Improve Template Matching Method in Mobile Augmented Reality for Thai Alphabet Learning

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Abstract

Due to Thai government policy give tablets to first grade students for use in learning and teaching. Mobile-augmented reality is used to help teach a powerful one. However, the most application programs are applied in English when used with the Thai alphabet is a decrease in performance. Therefore, we are developing template matching base-on ARToolKit used for Thai alphabet learning on mobile augmented reality. Especially, we are focusing on improvement character recognition for Thai alphabet learning, which enables extract character image as marker from mobile camera. To increasing the recognition rate of Thai alphabet base on ARToolKit by group similar shape for identifying each group of character. To dissimilarity, we propose a structured template matching technique for recognizing features such as knot of character. In this paper, we describe an abstract of our proposed method and present its experimental results.

Keywords: *Augmented reality, Mobile application, Template matching*

1. Introduction

Recently, new learning media and education system for the study were presented in various forms such as e-books, mobile phones, distance education, and so on. A new concept in educational system is how to collect of teaching and learning using information technology. Mobile learning, or m-learning, can be any educational interaction delivered through mobile technology. The software that underlies m-learning includes not only mobile applications designed specifically for learning purposes but also those designed for other uses that can be adapted for educational purposes.

Mobile Augmented Reality for Education [1, 5, 6, 7, 8] is a relatively young technology, but it has currently being used in disciplines such as medicine, engineering, tourism, and archeology, where these technologies help bring large data sets to life. The technologies are literally changing the way we see the world by creating 3D representations of complementary information and meaning that may not be possible to see by natural means merged into our visible reality. Furthermore, the possibility of incorporating touchscreens, voices and interaction have demonstrated the educational potential that scholars, teachers and students are embracing.

Development of various mobile augmented reality applications was created to be used as required for example a MARS eLearning architecture from Georgetown University and the Juxtopia Group, Inc. was used to guide workers to complete a wire harness assembly task, the Magic Book also exhibited great potential of AR in educational application [11], AR for Chinese phonetic alphabet learning provides a scenario for children’s collaboration to process exercises [3]. There were many applications in AR using ARToolKit [4] but it have limited for increase library and its marker.

In this paper, we propose a new education tool that combines a mobile application for learning of the 44 consonants of the Thai alphabet with augmented reality technique. It is a technique which superimposes characters, images, and objects onto a real world environment. In addition, we analyzed the identification processes of the markers of ARToolKit, designed and implemented the matching of marker. The markers were made by printed Thai alphabets. The method simplifies the process of identification and improves the accuracy of marker identification. The experiment result shows accuracy recognition of printed Thai alphabet maker which the graph is shown comparison of ARToolKit and our method in performance.

2. M-learning and Augmented Reality

Mobile technologies can be integrated into training deliveries to make learning more accessible and portable. An m-learning approach should be deployed only to enhance the training strategy or authentic context for delivery so that learners are provided with opportunities to work from location or work. Deploying m-learning materials can support equal access to learning by providing materials in a range of formats. An m-learning approach should respond to and address the diversity of the learner group, learning needs and styles. M-learning should be deployed to provide situated, relevant and flexible learning activities that enhance contextual learning and communication and learning opportunities between and amongst learners and trainers.

In this work, we propose a method for mobile experiences through the use of augmented reality as a learning tool for Thai characters knowledge through experiential learning. Learner can interact and react in a basic way with their natural environment while mobile augmented reality system digitally annotates real-world objects with digital content. This digital content, which each letter is named after something for example, Gor Gai, "Gor" is the sound that letter makes and "Gai" is a chicken, represents with multi-modal graphics.

There are two parts to developing experiments which we use ARToolKit; writing the application, and training image-processing routines on the real world markers that will be used in the application. Training pattern phase is largely simplified with the use of simple tool. The augmented reality system is shown in Figure 1.

