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A Intelligent English Situated Learning System based on Signboard Information

Jin-Il Kim[1] and Hee-Hyol Lee[2]

[1] *Dept. of Mathematics Education, Hannam University, 133 Ojeong-dong, Daedeok-gu, Daejon 306-791, Korea.E-mail : jikimi@hnu.kr*
[2] *The Graduate School of Information, Production and Systems, Waseda University, 2-7 Hibikino, Wakamatsu-ku, Kitakyunshu, Fukuoka, 808-0135, Japan hlee@waseda.jp*

Abstract

Recently, the prevalence of high-performance mobile devices and development of IT technologies, including augmented reality technology and location information service, etc. has led to the formation of an educational environment allowing learners to practice context learning theory ideally, subsequently contributing to active progress of relevant studies. Therefore, it is difficult to expect leaners to have an interest and a commitment since it cannot connect a lot of information coming through the perspective of the learner in a real-world environment with situated learning in real time. Accordingly, this paper proposes a intelligent English situated learning system that can practice situation context learning more reasonably using a location-based service and a recognition technology that automatically recognizes text information on street signboards that are easily accessible in everyday life, yet provide learners with a lot of information. The proposed system provides learners with English conversation learning contents that can be used in the business sector related to trade name recognized through text information on street signboards from images captured by cameras.

Keywords: *Situated Learning, Signboard, Intelligent Agent, Augmented Reality*

1. Introduction

Recently, the prevalence of high-performance mobile devices and development of IT technologies, including augmented reality technology and location information service, etc. has led to the formation of an educational environment allowing learners to practice context learning theory ideally, subsequently contributing to active progress of relevant studies.

In particular, a study on the mobile augmented reality that combines characteristics of the interaction that the augmented reality has with mobile computing that can provides learners with information they need effectively anytime and anywhere[1] and a situated mobile augmented reality research that overcomes the limitation of the technology and can be fused with a ubiquitous computing environment [2-3] have become a catalyst for these changes. Thanks to these technologies, a research on the intelligent agents to provide learners with situated learning depending on the environment they are in has also been actively conducted in the field of education.

Most of all, most of the existing foreign language-related situated learning studies allow learners to learn vocabulary by reading a value from the RFID tag attached to objects around learners through RFID reader mounted on PDA or provide learners with situated learning according to their situations by transmitting information on surrounding environment through wireless communications and real-time computing abilities of the network. However, situated

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learning of vocabulary using objects to which RFID tags are attached requires sensors and tags embedded in physical living environment, classrooms, hospitals, student accommodation, student cafeteria, library, and outdoor playground, etc. In addition, it poses a disadvantage that in case learners have an intimate knowledge of all the objects in a particular space, the space needs to be reconfigured with new things.

Therefore, it is difficult to expect leaners to have an interest and a commitment since it cannot connect a lot of information coming through the perspective of the learner in a real-world environment with situated learning in real time. Accordingly, this paper proposes a intelligent English situated learning system that can practice situation context learning more reasonably using a location-based service and a recognition technology that automatically recognizes text information on street signboards that are easily accessible in everyday life, yet provide learners with a lot of information. The proposed system provides learners with English conversation learning contents that can be used in the business sector related to trade name recognized through text information on street signboards from images captured by cameras.

2. Related Study

2.1. Situated learning

In situated learning, knowledge acquired in the context of real-world is more practical, has easier transition in solving the problems of the reality and maximizes the effect of learning compared to that obtained through direct instruction [4]. Due to the recent development of IT technologies, including augmented reality technology and location information service, etc. and prevalence of high-performance mobile devices, studies to practice situated learning theory have been actively carried out.

They include the design of mobile learning contents that support learning using mobile handsets through which wireless internet is available [5-6], research that implements learning contents from mobile devices of isolated forms[7] and mobile learning system using required contents downloaded from a web server into a PDA [8].

Studies of learning using situated learning deal with English vocabulary learning system called TANGO (Tag Added LearNing Objects) that reminds learners of words by attaching labels to objects around them [9], English situated learning system that recognizes the location and situation of leaners using RFID (Radio Frequency Identification) tags and a wireless communication technology of readers and provides the corresponding English situated learning services [10], and Chinese situated learning system that recognizes the location and situation of learners using RFID/USN(Ubiquitous Sensor Network) technology and provides the corresponding Chinese situated learning services [11].

