Anglo-American Playing Cards Identification Based on Counting Each Symbols and Scale Invariant Feature Transform (SIFT)

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***Abstract*—This paper is inspired by detection and identification of Anglo-American playing cards from an image using an entry-level webcam and computer vision. Some authors have been made algorithms for playing card recognition, but the solution of playing card detection and recognition is still in progress. Although one could think of methods, which classify using the upper left and lower right corners of the card where the numbers are, this paper focuses on the novel method. Without reading the card code, we counted each individual symbols in the playing card. We implemented this algorithm in Matlab solving two parts: Locating the card on the image obtained in a controlled environment, and recognizing the cards. The recognition of playing cards was achieved through thresholding combined with color segmentation and the counting of the symbols in playing cards from one to ten and using SIFT for another playing cards.**

***Index Terms*—Image Processing; Playing Card Detection; SIFT.**

I. Introduction

There are numerous games which use playing cards to play: One kind of playing cards is French playing cards that arrived in Europe from Mamluk Egypt around 1370 and reported in France in 1377. The Anglo-American deck is based on the French deck. One deck regularly contains 52 playing cards clustered into four suits. Each suit includes thirteen ranks of each of the four Anglo-American suits: clovers or clubs (♣), pikes or spades (♠), tiles or diamonds (♦) and hearts (♥). The suits are clearly represented by two colors: clovers and pikes with black and diamonds and hearts with red. Besides, the suit includes numbers from two to ten, an Ace and three cards with a face of Rouennais court; the Knave or Jack, the Lady or Queen, and the King.

Playing cards recognition using techniques of computer vision is a topic widely studied in different contexts. Brinks & White in [1] detected and identified playing cards with techniques as corner detection and template matching in Matlab. Poker & Blackjack (or "21") are two of the best-known games that are played with Anglo-American deck. Poker is an interesting field for artificial intelligence research. Martins, Reis and Teófilo presented in [2], the recognition of playing cards through template matching, while count chips with color segmentation in a poker game environment. Some special features were used in [3] to rotate and improve the poker playing cards recognition scheme.

In [4], Kim & Suzuki performed a visual perception system of the humanoid playmate to implement the recognition of the human nonverbal behaviors and poker card suits. In [5], Zheng & Green proposed a rotational invariant template matching to enable playing card recognition that covers character segmentation, affine transformation, template matching and edge detection, but the technique did not handle face cards well. A novel Blackjack analysis system was presented in [6], but the system only detected the existence of cards and chip stacks. In [7], Geoff Hollinger and Nick Ward developed an implementation of a Card Recognition System using Computer Vision Techniques to Blackjack. The authors in [8] described a vision system that can identify card counters and also dealer errors in Blackjack game with a combination of techniques as contour analysis, template matching and SIFT algorithm to recognize the cards. Cooper & Dawson-Howe [9] built a system that recognized cards on a special Blackjack table. Another kind of cards are called SET, in [10] researched how these SETs can automatically be detected from an image using Computer Vision, dealing with three problems sequentially: the locating of cards on the image, the classification of the cards and the finding of SETs amongst the cards.

Our algorithm counts the total number of cards in the workspace. Two processes are developed. The first process focuses on identifying the face cards and ace pike, where we identified the playing cards through in invariant features, in particular the Scale-invariant feature transform (SIFT) [11]. SIFT is a computer vision algorithm that is invariant to rotations, scaling transformations and robust to small and illumination variations and perspective transformations. SIFT descriptor is very useful for object recognition and image matching.

The second process is for playing cards from one to ten. First, we counted all the symbols in each card. Then, the properties of the color and area of an individual shape were classified individually.

This paper is organized as follows: Section II provides the detail of the steps of the algorithm in Matlab. Section III shows the experimentation and in Section IV presents the conclusions.

II. Experimental

The application includes:

i. Environment and template.

ii. Counting cards presented in the workspace.
- Binary image Thresholding.
- Filtering image.
- Filling image region and labeling.
- Inverting and cutting.

iii. Identification cards.

A. Controlled Environment and Template

The environment of the scene has been controlled, consisting of a green rug (workspace). It is useful for card segmentation. Images were acquired using an entry-level camera in Matlab RGB24_640x480 format.

The templates are for face cards (J, Q, K and Pike Ace).