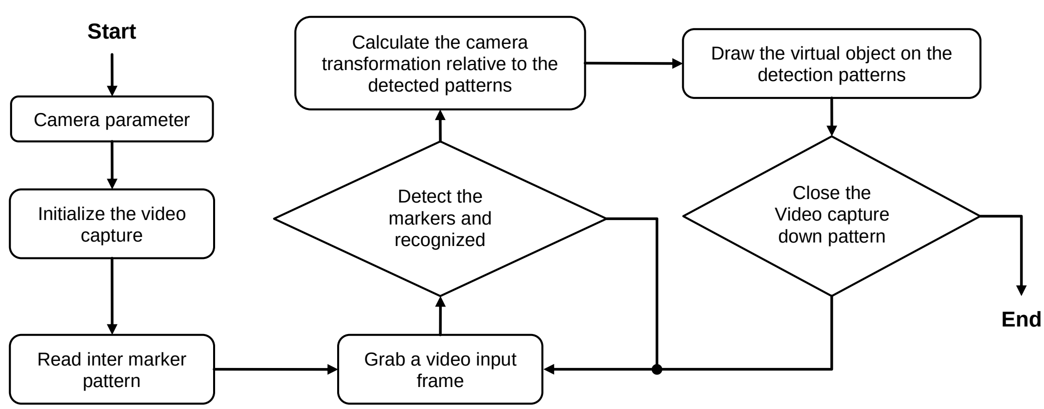

Figure 1. Augmented Reality System

2.1. Display Virtual Object in Scene

The augmented virtual objects must remain aligned with the observed 3D positions and orientations of the real object accurately, even when users move their viewpoint quickly. The basic procedure of augmented reality is first calculate the affine transformation of virtual model to camera plane, according to the location of the camera and marker information in the real world. Then, draw virtual model on the basis of affine transformation matrix. Finally, organically combine the video of real world and virtual model, and display it on the terminal screen. The concrete flow of augmented reality is divided into the following four steps :

2.1.1. Get Real-world Information: It is through input devices such as image sensors to collect and to enter real-world information mainly.

2.1.2. Analyze Real-world and Camera Position Information: This step is mainly through image recognition technologies, to analyze real world and the camera position information, and to get the information of virtual model's location.

2.1.3. Generated Virtual Model: Generate a virtual model with the location of the virtual model.

2.1.4. Integrate Virtual Model into the Video: Finally, organically integrate the virtual model into the video and display it on the terminal screen.

The basic workflow chart of augmented reality is shown in Figure 1.

2.2. Design of Marker

The makers for augmented reality applications are very important. We created the markers by editing the template provided in ARToolKit[2] since the inner region of the marker is interpreted by Thai alphabet. There are 44 Thai characters that are shown as Figure 2.

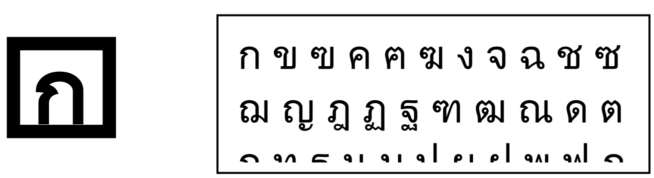

Figure 2. Marker Example and Thai Alphabet

Most Augmented Reality systems also work if only one marker is visible. The marker carries less information in AR applications, typically only an id to distinguish it from other markers. Hence the marker must have some distinct points, at least four, to allow for camera-marker pose calculation. Usually such markers have a quadrilateral outline, and the four corner points are used for three-dimensional pose calculation. The AR marker system flow diagram is showed in Figure 3.

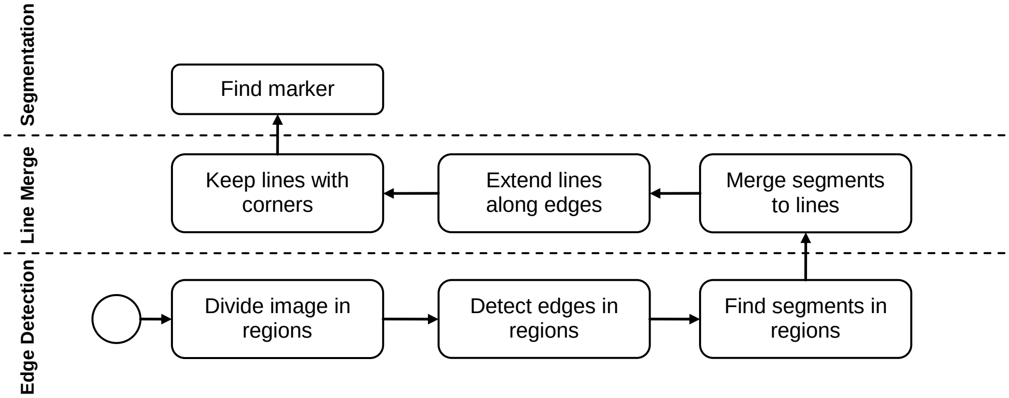

Figure 3. Marker Detection Diagram

The figure shows the method to find marker which it can be divided into the following seven steps. First the image is divided in small regions since the next 3 steps are executed apart inside these regions which boost the performance dramatically. Second, edge detection is used by a derivative of Gaussian, convolved on each scan line to estimate the component of the intensity gradient along the scanline. Third, the segmentation was found by a RANSAC-grouper algorithm which is used to construct line segments in each region [12]. Fourth, the separate lines were merged together and redundant stations were cut out. Fifth, the lines are extended along the edges, then keeps the line with corners. Final step is registration of all markers in the image.

3. A Method for Similarity-based Grouping

To improve the accuracy of Thai alphabet recognition, the character must be grouped by find similarities and spilt into small group. The features to measure the similarity are shown in figure 4.

