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Eduardo Hart
Pace University

Sung-Hyuk Cha
Pace University

Charles C. Tappert
Pace University

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Interactive Flag Identification Using Image Retrieval Techniques

Eduardo K. Hart
Sung-Hyuk Cha
Charles C. Tappert

PACE UNIVERSITY

Eduardo Kalman Hart completed his Master of Science in Computer Science at Pace University in May, 2004. He came to Pace holding a Master of Science in Control and Automation Engineering from Pontificia Universidad Catolica in Lima, Peru, as well as a baccalaureate in Mechanical Engineering from the same university.

From 1994 through 2001 Eduardo worked as a senior project supervisor and mechanical designer for Alicorp, the largest food processing company in Peru, and one of the most important in South America. There he designed industrial processes and specialized machines, including a pellet cooler for reducing the temperature of pasta pellets before packaging, a system of package elevators and aerial belt conveyors, and a flour mixing and packaging facility.

Sung-Hyuk Cha is Assistant Professor Computer Science at Pace University, based in Westchester. Dr. Cha holds baccalaureate and masters degrees from Rutgers University and a doctorate in Computer Science from the State University of New York at Buffalo. He joined the faculty at Pace University in September, 2001.

Dr. Cha's research interests lie in the areas of distance measure and pattern matching algorithms, pattern recognition, image analysis, and machine intelligence and data mining.

Charles C. Tappert holds a B.S. in Engineering Sciences from Swarthmore College, an M.S. and Ph.D. in Electrical Engineering from Cornell University, and was a Fulbright Scholar. He worked at IBM for 26 years, mostly at the T.J. Watson Research Center, on speech recognition and pen computing. He has over 100 publications: journal articles, book chapters, conference papers, patents, and technical disclosures. While at IBM, he adjuncted at Pace University, SUNY Purchase, and North Carolina State University. He taught full-time at the U.S. Military Academy at West Point for seven years before joining Pace University in 2000 as Professor of Computer Science.

At Pace Dr. Tappert has been involved primarily in the development of the Doctorate of Professional Studies in Computing, for which he is the Associate Program Chairperson and in leading the software engineering seminar, which is the two-semester capstone course in the Master of Computer Science program. His research interests include pattern recognition, pen computing and voice applications, graphics, algorithms, artificial intelligence, human-computer interaction, and e-commerce.

Interactive Flag Identification using Image Retrieval Techniques

Eduardo Hart, Sung-Hyuk Cha, Charles Tappert
CSIS, Pace University
861 Bedford Road, Pleasantville NY 10570 USA
E-mail: eh39914n@pace.edu, scha@pace.edu, ctappert@pace.edu

Abstract

We propose an interactive system for identifying flags in photos taken from natural scenes. The system is interactive in two respects. First, because segmentation can be a difficult problem, users are asked to crop the flag portion from a photo. Second, the user makes the final decision by selecting one of the top choices obtained from the machine classification system. The proposed system utilizes a color-based image retrieval technique. For experimental purposes a large number of flag images are synthetically generated from a small number of original ones in order to increase the reference image database. A nearest neighbor classifier produces a sorted list of candidate choices. Recognition accuracy of these choices varies from 82% to 93% depending on whether the correct flag is among the first 8 or 18 top choices, respectively, from a set of 186 flags.

Keywords: *flag recognition ,image retrieval*

1. Introduction

Classifying an unknown flag in a scene is challenging due to the diversity of the data and to the complexity of the identification process. Flag images in scenes are often blurred, shaded and, because of wind or movement, furled (curled and possibly folded). These distortions greatly increase the difficulty of identifying flags embedded in real photos. We present a flag recognition system using the content-based, image-retrieval technique. Given a large database of known flag images and an unknown flag image as input, the system retrieves all similar flag images in the database. Other applications of content-based, image-retrieval techniques have received attention (see the extensive survey [1]), and color components have been widely used to retrieve images [1-6]. We adopted this color-based image retrieval technique and, by comparing the color components of two flag images, we retrieve all similar flags.

