BI-DIRECTIONAL EDUCATION SYSTEM BASED ON POSITION PATTERN TECHNOLOGY

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Keywords: Interactive Education, Bi-directional Education, Computer-supported Collaborative Learning(CSCL), Position Pattern, Interactive Whiteboard, Digital Pen.

Abstract: A bidirectional interactive education becomes one of the important issues in computer-supported education area. The current computer-supported education system is often composed of an interactive whiteboard (IWB) for a teacher and personal computers or tablets such as iPad and Android tablets for students. Even though a tablet is good for providing various multimedia materials to the students, however, it cannot support the sufficient functionality to capture their feedbacks, especially handwriting inputs. This paper introduces a bi-directional interactive education system based on a position pattern technology. The proposed system consists of an IWB for a teacher, and digital pens and smart papers for students. In the proposed system, a teacher can communicate interactively with his/her students via an IWB and smart papers. Therefore, it is believed to be very useful framework for the computer-supported collaborative learning either in a classroom locally or in distance learning over the Internet.

1 INTRODUCTION

In past, most of the educational materials in a classroom were textbooks or printed reference materials. However, in a modern classroom, teachers want to use various form of teaching materials such as audio, image, video, and even web-pages in the Internet space. To provide these multi-media materials in a classroom, multiple *information technology*(IT) devices have been widely used and we call it as a computer supported education. The most widely used IT devices in a computer-supported education environment are a computer, an interactive whiteboard(IWB), an electronic lecture desk, and a smartpad(iPad and Android Tablet)(Eriti et al., 2011; Xin-Xing and Zhi-Qin, 2011). Recently, several researches have been performed to investigate the effectiveness and the developing strategy of the computer-supported education(Tatarolu and Erduran, 2010; Trel, 2011; Sahin et al., 2010; Tsonos et al., 2008). Though this new style education can meet a certain level of educational demands from teachers as well as students, higher level interactivity is still required for more efficient education.

The key IT device of a computer-supported education in a classroom is an IWB or a computerized blackboard(or whiteboard), that can replace the traditional blackboard in a classroom(Duan, 2010). The basic concept of IWB is that teacher's writing on a whiteboard surface is captured by a sensor, transmitted to the computer as mouse or tablet actions, and then the computer screen is projected on the whiteboard as shown in Figure 1. In most IWBs, film-type touch sensors, ultra-sonic sensors, infra-red sensors, and camera sensors are used to sense the writing action. Even though an IWB provides ranges of applications in a classroom, its educational effect looks limited because the education using an IWB is uni-directional rather than bi-directional education(Trel, 2011; Serow and Callingham, 2011; Slay et al., 2008). A vital element in education, however,

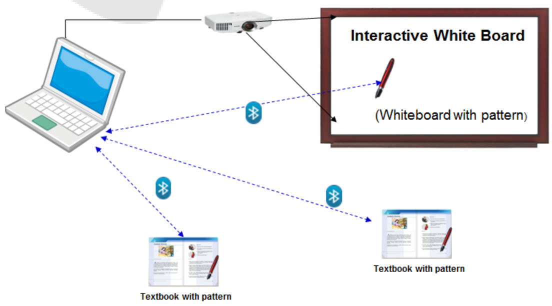


Figure 1: Interactive whiteboard and smart-paper.

Kim S., Kim J., Park J. and Lee S..
BI-DIRECTIONAL EDUCATION SYSTEM BASED ON POSITION PATTERN TECHNOLOGY.
DOI: 10.5220/0003923302120216
In *Proceedings of the 4th International Conference on Computer Supported Education* (CSEDU-2012), pages 212-216
ISBN: 978-989-8565-06-8

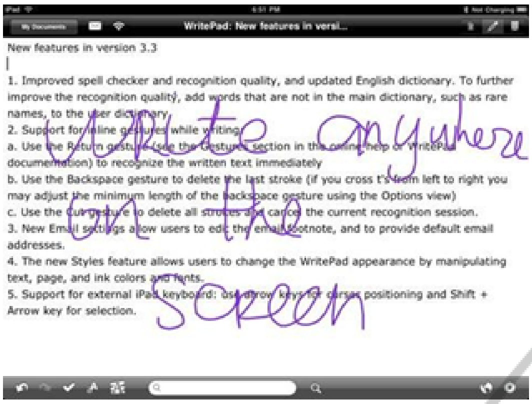


Figure 2: Note taking on smartpad.

is a bi-directional communication between a teacher and students through the students' feedback, and the hand-writing is the most effective method of students' feedback.

