect objects of interest in the environment as signs that indicate which is the place where the user is located. For this purpose a machine learning method is used for object detection using a dataset obtained in first instance from a camera. In this stage a ROI (region of interest) is obtained. After that, a color based segmentation is used to improve the detection. Since the vision system obtain images with perspective distortion, a homograpy is computed in order to get a rectangular sign. Then, an implementation of OCR (optical character recognition) using neural networks is employed to obtain the data of the sign. After that, the information is processed in order to give a response to the user using a text to speech component.

3 Methodology

In the first stage a set of 50 images with resolution of 8 megapixels were obtained. These images allowed to test the system. The dataset different features that includes, images taken from different point of view, background and sign color as can be shown in Fig. 1. For the implementation of the system, the OpenCV library was used.

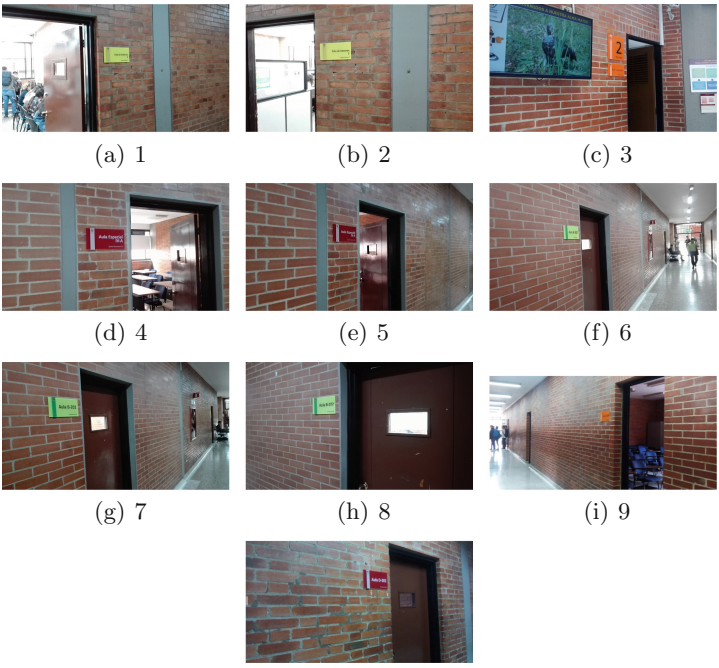
3.1 Object Detection

An object method based on HOG descriptors [7], that are computed by a sliding window is implemented for sign detection; the classifier is a support vector machine as is shown in Fig. 2.

3.2 Irregular Quadrilateral Recognition

After the sign detection, it is necessary to find the corners of the sign in order to apply a homography. This is done by computing the closest distance from the detected corners to the frontiers of a bounding rectangle as it is shown in Fig. 3.

The corner detection is necessary to specify a set of points that permits to create homography, the results are shown in Fig. 4.



(a) 1 (b) 2 (c) 3

(d) 4 (e) 5 (f) 6

(g) 7 (h) 8 (i) 9

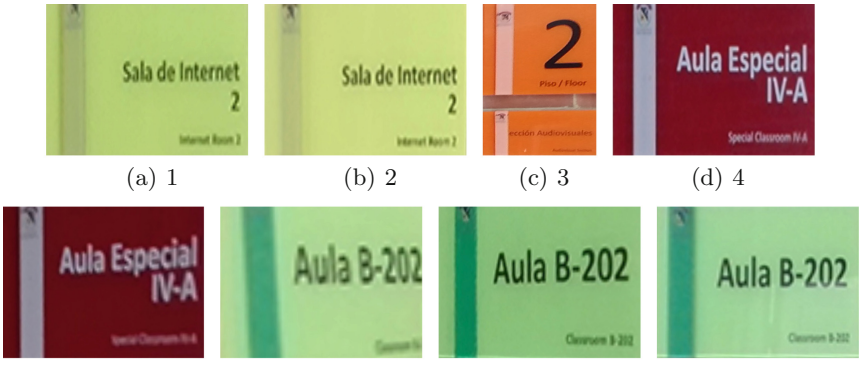
(j) 10

Fig. 1. Some examples of the initial dataset. (Color figure online)

Fig. 2. Object detection.

(a) 1 (b) 2 (c) 3

Fig. 3. Corner detection method.



(a) 1 (b) 2 (c) 3 (d) 4

(e) 5 (f) 6 (g) 7 (h) 8

(i) 9 (j) 10

Fig. 4. ROI detected and corrected.

(a) 1 (b) 2

Fig. 5. OCR process.

3.3 OCR Stage

It was necessary to use a database of characters in order to train a classifier that is able to recognize the characters that appears in the rooms signs. Before the optical character recognition (OCR) it is necessary to process the image in order to improve the contrast and binarize, obtaining a simplified input to the system as is shown in Fig. 5.

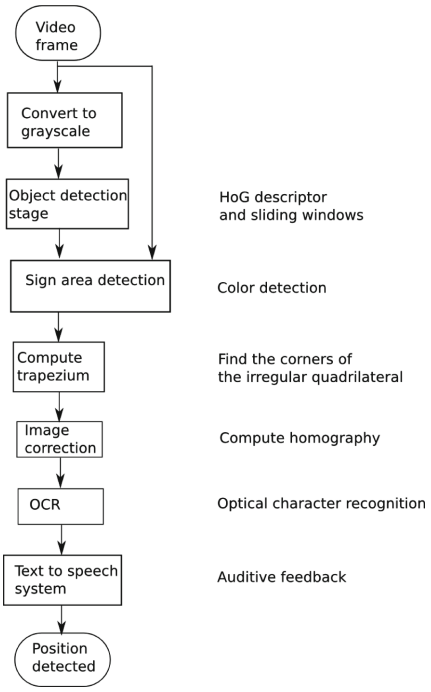


Fig. 6. Proposed process.

4 Results

After the object detection stage, the system is able to isolate the image of the sign using an image processing method, due to corner detection method a segmented rectangular sign is produced. A method for perspective correction based on homography is employed with good results. The proposed process is shown in Fig. 6.

5 Conclusions and Future Work

The actual system allows to distinguish the area where the signs are located inside the walls of the building. Moreover, it permits to detect the characters included in the sign.

In addition, a connection with a text to speech system is able to communicate the information to the blind user in an auditory feedback.

The study and development of an interaction method that improve the usability of the system is proposed as a future work.

Also the semantic relations that can be present in internal environments could be explored as a future work in order to improve the system.

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