2.2. Text extraction methods

Studies on the text extraction are divided in to graphics text extraction study and scene text extraction one. In recent years, a research on the image recognition in which text is included in natural images with complex background has been actively conducted. Looking at the study cases abroad, there are a technology that extracts texts from images acquired through mobile devices attached to the camera and converts them into those in native languages [12], a study that recognizes texts extracted from natural scene images and converts them [13], a research that detects Japanese characters and converts them to English ones [14], and a study that finds the location of the texts from natural scene images and recognizes them [15].

Domestic research covers development of "portable digital camera character recognition core technology" that converts contents on the signs and leaflets photographed with a digital camera to text information [16], creation of a signboard image database for the purpose of the signboard image recognition [17], delivery of information on the signboard images to users by recognizing a phone number from signboard images captured by mobile devices [18], and a system that extracts and recognizes texts included in images entered into a smartphone camera to output in a voice [19].

Meanwhile, errors that occur in signboard images vary, ranging from an error that occurs in the process of collecting signboard images (test losses by the shadow of buildings or roadside trees, losses due to reflection of sunlight), structural problems of signboard images, an error in shooting techniques (abnormality of shooting angle, distortion phenomenon due to the shooting location), to an error of the reader. Studies to compensate for the distortion of the image include a research on the method to correct the trade name by calculating the values of the distance between candidates of a database for trade names on signboards in consideration of the rankings of recognition candidates from the results recognized in the text recognition system of signboard images [20], and a study to estimate the outline of the text area by calculating the distorted information through the analysis of the vertical component included in images and correct the distorted images using a bilinear transformation based on the estimated outline [21].

2.3. Augmented reality

Since the augmented reality technology that can combine the information generated virtually into the actual environment can implement an instructional method which is almost consistent with context learning, it has received a lot of attention in the field of education. As virtual objects can be combined into real-world images in real time due to high-resolution screen of the smartphone and high performance of the camera, a variety of applications using augmented reality technology have begun to emerge in recent years.

The development practices of smartphone-based augmented reality applications are as follows. As the world-first smartphone-based augmented reality browser launched by Dutch company SPRXmobile, Layar provides various information located in the applicable direction on the image flashed by a camera by tracking the user's location in real time through the camera, GPS and compass features [22]. Sekai Camera, which is an augmented reality application program developed by Japan's Touchidot, can generate information in any location users want in the similar way to putting a post-it on the air [23]. Nearest Tube has a function to inform users of the nearest subway station as an augmented reality program developed by UK-firm Acrossair [24]. As a program developed by the Austrian company Mobilizy, Wikitude shows location information registered on a web page (Wikitude.com) into augmented reality trough a mobile device [25]. A study on the ecological education smart services that takes advantage of community board and augmented reality technology of smartphones improves the realism and immersion in ecology education by providing customized services and contents according to user's situations in real-life space [26]. A intelligent context-aware learning system based on mobile augmented reality can recommend appropriate learning contents automatically according to the context faced by learners based on the augmented reality on the popularized mobile devices [27].

3. The Proposed System

The proposed system provides learners with English conversation learning contents that can be used in the business sector related to trade name recognized through text information on the street signboards from images that enters the camera.

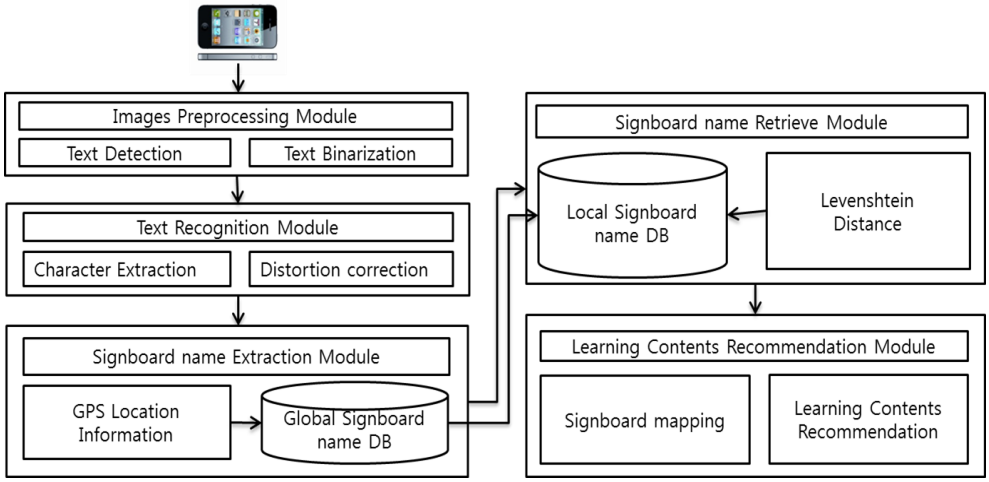

Figure 1. The Proposed System

3.1. System configuration

As shown in Figure 1, the proposed system consists of image pre-processing module, text recognition module, trade name extraction module, trade name search module, and learning recommendation module.

