U-Learning 을 위한 스마트펜 인터페이스 시스템 디자인 및 개발

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Design and Implementation of Smart Pen based User Interface System for U-learning

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Abstract

In this paper, we present a design and implementation of U-learning system using pen based augmented reality approach. Student has been given a smart pen and a smart study book, which is similar to the printed material already serviced. However, we print the study book using CMY inks, and embed perceptually invisible dot patterns using K ink. Smart pen includes (1) IR LED for illumination, IR pass filter for extracting the dot patterns, and (3) camera for image captures. From the image sequences, we perform topology analysis which determines the topological distance between dot pixels, and perform error correction decoding using four position symbols and five CRC symbols. When a student touches a smart study books with our smart pen, we show him/her multimedia (visual/audio) information which is exactly related with the selected region. Our scheme can embed 16 bit information, which is more than 200% larger than previous scheme, which supports 7 bits or 8 bits information.

1. Introduction

Ubiquitous is from Latin 'ubique' that means ‘Something seems to be everywhere’. This environment means without regard to time and place, people can use various information and communication services with information networks. Anytime, anywhere users can communication using many devices and equipments to integrate computer and information technology in environment based ubiquitous networking technology. Ubiquitous computing enhances computer use by making many computers available throughout the physical environment, while making them effectively invisible to the user. [1]. Service environment migrate to ubiquitous system, also studying and learning system try to give more various multimedia information for students to learning efficiency. Most multimedia learning services have just one-way service that is hard to communication with students. In case of one-way communication service, sometime it can give unwanted information to students. There don’t know what students need.

In this paper, design and implementation of U-learning system using various multimedia and high-precision dot patterns, contain large amounts of information in print media, It is better than existing methods, what is insert the information in the exhibits and easy to deal with move the exhibits also it can search information through printed materials such as paper. This rest of this paper is organized as follows. Section 2 introduces related work and background about CMYK ink model. Section 3 we design of smart pen based U-learning system. Then we present implementation of smart pen based U-learning system in section 4 and final section concludes this paper.

2. Related Work

In this paper, we design recognition technique based camera-vision without additional hardware such as RFID. It is part of general pattern recognition method. Researchers were defined ‘Pattern recognition’, it is estimate of the density function in multidimensional space and space split problem into categories or classes [8]. Also other hand it is physical objects or events are assigned on one of several already fixed categories [9]. Pattern recognition, it means a set of sharing patterns classified of specific set, it is characteristics of individual objects, classes or categories, groups, labels [10]. Fu et al. [11] presented if Halftone image insert hidden data using DHAPT (data hiding smart pair toggling) and MDHED (modified data hiding error diffusion) that have similar quality with the original image.

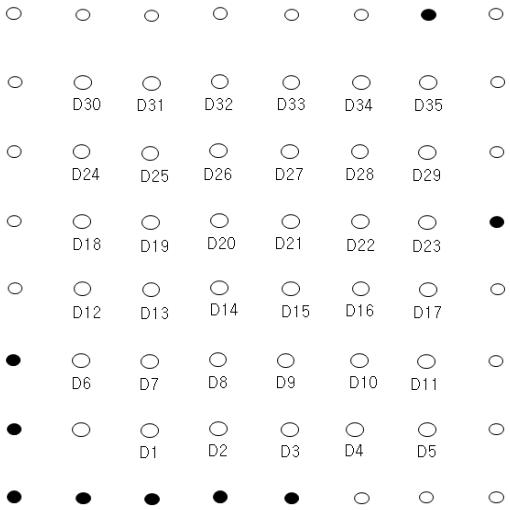
3. Design of Intelligent U-learning System

In this paper we design U-learning support system using smart pen applied to IR LED and IR pass filters with high-precision dot patterns in image or text data. It is transmitted to information search server Recognition of this patterns and

using this, search information data what is requested, and send to display.

