An Application of the Ubiquitous Forms Solution for the Work Document at a Construction Site

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***Abstract*—In this information age, the construction information generated in the process of a construction project has become more and more important. For this reason, the saving of information in a faster electric form has also become a priority. However, the daily report is currently redundant at construction sites, which means that it is usually hand-written at a construction site and then entered on a computer. This study aimed to resolve the problems reported with the daily report system by developing a Ubiquitous forms solution (UFS) system-based daily report system and applying it to an actual site, ultimately evaluating the applicability of the report system to the construction site. The UFS-based daily report system is expected to contribute to improving the work efficiency of daily reporting.**

***Index Terms*—information age, the daily report, Ubiquitous Forms Solution (UFS) system**

I. Introduction

As construction projects become larger in scale and more complex, massive amounts of construction information on work type, the number of labor workers, equipment and materials is generated in each phase of carrying out the project. Successful project management hinges greatly on the utilization of the information [1]. For this reason, a number of studies have been conducted with the goal of developing a more efficient information utilization method, one of which is the Ubiquitous Forms Solution (UFS)-based daily report system. Daily reporting is one of the methods used at a construction site to perform daily management of diverse types of information from each work type in the smallest unit (work type, the number of laborers, equipment and materials used, etc.) by planning or making out a document [2]. It is redundant to transfer the handwritten information on the paper report sheet to an electronic form, as this deteriorates the work efficiency [3]. However, using a UFS system will resolve this problem. The UFS system combines the mobility of a traditional pen and paper with digital technology, through which the information handwritten on an electric pad or touch screen can be converted into digital information [4]. Therefore, the aim of this study is to develop a UFS-based daily report system and analyze the applicability of the system to construction site by applying it to an actual site.

The recent research trend of a UFS system can be summarized as follows. Chin *et al*. (1999) [5] built a system through which diverse types of information obtained at a site can be shared more accurately and effectively using IT equipment and Internet technology, including a digital pen. Son *et al*. (2010) [6] suggested an efficient data collection system for a specific project by eliminating the manual work of entering information after handwriting it on a sheet of paper at a construction site. Kim *et al*. (2013) [7] presented an information accumulation and utilization plan for defect inspection, inspection date, defect type, specific location and inspected content by using a digital pen system. Similarly, studies have been actively conducted on a UFS system, but the findings of the previous studies have not yet been utilized at construction sites since they are the results of an analysis of the applicability of the systems or the development of a prototype. For this reason, the current study aims to develop a UFS-based daily report system and apply it to an actual construction site.

Your goal is to simulate the usual appearance of papers in the. We are requesting that you follow these guidelines as closely as possible

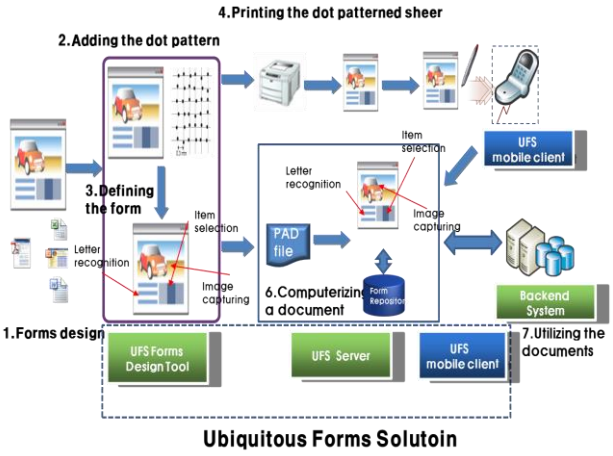

Figure 1. UFS system work flow

II. UFS (Ubiqution Forms Solution) System

The UFS is a direct digital conversion method of imaging. More specifically, it converts the handwritten

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document into a digital form in a safe and swift manner. The UFS system can be utilized in a diversity of work types at a construction site, and can also be integrated with the existing backend system at minimal expense. In addition, it is suitable for use in Korea's Internet environment, in which multimedia is frequently used.

The UFS system is configured to support pen data, multimedia and GPS data, and ultimately provide security and protect the user's privacy. Fig. 1 depicts the workflow of the UFS system.

The UFS system has been widely used in banks, medical and manufacturing industries. First of all, let's take a look at the bank industry. It usually takes at least 2 to 3 days to reflect the contract information after a contract is entered between a client and a sales person of the bank. However, when the UFS system is used, not only can the contract information (including the client's signature) be sent immediately after a contract is signed, but the bank can also manage the time the contract is signed. Therefore, it is possible to prevent any dishonest act related with a contract, such as changing the date it was signed, and greater convenience can also be secured through computerization. In a manufacturing industry, a manager would conventionally write the information on a paper report sheet at the work station, and then the data would be reentered on the computer in an office; however, the UFS system enables the data to be computerized immediately after it is entered. Therefore, it is possible to computerize the data entry process with the conventional work patterns retained as they were, except for the entry of data. In the medical industry, all records were signed and then scanned to save; however, the UFS system allows the record to be computerized without any scanning process. Similarly, the UFS system has been actively introduced and utilized in other industries, and there is an urgent need to introduce and utilize the UFS system in the construction industry in order to increase the work efficiency and eliminate unnecessary redundant work.

