

# Classification of the Latin alphabet as Pattern on ARToolkit Markers for Augmented Reality Applications

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**Abstract**—augmented reality is a technique used to insert virtual objects in real scenes. One of the most used libraries in the area is the ARToolkit library. It is based on the recognition of the markers that are in the form of squares with a pattern inside. This pattern which is mostly textual is source of confusing. In this paper, we present the results of a classification of Latin characters as a pattern on the ARToolkit markers to know the most distinguishable among them.

**Keywords**—ARToolkit library, augmented reality, K-means, patterns

## I. INTRODUCTION

THE specificity of augmented reality versus virtual reality is that the first aims to increase user's view by adding virtual objects while the world of the second is completely artificial. It is therefore matter in augmented reality to mix the real and the virtual [1].

In augmented reality-based marker (like what is shown in Fig.1), it is matter to detecting a marker along a video clip while inserting a virtual object in each frame in its hypothetical location relative to the marker.



Fig. 1 augmentation based marker (left figure contains a marker, and the right shows the same scene after augmentation) [2]

### A. Application fields

The application areas of augmented reality are many, we found in particular applications in medicine, maintenance, industry and also entertainment [3].

## II. ARTOOLKIT LIBRARY

ARToolKit [4] is a software library for making augmented reality application. In these applications it is always matter to overlay virtual images on the real world. For example, the right image of Figure 1 shows a three dimensional virtual character appears standing on a marker of the real scene. It can be perceived by the user through the head mounted display he wears. When the user moves the marker, the virtual character moves with, and seems to be attached.

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One of the difficulties in developing augmented reality applications is tracking viewpoint of the user to know the exact position of the virtual image. The application therefore needs to know at all times the user's position in the real world.

ARToolKit uses computer vision algorithms to solve this problem. It can calculate the position of the real camera and its orientation relatively to physical markers in real time. This allows easy development of a wide range of applications of augmented reality.

ARToolKit has the following characteristics [5]:

- Use of a single camera for identification and tracking..
- Use of simple black square called markers.
- Possibility to use patterns on square markers.
- Fast enough to create real-time augmented reality applications.
- Portability across different operating systems (Linux, MacOS, Windows ...).

### A. Application fields

The ARToolKit algorithm performs a sequence of operations on each video frame to detect the presence of a marker, and identify it between a set of different markers loaded into multi-markers application (Fig. 2) :

- The camera captures the video and sends it to the computer.
- The program proceeds to image's binarisation and lists all the black borders in each video frame.
- For each frame, the program uses mathematical formulas to determine marker's position and orientation with respect to the camera.
- The pattern present within each frame is compared with the patterns loaded into the program in order to associate its own virtual augmentation.
- This augmentation, which generally takes the form of a 3D object is then generated from the position and orientation of the marker and is superposed on the captured image. Its position, orientation and scale are adjusted relatively to the marker in real time.

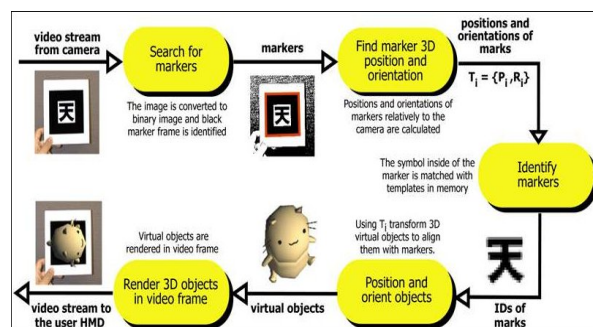


Fig. 2 functional principle [5]

III. MEASURES

Markers that we propose to use are made as shown in Fig.3, with a framework that respects the standards used in ARToolkit, namely a border of width equal to one quarter of the total width of a marker and with a letter of the Latin alphabet inside.

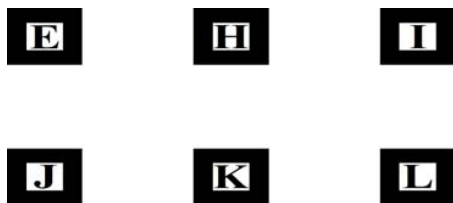


Fig. 3 Examples of markers used in our study

Since it is question in our study of textual patterns of markers, the basic element of a pattern can only be a letter of the alphabet that is why we proposed to compare markers each having a single letter.

During the creation and use of markers, we made sure to respect number of constraints:

- The letters used as a ground on the different markers all have the same size and same font type (Times New Roman).
- The markers are printed on the same type of paper (same brightness) to ensure they have the same contrast black and white.
- A simple single camera was used for all measurements.
- All measurements were performed under the same photometric conditions.
- Measurements were taken with the same distance, thirty centimeters from the camera.