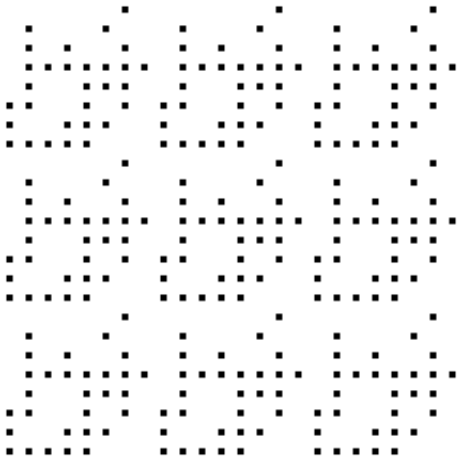
3.1. High-precision dot pattern for Data Representation

In this paper we use high-precision dot pattern for inserting data in printed materials. Figure 2 shows Configuration of high-precision dot pattern what is location of black and white points. Our pattern use 8x8 sizes of grid and outside guide line is used templates for correction using projective transformation. Templates detect and recognize image rotation and skew with camera position it is helping for searching inside data. Specifically the bottom of left side, "L" shape is template and two points at the top of right side, two black dots are used to purpose to determine the exact. Inside 6x6 sizes are used data location. It is configured total 35bit, 20bit data and 15 bit FCE (Forward Error Correction). If we want insert 1 data, marking the location and 0 data empty the location. The order of data insertion is insert 20bit data mod 4bit block and each block join 3bit CRC. Total, 35bit.data sequentially inserts data from bottom right and repeatedly inserts for physical damage.



(Figure 2) Configuration of high-precision dot pattern

Figure 3 shows an example of 20bit data of 0x53F24 using our high-precision dot pattern. Figure 3 is larger size then real for readability. Real size of each point is 0.032mm. It is most small size of printed printer.



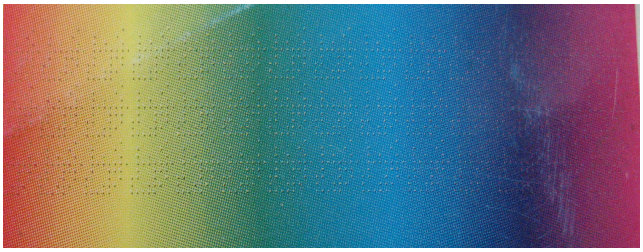
(Figure 3) 0x53F24data in high-precision dot pattern

3.2. Printing of study book

In this paper, our intelligent guide book system is easily printed by printer based CMYK (Cyan, Magenta, Yellow, Black) model. 4 color inks, it is used color ink jet printer and offset print, if we use IR pass filter we can't scan without K ink. Technically, IR pass filter normally respond carbons and color inks do not have carbons except black ink. That's why CCD in IR filter detects just black ink. In this paper we used K ink for insertion data in guide book.

(Figure 4) CMYK (4-COLOR PROCESS)

Figure 5 shows image that insert high-precision dot pattern using digital camera. It is hard to see the quality degradation with inserted patterns.



(Figure 5) Camera captured image

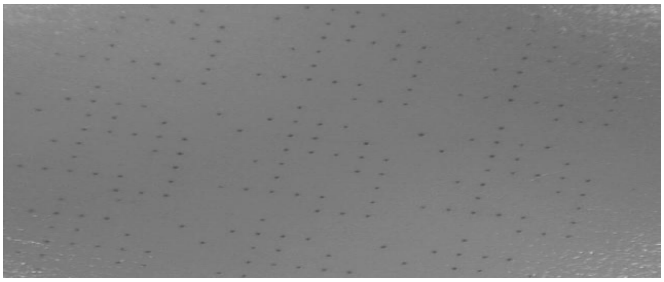
3.3. IR based Dot Pattern Recognition

In this paper, we had pattern recognition using topology Analysis to recognize the pattern in printed matter. The recognition scheme proposed in this paper, we made up of four sequential steps for this.

