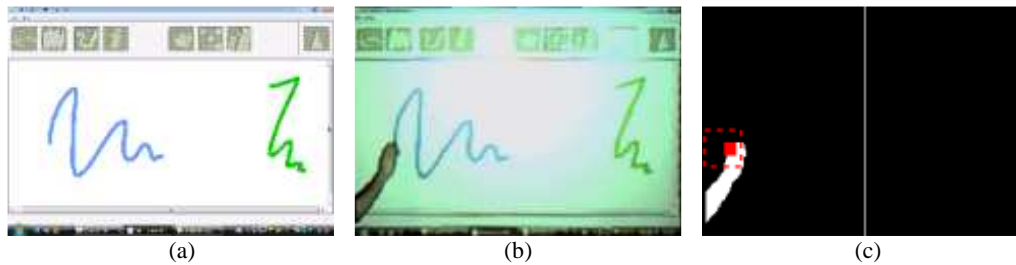# Gesture Controlled Interactive Whiteboard Based on SVM and Fuzzy Logic

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Figure 1: *The picture displayed by multimedia projector (a), the corresponding frame from the camera with the perspective corrected (b) and the result of image subtracting after applying image processing methods (c)*

1   Introduction

Nowadays, one of the main focuses of the Human-computer interaction area is controlling computers by gestures. Various gesture types provide means of controlling user interfaces and applications. However, most of them involve the front-facing camera and the user's gestures are recognized often from the static background. In addition, colorful gloves, gloves with motion sensors or infrared diodes are often used for this purpose.

The approach presented herein utilizes a camera placed behind the user, coupled with a multimedia projector. Gestures are recognized on the variable background. No special manipulators or infrared lights are necessary. To present the possibilities of such a use the Interactive Whiteboard application was developed. Besides the basic functionalities of writing, deleting the content, etc. the user can load images of various types and draw on them. Recognition of gestures enabling the user to rotate, zoom or to browse the images is provided by the system. Each gesture can be performed in very close proximity to the whiteboard (e.g. writing) or from a distance (e.g. for image handling).

Since multimedia projectors are often a standard equipment of classrooms, the whiteboard presented may be a cheaper solution in comparison with existing interactive whiteboards based on projectors, special frames with sensors and electronic pens.

2   Our Approach

The solution is based on subtracting the projected image (a) and the image extracted from the video stream (b), and recognizing gestures in the further processed, output (c). During the gesture recognition process SVM classifiers and fuzzy logic are employed [Lech et al. 2009].

First, the effective area of an image grabbed from the camera mounted on the ceiling projector is determined. This area, treated as a view of the image displayed by the projector, is determined by the user who points out positions of the image corners in the frame. Based on these positions, scaling of the projected image is performed to ensure identical dimensions with the image grabbed from the camera. Then, the perspective correction is performed. The next step consists in color calibration which reduces the impact of light conditions and distortion introduced by the camera lens, such as vignetting. During the calibration process five colored images (red, green, blue, white and black) are displayed. Tables of discrete constant values used in the later image processing are created as a result of subtraction of each displayed image and respective camera frame. Next, the processed frame obtained from the camera is subtracted from the projected image. As default, RGB subtracting is performed using only the green component. An appropriate value retrieved from the color calibration table is added to each output pixel. The result is binarized and subjected to separable median filtering with the square mask of size equal to 9x9 pixels. The obtained image is divided into a few vertical parts depending on the number of hands used for controlling (e.g. 4 for 2 persons). For each part SVM classifiers are used to match the palm shapes with masks describing the palm gestures. The velocity vectors are created based on hand positions between each two adjacent frames from the video stream, both separately in each part and within adjacent parts when no hand is found in a particular frame part. Magnitudes of the velocity vectors are determined by four triangular fuzzy membership functions. Directions of movements are determined by hypertrapezoidal fuzzy membership functions [Kelly and Painter 1996]. Employing fuzzy logic rules for the results obtained enable to recognize dynamic hand gestures (e.g. moving both hands farther apart). Each recognized gesture is interpreted according to the associated system event.

Acknowledgments

References

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