Our proposed system requires preprocessing to locate and to segment a flag from the surrounding background in a photo. To perform this preprocessing, we propose an interactive recognition system similar to that of an earlier flower recognition system [7]. Users crop the region of interest from a photo and then the system retrieves all the similar flags. Similar approaches can be found in sign recognition systems where the studies have focused on identifying commercial, informative, and traffic signs. In two key studies [8, 9] the signs to be identified had two common characteristics: regular shapes (polygonal) and no motion (signs move together with the background). Because the signs were difficult to segment automatically, the best results in these studies required user intervention. Once the sign is located, those systems executed automatic adaptations, like rotation, slant, and tilt correction, that facilitated accurate identification of letters or symbols. Those adaptations, however, cannot easily be applied to flags because flags are usually non-static (waving, folded, etc.). Interestingly, not being static is an advantage for flag segmentation because the motion could be used to assist an automatic segmentation process. Being furled (not flat and two-dimensional), however, not only increases the difficulty of applying automatic shape correction to flags but it also increases the difficulty of accurately identifying symbols or letters as defining features because portions of the flags may be obscured.

The proposed system consists of three main stages: segmentation, feature extraction, and classification. Although automatic flag segmentation is possible due to the non-static property, for this preliminary study we have the user locate the flag by selecting four corners of an area containing the flag. Patricia G. Foschi [10] describes an approach for image mining of aerial photos that automatically identifies the parts of the image corresponding to the Egeria

river. The core of her research is to divide the image into small blocks of 10x10 or 8x8 pixels and apply color and texture feature extraction to each block. Extracting features for the flag identification system is based on this concept. The target features are the colors and their corresponding percentage contribution to the segmented portion of the flag. The classification process uses the nearest neighbor method, and most of the references are synthetically generated from a small number of original flag images. For this study the references are based on 186 different flag classes and 36 samples per class. We tested the system on both synthetically generated images and on real photos of flags.

The subsequent sections are organized as follows. Section 2 discusses the flag image database of flags from 186 different countries, section 3 the feature extraction process, and section 4 the flag retrieval system with recognition accuracy results. Finally, section 5 draws conclusions of this work.

2. Flag Image Database Construction

The flag image database construction is the most important step of the flag recognition system. There are three kinds of flag images: plain, synthetic, and natural-scene. First, plain flag images are clean graphic images as shown in the upper left portion of Figure 1. They are used for the truth displayed to the users, and there are 186 of them representing the various countries.[1] Second, synthetic flag images are those synthetically generated from the plain flags as shown in Figure 1; they are used as references for matching. Finally, natural-scene flag images are obtained from a digital camera, and the flags in these images are often occluded or waving; they are used for testing.

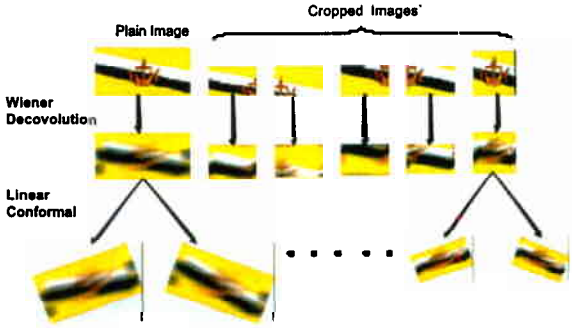

Figure 1. Data generation for Brunei.

To generate the synthetic flag images from the basic plain ones, we first cropped each plain image in five sections, four of them representing ¼of the image, and the fifth one a central area of 30% of the total image. Six more samples were generated by applying *Wiener Deconvolution* to the 6 first images, the original and the five generated ones. We used Wiener Decovolution to simulate the effect of camera movement or out of focus. From this set of 12 samples we created 24 more samples by using the *Linear Conformal Transform*. The rotation angle for this function was set to 20 and -20 degrees. The idea here is to cover the possibility of cropping rotated flags. Figure 1 depicts an example for Brunei. In all, there were 36 synthetic flags for each plain flag.

3. Color Feature Extraction

A previous study described the main characteristics of flags: colors, symbols, object counting, or color distribution [11]. It is apparent that using only one type of feature is not sufficient to successfully classify flags. For example, in Figure 2 (column 1) color alone differentiates between the flags. In column 2, both flags have the same three colors and what differentiates them is that the top one has symbols. Column 3 is more complicated because both flags have symbols and the same colors, but the number of objects is different with the flag at the top having 6 and the one at the bottom 8. The last example (column 4) cannot be solved by using the first three approaches – the flags contain the same three colors, do not have symbols, and have the same number of objects. Color distribution, however, makes the discrimination because one flag has a horizontal and the other a vertical arrangement.