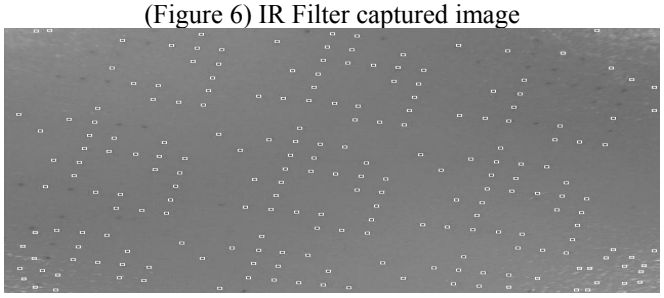
1. Image scan with IR pass Filter.
2. Detecting of Dot using Harris Corner Detector
3. Searching template
4. correction of projective transformation and to extract of data

First is a mechanical stage, we made smart pen applied to IR LED and IR pass filters in camera and USB interface. Figure 6 shows result image of a mechanical recording using IR pass filter. It confirmed the camera did not seem to respond without high-precision dot pattern, and pattern was

tilted about 80 degrees. Like this, when detecting high-precision dot pattern have some problems. One hand, detecting image has geometric distortion depending on the location. Another hand, texture has change with the amount of light. In the latter case we use strong IR LED for minimize the distortion of light, in the first case we use template, it can search start point. Figure 7 shows result of point detection using Harris Corner Detector. Each detecting point has a white square.

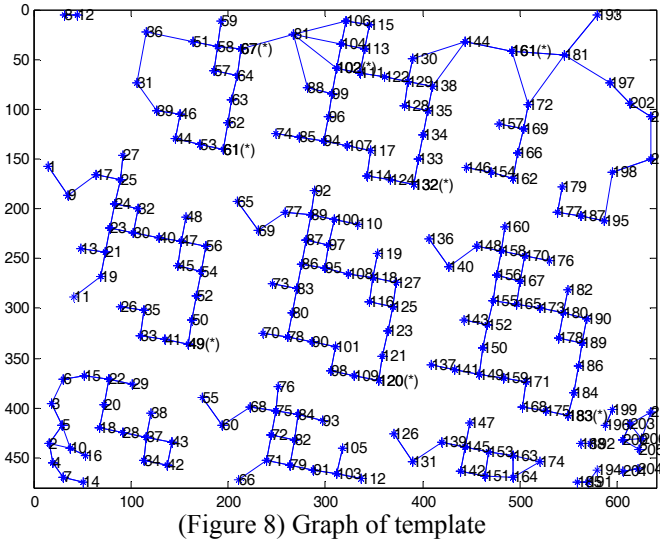


(Figure 6) IR Filter captured image



(Figure 7) Harris Corner Detector

Figure 8 shows result of searching template and drawing graph using data of high-precision dot pattern in Figure 9. Process of graph method is that between arbitrary point and nearest point is less than 1.2 time of minimum distance. Because if we don't have information about location, we have to check the arbitrary point is template or not with relationship of every points. But we would be able to reduce the search area with this processing. For example point 44 in Figure 10, if we try to know about it is a standard template point we need just to check a relation of point 46 and point 53. Because this processing checks nearest points and it is in the geometric line with them.



(Figure 8) Graph of template

Next step in this paper we have DFS (Depth First Search) using graph configured last step. In this case if it has many sub-nods, check gradient of between origin and now-node and find the smallest gradient with other sub-node. We can find location of arbitrary points with standard template point with vertical distance position and horizontal distance position We don't use camera image data for vertical distance position and horizontal distance position, we use origin high-precision dot pattern standard distance position we search the template, incremental of five horizontal points and three vertical points for this. In the template if we call class of horizontal points is H{h1, h2, h3, h4, h5…}and class of vertical points is V{v1, v2, v3…}, standard template point is P and incremental of horizontal and vertical are LH and LV we can express the following algorithm.