IV. EXPERIMENTAL RESULT

To perform the experimental study, we first set the parameters of ARToolkit to detect a marker with the letter A as a pattern, and we measured each time the degree of similarity with a marker that has as a pattern another letter of the alphabet. The similarity measure calculated is the same used in the ARToolkit library.

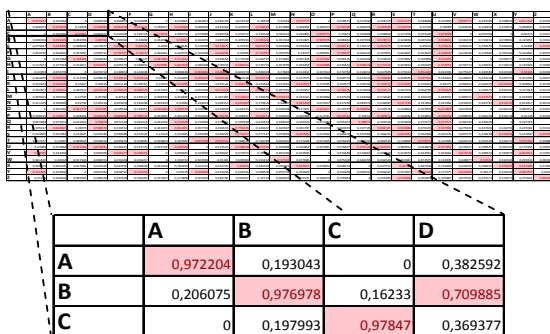


Fig. 4 Measured values of similarity between the letters of the Latin alphabet realized experimentally. The color values are where there is confusion between markers by considering the value 0.5 as the threshold

We've made it as explained in the previous section (Measures) to respect the same distance, the same photometric conditions and use the same camera to eliminate factors that may influence the measurements. Then we noticed the results in a table where the line representing the reference pattern and patterns the columns compared to this one and we repeated the process for all letters of the alphabet. So we got the table shown in Fig.4.

From this table, if you take the marker having the character B as reference marker (the second row of the table), its degree of similarity to the marker with the letter A as pattern is 0.206075 and with the marker having the letter D as pattern is 0.709885.

By applying the K-means algorithm on the table of obtained measurements (Fig. 4), and since the algorithm must have the number of classes as input, we obtained the following:

- For a number of classes equal to two:

Class 1: A I J N S T V W X Y Z  
 Class 2: B C D E F G H K L M O P Q R U

- For a number of classes equal to three:

Class 1: A I N T V W X Y Z  
 Class 2: B E F J K L M P R S  
 Class 3: C D G H O Q U

- For a number of classes equal to four:

Class 1: A I N T V W X Y Z  
 Class 2: B E F J K L M P R S  
 Class 3: C G O  
 Class 4: D H Q U

- For a number of classes equal to five:

Class 1: A I T V W Y Z  
 Class 2: K M N R S X  
 Class 3: C G O  
 Class 4: D H Q U  
 Class 5: B E F J L P

- For a number of classes equal to six:

Class 1: A I T V W Y  
 Class 2: K M N R S X Z  
 Class 3: C G O  
 Class 4: D H Q U  
 Class 5: B E L  
 Class 6: F J P

- For a number of classes equal to seven:

Class 1: A I T V W Y

Class 2: K M N R S X Z

Class 3: C

Class 4: D H Q U

Class 5: B E L

Class 6: F J P

Class 7: G O

- For a number of classes equal to eight:

Class 1: A I N T V W X Y

Class 2: B S

Class 3: C

Class 4: D Q U

Class 5: E L Z

Class 6: F J P

Class 7: G O

Class 8: H K M R

- For a number of classes equal to nine:

Class 1: A N V W X Y

Class 2: B S

Class 3: C

Class 4: D Q U

Class 5: E L

Class 6: F J P

Class 7: G O

Class 8: H K M R

Class 9: I T Z

- For a number of classes equal to ten:

Class 1: A N V W X Y

Class 2: B S

Class 3: C

Class 4: D Q U

Class 5: E L

Class 6: F P

Class 7: G O

Class 8: H K M R

Class 9: I T

Class 10: J Z

- For a number of classes equal to eleven:

Class 1: A V W Y

Class 2: B

Class 3: C

Class 4: D U

Class 5: E L

Class 6: F P

Class 7: G O

Class 8: H Q

Class 9: I T

Class 10: J Z

Class 11: K M N R S X

- For a number of classes equal to twelve:

Class 1: A V W Y

Class 2: B

Class 3: C

Class 4: D U

Class 5: E

Class 6: F P

Class 7: G O

Class 8: H Q

Class 9: I T

Class 10: J Z

Class 11: K M N R S X

Class 12: L

- For a number of classes equal to thirteen:

Class 1: A V Y

Class 2: B

Class 3: C

Class 4: D U

Class 5: E

Class 6: F P

Class 7: G O

Class 8: H Q

Class 9: I T

Class 10: J

Class 11: K N R S X

Class 12: L

Class 13: M W Z

- For a number of classes equal to fourteen:

Class 1: A V Y

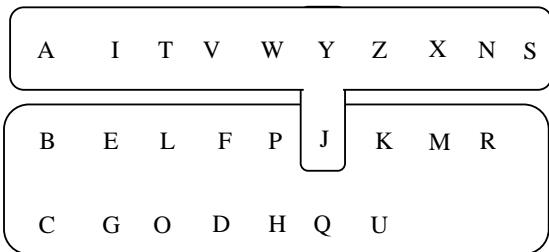
Class 2: B

- Class 3: C
- Class 4: D U
- Class 5: E
- Class 6: F P
- Class 7: G O
- Class 8: H Q
- Class 9: I T
- Class 10: J
- Class 11: K R
- Class 12: L
- Class 13: M W Z
- Class 14: N S X