B. Counting Cards Present in the Workspace

Binary Image Thresholding. The purpose of Thresholding was to extract those pixels from some images, which represent an object (playing cards). Binary Thresholding was performed using Otsu's method which exhaustively search for the threshold to minimize the intraclass variance of the black and white pixels. Thresholding erased some noise. We converted the RGB image (that have Red-Green-Blue channels) to a binary image. The output image replaced all pixels in the original image doing a threshold where white cards were represented in a binary image as white and replaces all other pixels with black.

Filtering Image. A slightly filter was performed to remove particles in the scene. Filtering was a neighborhood operator and the output pixel value was determined by the application of a specific algorithm to neighboring pixels.

Filling Image Region and Labelled. The function in Matlab was based on morphological reconstruction. It performed a flood-fill operation on binary images. It changed the connected background pixels (zeros) to foreground pixels (ones), stopping when it reached the object boundaries. The connectivity determined the boundary for fill operation. After filling the holes, we labeled the connected components in 2-D binary image using a function that uses the procedure outlined in Matlab: This was a method for identifying each object in a binary image. Each detected part above a level of pixels was stored as it was a mask that corresponded to the detected playing card.

Inverting and Cutting. For the subsequent counting process, we inverted the image (counting is made with white parts). Morphologic sum between the inverted image and a black image was performed.

The extraction of the playing card was done with the mask obtained before.

C. Identification Cards

To separate the analysis between the playing cards with the numbers and with faces, we searched if there was a very large area in the card, the part of the algorithm that evaluated the card through SIFT algorithm will be run.

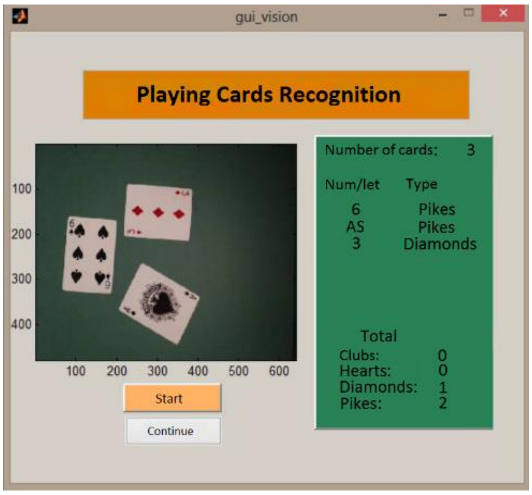
Playing Cards from One to Ten. The opening and closing processes were executed. These operations remove small objects from one image, while the shape and size of large objects were preserved. Closing was a dilation plus an erosion while an opening was an erosion plus a dilation that applied the identical structuring element. After that, we counted the symbols on the region that identifies the number on the playing card. One of the symbols was extracted from the original image.

The suit was defined by color and area. Playing card was characterized by its color and shape. We used the histogram for color segmentation. It was a representation of the distribution of range colors in an image. In histogram, thresholding different color ranges was represented to make regions of an image. The area of the symbols was used to classify between hearts and diamonds, the least of them was the diamond.

Playing Cards with Faces. We used SIFT algorithm for this process because it is a rapid fast image recognition that relies upon feature point calculation and comparison, and SIFT has already been implemented in Matlab. We can define the keypoints that characterize the image that can then be located although there are rotations, scale and illumination changes and partial occlusions. Feature description was created with the object interesting points. This description obtained from a training image was used to identify the object. The features usually stayed on high contrast spaces as object edges.

III. Results And Discussion

We developed a GUI (Graphical User Interface) in the Matlab Software (Figure 1).



Number of cards: 3

Num/let	Type
6	Pikes
AS	Pikes
3	Diamonds

Total

Clubs:	0
Hearts:	0
Diamonds:	1
Pikes:	2

Figure 1: Graphical User Interface in Matlab

The algorithm was setup by pressing the Start button. The interface displays the information as total cards, the suit to which they belong and which playing card was specifically (number/letter and type) identified.

The phases are detailed in the Figure 2. First, we counted the total playing cards in the workspace, for that some vision techniques were applied: Thresholding with a suitable level, filtering, morphological operations like dilate, erosion, and, not, counting regions.

