Multimedia-Enabled Dot Codes as Communication Technologies

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INTRODUCTION

Augmentative and alternative communication (AAC) technologies are widely used, providing students with severe speech, language, and communication difficulties the opportunity to improve their communication, and by extension, their relationships with others. AAC systems utilize assistive technology (AT) devices that range from no-tech to high-tech. Modifying young children's environments by using AT, defined as any tool, device, or adaptation that allows them more ways to gain access to the people, places, and setting where they can be exposed to typical developmental activities, increases opportunities for learning (Sadao & Robinson, 2010). Dell, Newton, and Petroff (2016) described the practical use of such devices in a classroom. Carpenter, Johnston, and Beard (2014) published a text for both in-service and pre-service educators to introduce AT. Jonge, Scherer, and Rodger (2007) provided an opportunity to try to understand the experiences of AT users in the workplace.

A widely used AAC tool, voice output communication aids (VOCAs) utilize single-level or multi-level outputs to convey sounds. Although there are a variety of VOCAs catering to students with different abilities and needs (Inclusive design research center, 2016; RESEARCH AUTISM, 2016), most devices are severely hampered by their low-output numbers and short lengths of time that they can record.

Approximately ten years ago, to address the above problems the present author started using Scan Talk dot codes developed by Olympus Co. (1999). Such codes transform voices and sounds into two-dimensional dot codes directly outputted on ordinary paper. Students with severe hand, finger, or mental challenges, however, could not correctly trace Scan Talk codes using the Scan Talk Reader. The present author, therefore, used new dot codes developed independently by Gridmark, Inc. (2009) and Apollo Japan (2005) and conducted school activities with original handmade teaching materials overlaid with these dot codes. In our work, just touching the "invisible" dot codes printed on the paper or symbol icons by using a sound pen clearly reproduces voices and sounds. By using the identical sound pen or a scanner pen connected to a tablet or PC, multimedia sources such as movies, Web pages, and PowerPoint files, in addition to voices and sounds, can be reproduced on its screen.

In this article, state-of-the-art dot code technology is outlined, and basic information regarding the creation of original handmade materials using dot codes and the use at both general and special needs schools is presented.

BACKGROUND

Outline of Dot Code Technology

GridOnput Dot Codes

GridOnput (Gridmark, 2009) is a set of novel two-dimensional codes comprising extremely small dots. Such dot codes can invisibly overlay any graphically printed letters, photos, and illustrations with no impact on the designed visual images, meaning that letters, photos, and illustra-

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tions can be changed into information-trigger icons. A maximum of four voices and sounds can be linked to each icon, as well as other media such as movies, Web pages, and PowerPoint files. Simply touching the dot codes printed on ordinary paper with a sound pen (e.g., G-Talk or G-Speak) or a scanner pen (e.g., G-Pen) enables students to directly access the corresponding digital information.

To print document content that includes the "invisible" GridOnput dot codes, industry-standard Cyan-Magenta-Yellow-Black (CMYK) processes are required. More specifically, carbon ink that absorbs infrared rays is used only for dot code printing, while non-carbon ink is used to print graphics. The sound and scanner pens read the invisible dot codes using built-in infrared cameras.

ScreenCode Dot Codes

Developed by Apollo Japan (2005), ScreenCode is a microscopic barcode that allows developers to map data onto printed surfaces, such as printed documents. Unlike other data-coding systems that map data onto expensive metallic-based inks, ScreenCode allows users to map data using regular ink similar to that found in household printers. Apollo Japan has recently published their ScreenCode smartphone and tablet application in which the built-in camera of the smartphone and tablet, using a specially designed lens, can identify ScreenCode and reproduce linked multimedia such as movies, audio files, photos, and Web pages on their screen.

Other Dot Codes

Developed by DENSO WAVE, Inc., the well-known QR code (1994) is an open code that anyone is allowed to use; it has become quite widespread as Micro QR codes, iQR codes, SQRCs, and Frame QRs. These QR codes incorporate high-level features such as illustrations, letters, and logos, and provide high-capacity data encoding, small printout sizes, Japanese Kanji and Hirakana character support, dirt and damage resistance, 360-degree readability, and structured appending features. DENSO WAVE distributes their QR-code-generation programs, QRdraw Ad (DENSO WAVE, 2016a) and QRmaker Ad (DENSO WAVE, 2016b), free of charge.

Developed by TOPPAN TDK LABEL Co., LTD, the Z code (TOPPAN TDK LABEL, 2016) is composed of tiny dot codes and does not spoil illustrations or texts. The Z code is now used to integrate digital media with analog media and assess whether printed matter is genuine or false.

Developed by ZAK Co., the Simple Microdot Code (SMC) (ZAK, 2009) creates a sophisticated algorithm to print data on a 2.5 mm^2 area that can be decoded with an optical device. These tiny swatches of encoded dots can also be used to trigger electronic links, applications, databases, etc. The SMC dot code patterns can easily be integrated into a print file by end users using any of today's desktop publishing software that support CMYK printing processes, thus allowing SMC dot code patterns to be placed anywhere on a printed surface, either as a standalone pattern or embedded in a directional graphic element.

Franklin Electronic Publishers, Inc. developed AnyBook (Franklin Electronic Publishers, 2016) using dot code technology, which is a set of reading enhancement products that allow children to hear their parents or a loved one reading any book for a more intimate learning experience, even when these readers are not physically present. These products consist of a reading pen that enables the words and pictures to talk with any book using vocal recording software. A variety of AnyBooks are available; for example, holding up to 200 h of audio, AnyBook Anywhere (DRP-5100) has 420 reusable stickers with pre-recorded sounds that are created using a special glue that does not harm the pages of the books, a headphone jack for private listening, and backup and sharing capabilities with AnyBook Case.

Afaya Technology Co., Taiwan, has developed a dot code incorporating charge coupled device scanning technology, which identifies the printed