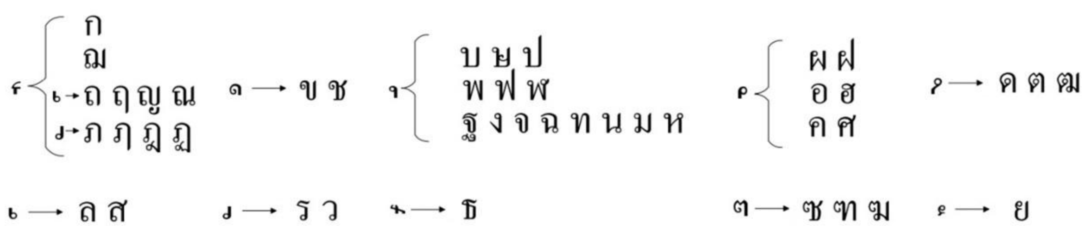

Figure 4. Knot Feature and Similarity Grouping

Separation characteristics of the text are divided into 10 groups and each group can be divided in a letter to another. For example, the feature is  and  the letter, which takes into groups ถ ฤ ญ ณ template letters in the group that these were tested for recognition [13].

4. Structure Template Matching

In this paper, we have added features to enhance the efficiency of matching method. The first matching extracts candidate areas thoroughly including a small part of character by nonlinear heuristic filtering with micro-block templates.

This process determines whether feature template values of each pixel block have feature characteristics or not, by heuristic filtering.

The micro-template matching defines binary mask value *M(x,y)* for given 256 gray-scale image $I(x,y)$ $(0<=x<=Nx-1, 0<=y<=Ny-1)$

In case of *4x4* pixel micro-template, we define *2x2* inside pixels as *A(I)* and the other 12 outside pixels as *B(I)*. Using these pixel values, we calculate the following 7 statistical parameters: minimum/maximum/average/ value of outside and inside pixel, and standard

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Then, we have to consider both two kinds of candidate patterns, the inside part is brighter than the outside and its negative pattern. In order to determine some pixel (x,y) included in candidate *M(x,y)=1*, the following 5 conditions should be satisfied using the 7 predetermined slice levels.

M(x,y) = 1 ::
if *|ave(B(I)-ave(A(I)| > average slice level* **or** *max(B(I)-min(A(I)>std slide level*
if *(max(B)-min(A)>max(A)-min(B))***or** *max(A(I)-min(B(I)>std slide level*
if *(max(A)-min(B)>max(B)-min(A))***or** *ave(B) > std outside slide level*
and *ave(B) < max outside slide level* **or** *ave(A) < min outside slide level*
if *ave(B) > ave(A)* **or** *ave(A) > min inside slide level*
if *ave(A) > ave(B)* **or** *std(A) > std inside slide level*

These kinds of slice levels can be defined interactively by indicating areas where target character are included on the image displayed screen. For each pixel in our indicated areas, we calculate the 7 statistical parameters based on the equation 1, and using either the minimum or maximum statistical parameters, we can define the slice levels as the following.

*average slice level = min(|A-B|)*0.9*
*std outside slide level = min(R1,R2)*0.9*
R1 = max(B)-min(A), **if** *max(B)-min(A)>max(A)-min(B)*
R2 = max(A)-min(B), **if** *max(A)-min(B)>max(B)-min(A)*
*min outside slide level = min(ave(B)*0.9)*
*max outside slide level = max(ave(B)*1.1)*
*min inside slide level = max(ave(A)*1.1) if ave(B) > ave(A)*
*max inside slide level = min(ave(A)*0.9) if ave(A) > ave(B)*
*std inside slide level= min(std(A))*0.9*

In case of the pixel value of given grey level image is between 0 and 255, we give typically these slice levels vector as *[15, 80, 100, 160, 35, 245, 10]*.

The second matching removes excessively matched relatively large candidate areas, which do not include a small part of object with multiple 8-neighbored connected micro-block templates.

This process also can be made at very little calculation load and decrease more the following third matching load.

The third matching is a macro-template matching whose size is almost the same as target character, and it identifies each character in the segmented candidate areas by the pixel-value correlation based pattern matching.

5. Experimental Results

The results show the recognition rate of Thai alphabet marker by improve matching template for AR eLearning system as shown in Table 1., which shows identification precision rates in three kinds of experiments whether adding a micro-template matching or a clustered micro-template matching. However, correct identification rate has been slightly worse, which should be improved in the future.

Table 1. Experimental Results

	ARToolKit		Our Method	
	Without Grouping	**With Grouping**	**Without Grouping**	**With Grouping**
Thai character	83.75%	87.56%	90.62%	95.75%
English character	97.5%	100%	100%	100%
Thai and English character	81.29%	85.43%	93.75%	95.34%

6. Conclusion

This paper has proposed improve template matching of mobile augmented reality for alphabet learning. The result shows our method is better than the original tool. For the future we will develop an interactive m-leaning system using recognition algorithms and augmented reality. The proposed m-leaning system provides students with realistic audio-visual content according to the recognition results. The proposed m-learning system has been applied to the public elementary school successfully. It is expected that the proposed m-learning system becomes popular faster, when recognition errors are reduced and authoring tools are provided to produce the educational contents and scenarios.

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