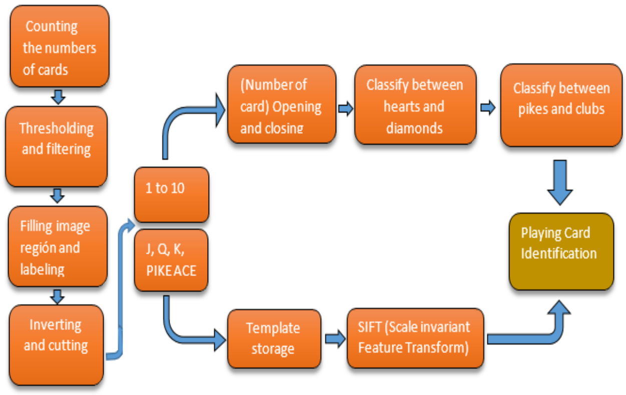

Counting the numbers of cards
Thresholding and filtering
Filling image región and labeling
Inverting and cutting
1 to 10
J, Q, K, PIKE ACE
(Number of card) Opening and closing
Classify between hearts and diamonds
Classify between pikes and clubs
Playing Card Identification
Template storage
SIFT (Scale invariant Feature Transform)

Figure 2: Block diagram of the processes of the algorithm

Table 1
Result of playing card identification

N	Description	Identification (Detected/Total samples)
1	Number cards	38/40
2	J Q K Ace	10/10
3	Clubs	10/10
4	Pikes	10/10
5	Diamonds	09/10
6	Heart	08/10
7	Occluded	Not identified

In one experiment, the algorithm worked with three playing cards. All individual phases of the algorithm are displayed in Figure 3: a) Original Image was acquired by entry-level camera. b) Binary image using Otsu's method was applied to RBG image. c) Filtered image for removing noise. d) Filled image and labeled image, the result was a black image with only white shapes. e) Inverted image for counting the symbols. f) And operation was performed to eliminate the background. g) Mask for extract card from the original image. h) A card that was detected. i) Image was obtained to identify the number of playing card. j) Suit was identified through color and area segmentation. k) Face was identified through SIFT algorithm.

Several tests were done by selecting the deck random card (Table N1). The program can identify many cards at the same time. The card q j k ace and the number cards were detected well in the experiments and problems arise when the card was occluded. Occlusion refers to impede viewing of symbols in the card, but not occluding the letter code as this part was not used in the processing. The six cards of heart have an error, the program identified it as the six of diamonds. The same happened in reverse.

IV. Conclusion

The implemented application is a creative method to identify playing cards that works satisfactory in a controlled environment. Our algorithm does not take the letter code presented in two of the corners of the card. The application gives an intuitive interface in Matlab, where it is possible to see the types of card and the number of cards for each suit. The recognition is better for images with low noise. Changes occur in the orientation or illumination because bad identification in numbers playing cards, but a face card recognition that uses SIFT works well. An improved paper should separate the rectangular shapes when they are slightly occluded.

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References

[1] Brinks Dan and White Hugh. 2007. Texas Hold'em Hand Recognition and Analysis.

[2] Martins, P., Reis, L. P., & Teófilo, L. 2011. Poker vision: Playing Cards and Chips Identification Based on image processing. In Pattern Recognition and Image Analysis Springer Berlin Heidelberg. 436-443.

[3] Chen, W. Y., & Chung, C. H. 2010. Robust Poker Image Recognition Scheme in Playing Card Machine using Hotelling Transform, DCT and Run-length Techniques. Digital Signal Processing, 20(3):769-779.

[4] Kim, M. G., & Suzuki, K. 2012. A Card-playing Humanoid Playmate for Human Behavioral Analysis. Entertainment Computing, 3(4):103-109.

[5] Zheng, Chunhui; Green, Richard. 2007. Playing Card Recognition using Rotational Invariant Template Matching. En Proc of Image and Vision Computing New Zealand, 276-281.

[6] Zaworka, Arno; Scherer, Stefan. 2001. Machine Vision Driven Real-Time Black Jack Analysis.

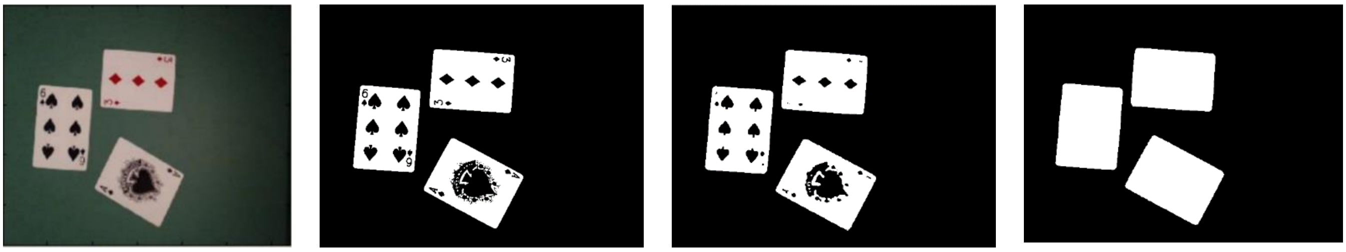
[7] Hollinger, G., Ward, N., & Everbach, E. C. (2003). Introducing Computers to Blackjack: Implementation of a Card Recognition System using Computer Vision Techniques. Colby College, Waterville.