A smartpad that is a special form of tablet PC with a hand-touch screen and communication capability such as iPad and Android tablets recently becomes to be used for the bi-directional education(Alvarez et al., 2011; Mutter, 2011). With a smartpad, students can not only read multi-media reference materials but also put hand-touch inputs as shown in Figure 2. However, with the current IT devices used in a classroom such as smartpads, it is very hard to capture students' hand-written scripts even though they are very useful to show multi-media materials to the students. According to the survey on the educational effect of Smartpad, a lot of students felt the lack of free note taking on their contents displayed on Smartpad. As a result, there is a mismatch between multi-media-based education and students' feedback. To overcome this discrepancy, more emotional and reactive IT device is necessary.

In this paper, bi-directional computer supported educational environment using smart-paper and electric pen along with IWB is proposed.

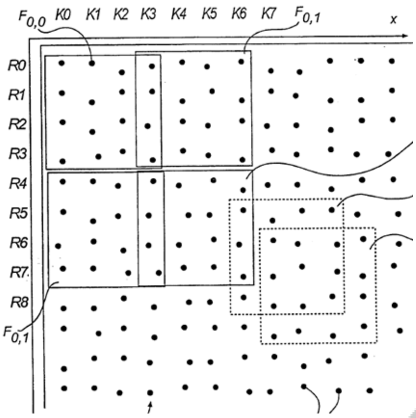
2 SMART DEVICES USING PATTERN

2.1 Position Pattern

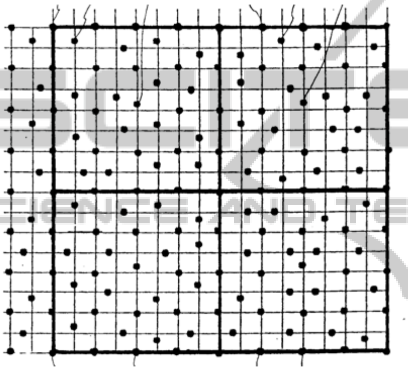
To provide a bi-directional communication in a computer supported education, a special input mechanism for a student is necessary. Because the touch screen of a smartpad is not accurate enough to capture hand-writing script as shown in Figure 2, it might be inappropriate to the required input mechanism. While using a normal pen and paper is believed to be the most accurate and natural method, the handwriting on the paper has to be captured to couple it with IT devices. A special device such as tablet and ultra-sonic sensor can be used to do this. The other approach is to use a special paper based on a position-coded micro pattern technology. If a student writes something on the special paper with a digital pen, the handwritten can be automatically sensed and transmitted to a computer. The trajectory of the digital pen is recognized based on the position-coded micro pattern printed on the special paper.

The position-coded micro pattern (position pattern) is composed of several micro dots printed on a paper surface and represents the center position of the pattern area where it is printed. By varying the spatial distribution of micro dots printed within a pattern area, the great number of position patterns with different position information can be generated. Several position patterns have been invented by several companies such as Anoto Inc, Yosida Kenji, IBM, and Microsoft, and they are distinguished from the method of encoding position information into the pattern, and the representation of micro dots.