The image pre-processing module is composed of a binarization process to divide signboard images entered from the camera into character area and background area, and a process of splitting the character area into the unit of individual characters. The binarization process converts RGB image obtained from the signboard images into gray image and detects text area [28]. As for character segmentation, all the adjacent pixels connected are found and created into objects, and then they are divided by the unit of characters based on the location relationships of initial consonants, medial vowels and final consonants after analyzing the elements of the character area [29].

The text recognition module consists of character extraction and distortion correction. As for character extraction, candidate group is extracted by extracting characteristics of the input image and obtaining Manhanttan distance between the recognition targeted characters and extracted characteristics. The distortion correction is implemented by using the location of characters and placement information in general, but there are a lot of difficulties due to the characteristics of signboards. The upper and lower outlines are estimated by measuring the slope of the vertical component in the image and analyzing the histogram of the character image. The corrected results can be obtained by performing a bilinear transformation based on the outline of the estimated character area [21]. In this paper, characters of the candidate group are compared with the vector of the input image to increase the precision of the extracted candidate group. In this process, the case in which the feature vector of similar shape is generated despite the difference in characters occurs, resulting in degradation of the recognition rate in the overall recognition process. However, in case the vector data of recognition images to be compared is simple, the degradation of the recognition rate can be prevented.

In the trade name extraction module, a database of local trade name within a certain distance (200m) from a database of trade name at a national level is created based on the current GPS location information of users, which makes the reduction in the number of similar trade names to be compared with recognized data, subsequently helping not only to increase the recognition rate, but also to ensure faster processing speed due to a decrease in computational complexity and memory space required for the operation process.

In the trade name search module, distance value on the character string recognized using the Levenshtein Distance [30] is calculated to find the most similar character string through a comparison with trade names in a database of the local trade name.

In the learning content recommendation module, the recognized signboard characters are displayed in the proper positions, and learning contents corresponding to the business sector on the signboard are recommended to leaners. In this module, English conversation sentences are automatically recommended. When leaners click on the recommended English sentence, English sound file is automatically executed so that they can practice or take advantage of the English conversation sentence. The functions and features of the main function are shown in Table 1.

Table 1. Situation Sentence Management

Name	Functions
OnCbnSelComboBc	Select industrial classification Sub-Industry
OnCbnSitStatus	Select Situation Sentence
Open_SenFile	Set Situation values
Open_DataFile	Call Situation Sentence
OpenPlayMp3	Play voice files(mp3)

3.2. Algorithms

The character recognition algorithm recognizes texts on the signboards based on the existing algorithms and recommends appropriate learning contents in connection with the business sector associated with the recognized texts. The proposed algorithm should have the flexibility on the character recognition errors of signboards since causes for errors that occur in the recognition of signboard images vary. In this regard, this study attempted to minimize errors and increase recognition rates by extracting information within the viewing distance using the location information of learners and comparing it with the recognized text data. The algorithms used in this study are as follows.

```
// Get the current location information(Assisted GPS)
 GetCurrentLocation();
DisplayCurrentLocation();// Display the current location information
DetectTextDomain();
// Check the Screen of Augmented reality, Detect the text regions
BinarizationText();// Binarize the text
ExtractionCharacter();// Extract each character
CorrectionDistortion();// Correct Distorted characters
RecognitonText();// Recognize the text.
PostprocessingText(); // The characters extracted in a word
TranslationText();
CompareResults(); // matching a word against extracted a word
SceneManager();
DisplayCharacterInformation();
// Display the learning contents corresponding to the business sector
```

The proposed algorithm can display information of the current location and provide context learning using signboard information within the viewing distance. In addition, its efficiency on the context learning can be considered to be high since the most similar trade name is selected within the area despite the low recognition rate on the signboard, and learning contents is determined depending on the business sector to which the selected trade name belongs.

4. System Implementation and Evaluation

4.1. Overview of the experiment

The development environment of the proposed learning system is shown in Table 2, and the simulation assumes the following conditions.

First, a database of trade names dictionary in the area around the City Hall of D city is required to compare it with recognized trade name. Although the number of trade names at national level is about 4 million, only data within the distance close to the location of leaners needs to be compared in case of using the location information of leaners. Thus, significant results can be derived even if data is limited to the trade names within the restricted area. Second, signboards are limited to the ones with trade names in Hangul.