[8] Cooper, Wesley; Dawson-Howe, Kenneth. 2004. Automatic blackjack monitoring. En Proc. of Irish Machine Vision Conference. 248-254.

[9] Zutis, K., & Hoey, J. 2009. Who’s counting? Real-time Blackjack Monitoring for Card Counting Detection. In Computer Vision Systems Springer Berlin Heidelberg. 354-363

[10] Kool, Wouter. 2013. Analytics, Master Business. Automation of the SET Card Game.

[11] Lowe, D G. 1999. Object Recognition from local Scale-Invariant Features. The Proceedings of the Seventh IEEE International Conference In Computer Vision. 1150-1157.

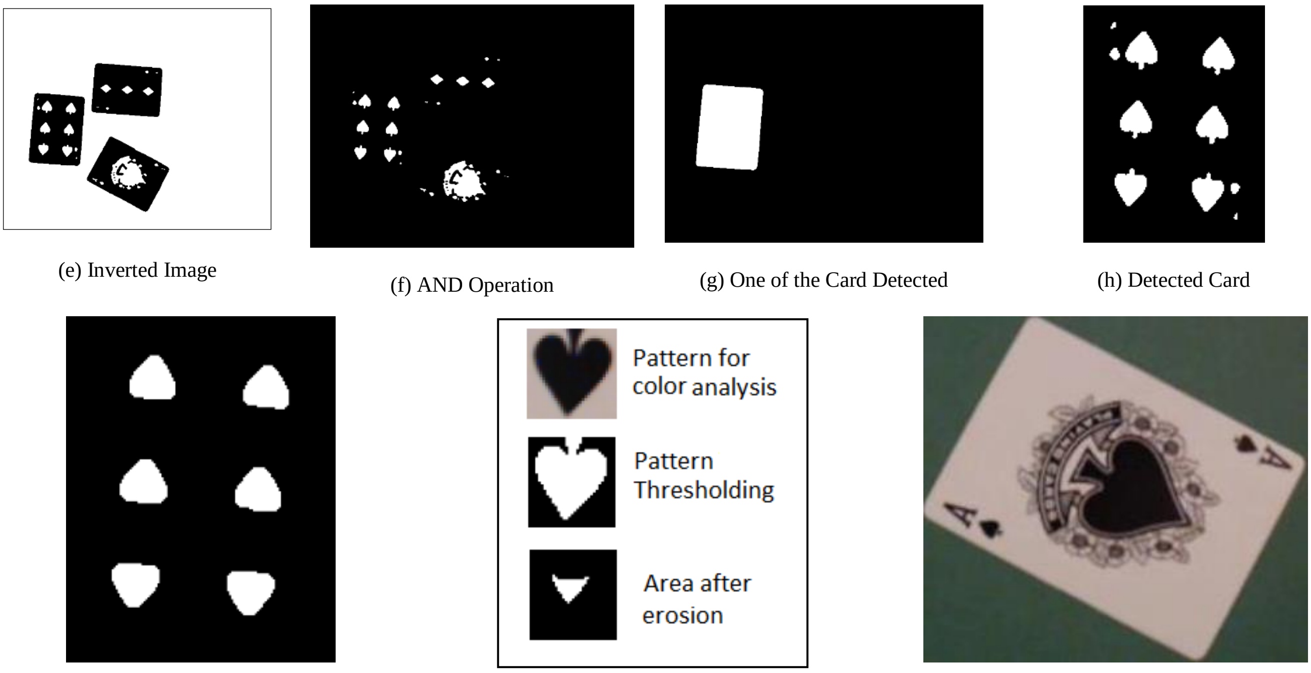


a) Original Image

(b) Binary Image

(c) Filtered Image

(d) Filled and Labelled Image



(e) Inverted Image

(f) AND Operation

(g) One of the Card Detected

(h) Detected Card

(i) Image After Opening and Closing

(j) Suit Identification

(k) Section for Face Identification

Figure 3: Phases of the playing card Detection