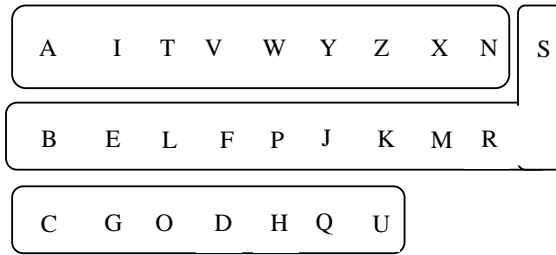
- For a number of classes equal to fifteen:

- Class 1: A V Y
- Class 2: B
- Class 3: C
- Class 4: D U
- Class 5: E
- Class 6: F P
- Class 7: G
- Class 8: H
- Class 9: I T
- Class 10: J
- Class 11: K R
- Class 12: L
- Class 13: M W Z
- Class 14: N S X
- Class 15: O Q

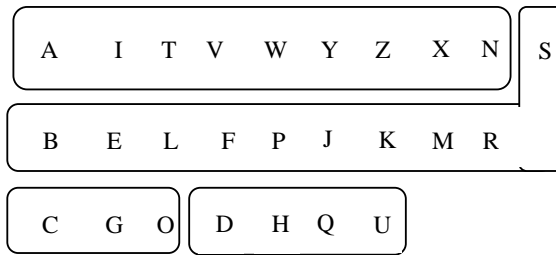
The following figure (Fig.5) illustrates this graphical composition.



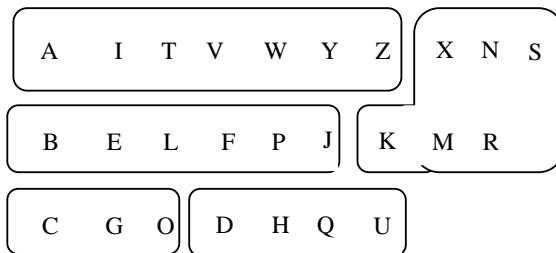
2 classes



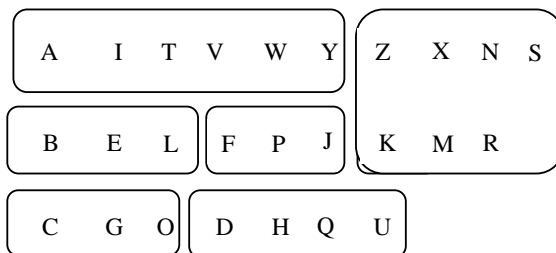
3 classes



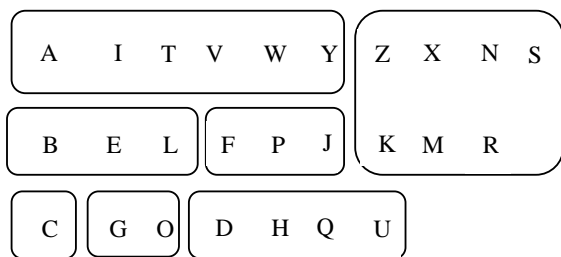
4 classes



5 classes



6 classes



7 classes

Fig. 5 Classification of the Latin alphabet by the K-means algorithm

The threshold at which the system considers that there is a similarity between the patterns of markers will allow us to decide on how many classes to take.

We will consider the value of the threshold at which the system assumes that there is a similarity, equal to 0.5 (default value of the ARToolkit library), since if we increase the threshold, it is true that the risk of having wrong marker decreases, but instead the system may have difficulty detecting a given marker at a small angle or at a great distance, so there is a compromise that the threshold should not be too big or too small and the default library seems to be logical. In this case, we can see on the table that there is confusion between patterns B and D. color values are precisely the cases where the system confuses between markers. For example on line A, there are five color values, then the letter A can be confused with the letters N, S, V and Y.

Considering the color values (values that the system was wrong of markers considering the threshold equal to 0.5), we were able to match these results with those obtained by the K-means algorithm, which allowed us to select the classification into seven classes:

Class 1: A I T V W Y

Class 2: K M N R S X Z

Class 3: C

Class 4: D H Q U

Class 5: B E L

Class 6: F J P

Class 7: G O

## V.CONCLUSION

At the end of the previous section, experimental results have allowed us to make the following conclusions:

- The textual pattern of ARToolkit markers are sources of potential confusion.
- The Latin alphabet can be composed into seven distinct classes of letters that can be confused between them.

- To reduce the possibility of confusion, it is recommended to use letters of different classes and it is especially advisable to use letters from small class cardinalities. The 'M' is a typical example.

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