Algorithm: Data Decoding using Template

```
If (H== 5 && V ==3)
 then
   LH = [h5-h1]/4
   LV = [v3-v1]/2
End
```

Also we can get a data of location with LH and LV. For example if we want to get a data of location D8 in Figure 4 we can get this with following equation.. It finds sequentially location data of points D1 to D35 and system sands 20bit data to correct the error using CRC code.

$$Find(D8) = P + LH*3 + LV*2$$

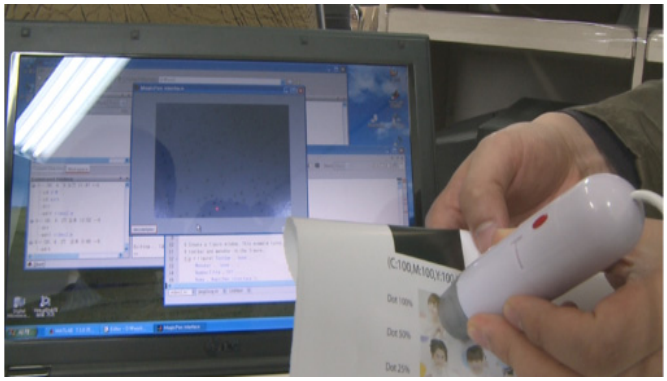
Looking at the template information in Figure 8, we can find eight standard template points 49, 61, 67, 102, 120, 132, 161, 183. But 67, 102, 161, there are not real standard template points just similar ones, and do not have two points on the top of right side in Figure 2, therefore system does not get to wrong data. Other five points are real standard template points but 61 and 132 do not have two points on the top of right side in Figure 2, therefore system does not get to data. Location of 49 point, it is real standard template point. But it gets the wrong data, because Harris Corner Detector does not find three points of data in Figure 7. Its real decoding data is 0x53D24. Wrong data are second, third, fifth 4bit data and CRC does not correct third data. Location of 120 point, it does not find one point in Figure 7, and it has error in fifth 4bit data but CRC corrects data and it has accurate data 0x53F24. Location of 138 point, it does not have error data thus data is correct.

4. Implementation of U-learning System

Figure 9 shows about the overall structure of the implemented system in this paper. Pattern set in the guide book, and is scanned the smart pen applied to IR LED and IR filters. Entering information to sever system it has analyzed patterns, and therefore received the desired information also it is broadcast to eyewear type display in this guide system

(Figure 9) U-learning system

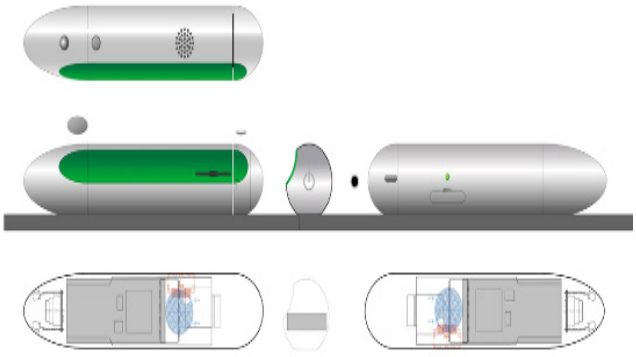
We design a program to check the accuracy of the input pattern and searching information with this. We make image it just used CMY ink because we insert high-precision dot patterns made by K ink in this image. And we set the program if system get pattern data then play video. Figure 10 is scanning pattern with the smart pen applied to IR LED and IR filters. And we ascertain that using this pattern information show a video media on display in Figure 11.



(Figure 10) Scanning pattern

(Figure 11) Search and play

Also we design our smart pen prototype. It is based normal pen type design and small hand digital microscope design. In front, IR filter lens with zoom camera surrounded by IR LED. Communication chip and other system chips are located in rear. If someone needs just audio U-learning information service system it has option for speaker system. Figure 11 shows our smart pen outline design.



(Figure 12) Smart pen design

5. Conclusion

In this paper, we design and implement the smart pen based user interface for U-learning System. In most multimedia learning system we have to follow the system's order. But in this paper implemented the system, using paper book like a study guide book, we can directly search information what we need with smart pen if the book has our High-precision dot pattern in its background. Our system is another new media system for bridging of the digital smart phone and analog reading books using smart pen and high-precision dot pattern. We expect our system should be using many kinds of system like advertising, education, information search, even as well as guide system.

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