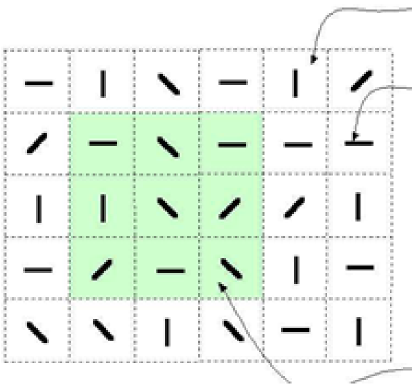
The position pattern shown in Figure 3(a) was suggested by Anoto Inc.(Anoto AB, 2011) . It is generated by shifting each micro dot horizontally or vertically from a virtual 2-dimensional lattice point, and does not use the pattern boundary separating each other from adjacent position patterns. Since the encoding mechanism is based on the sequence of a specially-selected numbers, the decoding process is very simple. In addition, the position accuracy is very high due to the concept of floating pattern. The position pattern invented by Yosida Kenji is composed of two kinds of micro dots as shown in in Fig. 3(b). The first one is used for representing position information, and the other is for separating the adjacent position patterns. Accordingly, the size of each position pattern is relatively larger than that of other technologies, and thus the position accuracy may be low(Kenji, 2006). On the other hand, the position pattern suggested by authors has the different encoding mechanism and the different method of representing encoded value into the pattern(Lee and Park, 2006). The encoding value is drawn by a kind of short line which is often described with two closely-spaced dots. An example of our position pattern is shown in Fig 3(c). The generation of our position pattern is based on the stochastic error reduction to escape the appearance of the same pattern. The position pattern described can be printed onto any surfaces such papers, plastic sheets, and glass plates.



(a) Anoto's pattern.



(b) Yoshida Kengi's pattern.



(c) Lee and Park's pattern.

Figure 3: Position-coded patterns.

2.2 Digital Pen

The position information is decoded from the captured image via the digital image processing algorithm. For doing this, the image of position patterns observed below the pen tip of the pen is captured by a CMOS image sensor embedded in the digital pen. Since the position information is repeatedly extracted from the captured images 100 times per second, the recognized trajectory of the pen is nearly identical to the shape of the handwriting. Commercially available digital pens usually use Bluetooth communication between a digital pen and computer, by which real-time handwriting can be transimitted to computer.

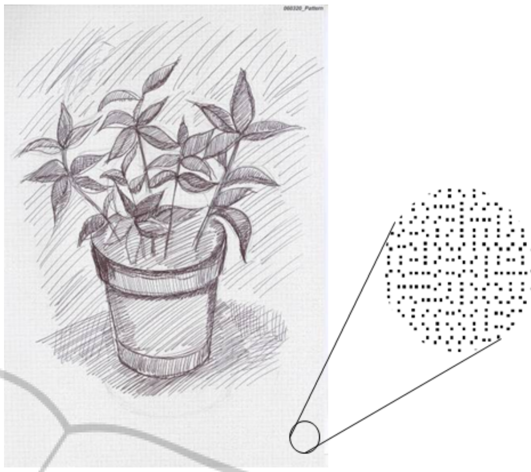


Figure 4: Smart paper with position pattern.

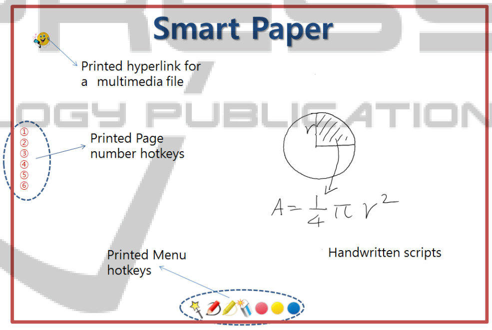


Figure 5: Smart paper with hot spots supporting the direct controllability of a program.

2.3 Smart Paper

The position pattern described in the previous section is a useful technology to recognize a sophisticate movement of a pen. A *smart paper* is a normal paper with position pattern printed. Because each dot, the constituent of the pattern, is very small (approximately 80μm), the position pattern printed is nearly invisible. Thanks to the invisibility, the natural handwriting is possible. Figure 4 shows the concept of smart paper and its usage.

Besides supporting the mere handwriting capability, pattern on a smart paper can be used to define a certain area as a special hotspots with which menus, page navigation, and hyperlinks are easily implemented as shown in Figure 5.