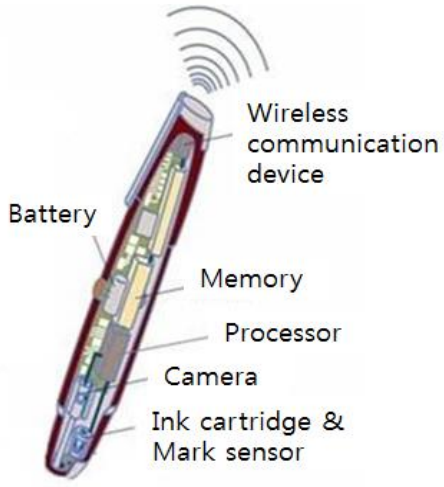

Figure 2. Digital pen structure

The UFS system consists of a digital pen, a UFS system server, and a UFS Forms Design Tool. The digital pen is an IT device that incorporates both analog and digital concepts. With the digital pen, the information is simultaneously saved in the internal memory of the pen while a user is writing it by hand on a piece of paper, and then the information can be sent to a computer in a data form. The digital pen looks like a normal pen, but is composed of an ink cartridge, an infrared camera, an image processer, a Bluetooth wireless communication device, a memory, and a battery. For this reason, it is possible to make out a document in the same manner as the conventional one. The document made out with the pen can be computerized and saved on a server as it is. Fig. 2 illustrates the structure of the digital pen.

The UFS system server creates digital images and saves the information through the recognition of handwritten letters, and is also linked with the backend system. The UFS Forms Design Tool is a tool to add to and lay out components such as a dot patterns, drawing area, user area, or Pidget. In addition, the FDT can register information in a file format as PNG on the server.

III. Setup of the UFS-Based Daily Report System

In the daily report system developed in this study, a daily report is made out with a digital pen and then sent in a PCG file format to a client via USB or Bluetooth. The client receives and sends PGC data to the server via USB or Bluetooth. The server creates digital letters after recognizing the digital image on the PCG data and the letters handwritten on the User Area. The handwritten document is computerized using a digital pen and printed sheet of paper at a construction site through the procedure below.

- Information such as company name, work type, date, workload, number of laborers, number of pieces of equipment used is written on the daily report.
- It is recognized as complete when the pen touches Pidget.
- When the pen is put on the cradle, the PCG data is sent to the client via USB (in this study, a notebook computer was used as the client).
- The client sends data to the server by identifying a specific service.
- The server receives the PGC data and identifies the service.
- The server creates the digital image by rendering PGC on the entire drawing area.
- The server saves PGC information entered on the user area on a server after capturing it.
- The client receives the final recognition result of handwritten letters and digital images by the server, and the user checks whether they are correct or not.

IV. Application of the UFS-Dased Daily Report System

The UFS-based daily report system developed in this study was applied to a construction site as an example. It was actually used for a total of 10 days. Information recorded included the date, weather condition, work type

(e.g. form work), waterproofing work, or concrete placement, number of laborers and the equipment used. Next, when the site manager recorded the work information as shown in Fig. 3, it is computerized automatically, as shown in Fig. 4.

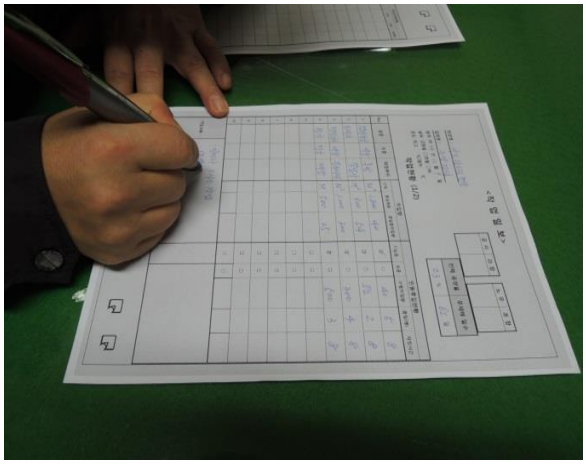

Figure 3. Daily reporting using a UFS system

Figure 4. An example of the UFS-based daily report

V. Analysis Results of the UFS-Based Daily Report

The UFS-based daily report was applied for 10 days, and then the application results were analyzed in terms of accuracy. Table I shows the results of the analysis.

TABLE I. Results of Recognition Accuracy

Classification	Accuracy of recognition				
	Single letter		Combination of two or more		Accuracy (Number of letters correctly recognized /Number of letters entered)
	Number of letters entered	Number of letters incorrectly recognized	Number of letters entered	Number of letters incorrectly recognized	
Case1	43	0	11	0	100%(54 / 54)
Case2	37	3	5	1	90%(38 / 42)
Case3	29	0	7	1	97%(35 / 36)
Case4	27	0	9	1	97%(35 / 36)
Case5	36	2	9	1	93%(42 / 45)
Case6	43	1	13	3	93%(52 / 56)
Case7	28	2	8	1	91%(33 / 36)
Case8	35	2	13	2	91%(44 / 48)
Case9	26	0	10	1	97%(35 / 36)
Case10	35	2	10	1	93%(42 / 45)

※Accuracy of recognition = [{(A-B)+(C-D)} / (A+C)]

The workload was actually measured at the construction site and the number of recognition errors of the handwritten words was analyzed. For a more accurate analysis, the letters were classified into single characters (Korean letter, English letter, or single number) and combinations of two or more words (specification or unit). In terms of the analysis results, the accuracy of recognition was found to be higher than 94.2%.

VI. Conclusion

As construction projects become larger in scale and more complex, the importance of information on the costruction project including work type, number of laborers, and materials used increases. Therefore, in this study the UFS-based daily report system was proposed and applied to enable a construction company to computerize the information more easily and conveniently compared with the conventional daily work report. Through an analysis of the results, it was found that more than 90% of letters were recognized in all cases, and there was no additional work such as manual input of the handwritten information required to computerize it. In the future, it is necessary to accurately identify the reasons for incorrect letter recognition through an analysis of recognition errors, and prepare an improvement plan.

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