Table 2. Environment of System Development

OS	android 2.3.5
Language	Java JDK, android SDK
Resolution	WXGA(1280x800)
Database	SQ Lite
Mobile Device	Galaxy Note1(SHV-E160S)

4.2. Operation test

Figure 2 shows the screen of augmented reality in D region of D city. The current location (using GPS, and WiFi, etc.), direction (EWSN), and address, etc. are displayed. In the upper part of the screen, GPS information such as latitude and longitude, etc. is displayed, and the current location is displayed at the bottom of the screen.

In the case of the screen of augmented reality, re-recognition at a unit of the character does not made on the image screen in case the result of comparison between the moving distance of the current screen and that of previous screen is within the reference distance (right and left/top and bottom of the screen). In other words, the characters recognized previously are displayed in the same way as before.

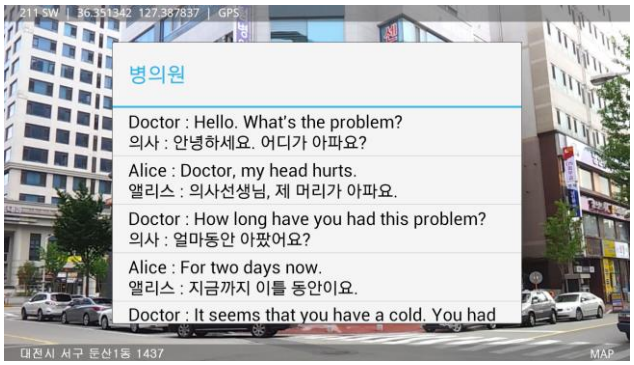

Figure 2. The Screen of Augmented Reality

However, in case it is beyond the reference distance, characters are re-recognized from the image screen. If characters are recognized, they are displayed in green, and if not recognized, a question mark (?) is displayed. As for the size of the area in pixels on the screen that can be recognized as characters, the size of less than 24x24 pixels based on the screen size of augmented reality (1280x720) is excluded form the recognition. In addition, signboards with mixed use of Hangul and English and those in English are treated as exceptions, and they are not recognized in this system.

If there are items that coincide with the results of a comparison between trade name/business sector around the current location and character recognition, the recognized trade name on the signboard and business sector is displayed (colors are divided separately). If there are no identical items, the results of the trade name around the current location /business sector are displayed, and learning contents corresponding to the business sector on the signboard is recommended to learners. Then, learners can acquire practical knowledge in the context of the real life, and they develop abilities to solve problems more easily when faced with the actual situation.

4.3. Discussion

The system implemented in this study can recognize the signboard information on the street, convert it to a foreign language corresponding to the recognized text and present English conversation sentence according to the business sector of the recognized signboard. In addition, information that can be learned in the context of real life is provided by displaying the converted text of the recognized signboard on the screen in real time through augmented reality technology. And it brings the effect of increasing the accuracy on the learning information to learners by performing a comparison between trade name within the viewing distance and a database of local trade names based on the current location of learners even though the text recognition rate on the signboard is not complete.

5. Conclusion

In everyday life, what provides learners with a lot of information is a signboard that can be easily seen on the streets. Accordingly, a intelligent English situated learning system based on the signboard information that can practice the context learning more reasonably by recognizing the text information of the signboard automatically was designed and implemented through this study. The proposed system increase the recognition rate by means of a post-processing method that compare a database of trade names within the recognition distance using input results and location information by recognizing individual characters from the signboard images on the streets. In addition,

it provides leaners with relevant learning information using the recognized trade name and location information.

The following future studies are needed to generalize and take advantage of the learning system developed as a result of this study with versatility. First, there is a need to develop a program to register and manage name and location information required by leaners so that they can use the developed system more easily and conveniently. Second, a database of nationwide trade names should be established to take advantage of the proposed system throughout the country. Third, as there are many signboards with mixed use of Hangul and English, an algorithm to recognize English needs to be added.

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Authors

Jin-Il Kim, he received the BS, the MA and the PhD degrees in computer science from Hannam University, Korea, in 1991, 1993 and 2000, respectively. Also He received the MA and the PhD degrees in Education from Korea University, Korea, in 2003 and 2009, respectively. His research interests include Parallel Processing & Network, Situated Learning and u-Learning.

Hee-Hyol Lee, he received the PhD degrees in Division of Science and Engineering from Waseda University, Japan, in 1986. His major areas of study are intelligent control, Designs of Control Systems, Development of Ultracompact Power Generation System using Renewable Thermal Energy Sources and Development of Traffic Signal Control System.