[1] The plain flag images come from the World Flag Database, http://www.flags.net/.

Figure 2. Feature extraction alternatives

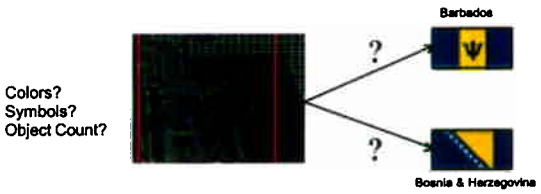

Figure 3. Limitations of feature extraction in real photos.

Because there are many factors present when a photograph is taken, a real picture doesn't look as perfect as in the images above. Movement (the flag is waving), light, focus, distance, and position of the camera make it difficult to recognize features. Most of the actual photos look something like the flag in Figure 3 where it is not possible to determine the number of objects, symbols, colors (besides red and yellow) or color distribution. For this reason the feature vector for this preliminary design of the system considers only colors and percentages of color participation. All colors are clustered into nine colors using HSV color values. Thus, flag images are represented as a vector F_i where $i = 1 \ldots 9$ and each element represents the percentage of the color.

4. Flag Image Retrieval and Results

The classification process uses an image retrieval technique involving a similarity measure. As we indicated above, our reference is generated from a set of 186 different classes and 36 samples per class. We tested the system on synthetically generated flag images and on real photos of flags. Let F_i be a plain flag image where the subscript, i, indicates ith country flag. Let $S_{i,j}$ be synthetic flag image of ith country and jth synthesized flag. Finally, let Q be an unknown flag photo image taken from a digital camera. Then the inputs to our system are $S_{i,j}$ and Q. The output is a sorted list of F_i's according to $d(S_{i,j}, Q) = \sqrt{\sum_{k=1}^{9} (S_{i,j,k} - Q_k)^2}$

The output of a typical pattern recognition system is $\underset{S_{i,j}}{\operatorname{argmin}} \sqrt{\sum_{k=1}^{9} (S_{i,j,k} - Q_k)^2}$, i.e., the top match. Instead, we retrieve all flag images in order of similarity. Figure 4 shows the recognition performance graph where x axis is the number of retrieved flags, often called 'hits' and y axis is the percentage of correctly retrieved flags within the top k hits.

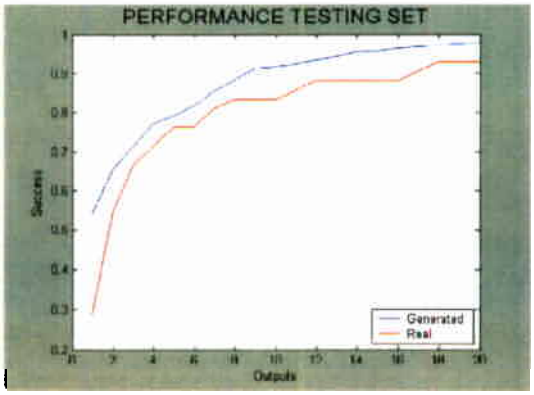

Figure 4. Performance of the Testing Set.

To test the system interactively we developed a graphical user interface in which the user is allowed to crop the image and the system displays the first three matches. Users can also request to see the next three matches, etc. Figure 5 depicts 10 original photos, the cropped area, and the 10 first outputs after the retrieval.

5. Conclusion

We presented an interactive flag recognition system that identifies flags embedded in photos of natural scenes. Since obtaining a large volume of flag images is time-consuming and difficult, we generated a large number of synthetic flag images from plain flag images. Applying a color-based image retrieval technique, we reported good flag identification results. The proposed system is an interactive system because of two reasons. First, users are asked to select the region of interest by cropping the flag part. Second, the system does not automatically identify the flag to its respective country but lists the countries based on the color similarity. Users are then choose the right one.

For future work, we plan to make improvements in three main areas: segmentation, data generation, and feature extraction. We plan to improve segmentation to retrieve as much information as possible from the area considered part of a flag. For data generation we plan to base the sectioning of plain images more on the actual characteristics of the flags, which should reduce the number of references and increase the system's performance. For feature extraction we plan to add an algorithm to weight colors according to a degree of fulfillment.

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Figure 5. Samples of first 10 outputs after cropping and classifying real photos.

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