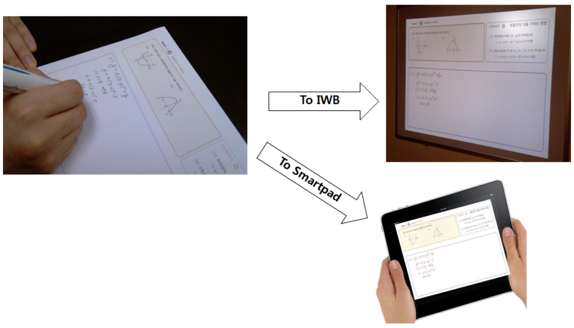


Figure 6: Handwriting with IWB and smartpad.

2.4 Interactive Whiteboard

Normal IWB requires a sensor to capture handwriting on it. Sensors for IWB includes touchscreen panel, ultra-sonic, infra-red light beam, or camera sensors. Since the accuracy of these sensors is very limited, however, details of handwriting are very hard to capture.

The position pattern can be used for IWB as well. If the whole area of IWB is printed with huge number of these position patterns, the writing trajectory of the handwriting on the surface of IWB can be accurately recognized and projected on the whiteboard surface via beam projector. This IWB based on a position pattern provides a high precision of position recognition and prompt speed compared to other IWB sensors.

3 INTERACTIVE EDUCATION

In the previous sections, three devices such as digital pen, smart paper, and IWB using a position pattern, are introduced. By combining these three, an interactive education is possible. In Figure 1, smart paper and IWB are used altogether. Teacher uses an IWB and a textbook based on a smart paper(called smart book) and students use smart book or smart notepad for handwriting. The handwriting on either IWB or smart paper by a teacher and students can be shown simultaneously on IWB and shared by all participants. This means the bi-directional interactive education between a teacher and students is possible using position pattern technology, which is almost impossible using a normal IWB and smartpads. Using multiple pens enables computer supported collaborative learning(CSCL) in a classroom as well.

The smart paper can also be used with smartpad. The shortcoming of smartpad such as iPad is that handwriting is almost impossible. However, since the handwriting on a smart paper can be also shown in smartpad as well as IWB, more natural handwriting script by a student can be shared as shown in Figure 6. A special test paper for taking an exam during class can be easily prepared with just printing the content image including some test questions on the special paper via a normal printer. If one student solves the test question printed on the special test paper with his digital pen directly, the process of solving the question will be recognized in real time and the recognized result will be displayed to IWB and/or the screen of his smartpad as shown in Figure 6. After solving the question, teacher can correct the mistake of the student and also evaluate the solving result. In particular, this interactivity would be very useful for teaching mathematics.

Beyond a simple handwriting pad, a smart paper can be used as more interactive and reactive tool. Figure 5 shows the reactive usage of a smart paper on which any hyperlink, menu hotkeys, and papge navigation are printed. Students using this reactive smart paper as well as a teacher using an IWB can participate a more interactive and bi-directional enducational environment. Futhermore, a multimodal document generation framework enables a sophisticated multi-accessable envrionment in a classroom(Tsonos and Kouroupetroglou, 2008).

This concept of interactive education can be expanded to cyber space over the Internet. Figure 7 shows a concept of interactive education for a distance learning over the Internet. Teacher's writing on an IWB and students' writing on a smart paper can be shown on a IWB simultaneously and shared by others. Specially, a smart mobile devices with a high speed network capability get rid of the geographical limitation nowadays. Even current distance learning system supports on-line chatting and video sharing feature, natural handwriting is not supported but it is very important factor in many educational fields including mathematics, science, architect, design, and etc. The higher level of the computer supported collaborative learning(CSCL) and work(CSCW) are also possible using a smart paper and IWB.

4 CONCLUSIONS

This paper introduces a bi-directional interactive education system that can be used either in a classroom or cyber-space over the Internet. The proposed educational system consists of an IWB, digital pens, and smart-papers that are based on the position pattern with which capturing the details of handwriting is possible. Within the proposed system, teachers and students can communicate interactively using an IWB

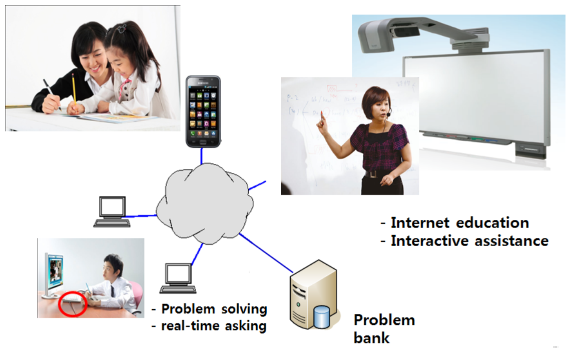


Figure 7: Online interactive education.

and smart papers, respectively. This interactive education concept can apply to the computer supported collaborative learning (CSCL) for a distance-learning over the Internet and will be very useful for helping the convenient education of the disabled students in particular.

ACKNOWLEDGEMENTS

This paper is partially suppported by the research grant of Inha Unversity, Korea. Authors also thank to Pen Laboratory Inc. (http://www.penlab.co.kr) and Easy Systems Inc. (http://www.easy.co.kr) for their support to review their electric pen, Interactive Whiteboard(IWB), smart paper, and HandiPDF software.

REFERENCES

Alvarez, C., Alarcon, R., and Nussbaum, M. (2011). Implementing collaborative learning activities in the classroom supported by one-to-one mobile computing: A design-based process. *Journal of Systems and Software*, 84(11):1961–1976.

Anoto AB (2011). Method and device for decoding a position-coding pattern. US patent 7,999,798.

Duan, Y. (2010). Teaching interactively with interactive whiteboard: Teachers are the key. In *2010 International Conference on Networking and Digital Society, ICNDS 2010*, volume 1, pages 144–147.

Eriti, S. D., Haseski, H. I., Uluuysal, B., and Karakoyun, F. (2011). The use of mobile technologies in multimedia-supported learning environments. *Turkish Online Journal of Distance Education*, 12(3):130–141.

Kenji, Y. (2006). Information input and output method by use of dot pattern. PCT Patent JP2003 003162.

Lee, S. and Park, J. (2006). System and method of detecting absolute coordinates. PCT Patent KR2001 02182.

Mutter, B. V. (2011). Using pen-based tablet pc technology to improve instruction in engineering economics. In *ASEE Annual Conference and Exposition, Conference Proceedings*.

Sahin, Y. G., Bal, G., Misirli, G., Orhan, N., and Yucel, K. (2010). Teachers' expectations from computer technology and interactive whiteboard: A survey. In *ICETC 2010 - 2010 2nd International Conference on Education Technology and Computer*, volume 3, pages V3153–V3157.

Serow, P. and Callingham, R. (2011). Levels of use of interactive whiteboard technology in the primary mathematics classroom. *Technology, Pedagogy and Education*, 20(2):161–173.

Slay, H., Siebrger, I., and Hodgkinson-Williams, C. (2008). Interactive whiteboards: Real beauty or just "lipstick"? *Computers and Education*, 51(3):1321–1341.

Tatarolu, B. and Erduran, A. (2010). Examining students' attitudes and views towards usage an interactive whiteboard in mathematics lessons. In *Procedia - Social and Behavioral Sciences*, volume 2, pages 2533–2538.

Trel, Y. K. (2011). An interactive whiteboard student survey: Development, validity and reliability. *Computers and Education*, 57(4):2441–2450.

Tsonos, D., Ikospentaki, K., and Kouroupetrolgou, G. (2008). Towards modeling of readers' emotional state response for the automated annotation of documents. In *Proceedings of the International Joint Conference on Neural Networks*, pages 3253–3260.

Tsonos, D. and Kouroupetroglou, G. (2008). Accessibility of board and presentations in the classroom: A design-for-all approach. In *Proceedings of the 4th IASTED International Conference on Telehealth and Assistive Technologies, Telehealth/AT 2008*, pages 13–18.

Xin-Xing, Q. and Zhi-Qin, L. (2011). Research and design cscl model based on ubiquitous learning environments. In *ICCSE 2011 - 6th International Conference on Computer Science and Education, Final Program and Proceedings*, pages 811–814.