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## Development of Construction Site Access Management Automation System based on Hand Vascular Pattern

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**ABSTRACT:** Along with the changing pattern that the construction project is getting complicated, large-scaled and up-to-dated, necessity of efficient management of manpower and resources of the construction site is being increased. In particular, considering that the construction site requires a lot of labor force and in terms of the construction cost, labor cost shares 30-40%, labor management has become a very important factor. In this study, in order to support a stable and successful construction project implementation and supplement the existing system being utilized at the current site, construction site access management automation system based on hand vascular pattern, a biometrics system, is intended to be developed. Relevant theory for the system development and the problem of existing RFID system were evaluated and based on this findings, a system design and DB composition chart were envisaged. In addition, by applying this developed system to a number of sites, its result was analyzed

*Keywords: Access Management, Biometrics, Hand Vascular Pattern, RFID, Labor Management*

### 1. INTRODUCTION

#### 1.1. Background and Goals of the Research

Changing pattern of the construction project being large-scaled, complicated and up-to-dated requires more efficient management due to increased demand for material, labor force and equipments during the construction.

In particular, as the construction project is a labor-intensive industry that requires a lot of labor force during the construction and in terms of the cost composition, labor cost shares 30-40% of the net construction cost[1], manpower management is a very important factor.

Site access management is the most important factor of the labor force management, playing an important role in site safety/ security control and labor cost estimation.

Previously site access was controlled by the personnel at the gate directly but currently manpower control system based on bar code and RFID technology has been developed and a lot of sites are utilizing this system.

However, in reality, this access control system using high-tech RFID technology is losing control of an exact management due to reproduction of bar code and RFID chips, chip missing and lending practice, etc.

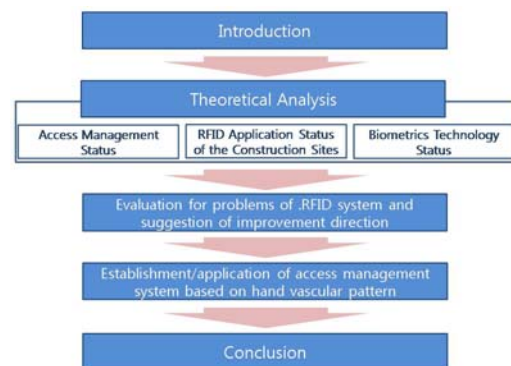
Consequently, in this study, in order to implement a stable and successful construction project, a new construction site access management automation system

is intended to be developed by introducing a hand vascular pattern, a biometrics technology, as a means of improving the existing access management system based on RFID system.

#### 1.2. Scope and Contents of the Study

Scope of this study was defined to be applied for the construction site actually by establishing an access management system based on hand vascular pattern in order to supplement the existing RFID system.

This study has been carried out as following method.



**Fig.1.** Research Flow Chart

First, as a preliminary consideration, access management status of the current construction site, RFID

utilization status of the construction industry and biometrics technology status were surveyed.

Second, based on the findings of the survey by evaluating the problem of the construction site access system based on RFID, an improved system using hand vascular pattern was suggested..

Third, access management system based on hand vascular and system DB were designed and established. And established system was applied for the site directly and its application result was evaluated.

Fourth, as a conclusion, a direction for the forthcoming research was suggested based on the summary of this study and the result of the system application.

**2. Theoretical consideration**

**2.1. Access management status**

Access management of the construction site is the most important factor for labor control with having top priority. Composition system of labor force can be classified as follows, though it is somewhat different depending on its magnitude and nature.

**Table.1.** Composition system of labor force.

Class.	Type of employment	Position
Site controller	Regular staff	Site manager, cost controller, construction, engineer, etc.
Working team leader	Monthly term contract	Control of team and daily labor
Technician	Quantity unit price/daily term contract	Team leader/members undertaking the works
Daily labor	Daily/monthly term contract	Common labor(site arrangement/cleaning/simple job)

At the construction site, it is difficult to control labor force as diversified labor force are working at the different work types.

As an information control for the diversified labor force at the construction site, various methods including daily attendance report, bar code system utilizing information technology and RFID technology currently applied tends to be employed.

However, an exact access management is losing its control due to the problems of missing of access card, proxy attendance, etc., and leaving during working hours and controls for safety/working/education have not been properly implemented.

**2.2. RFID application status at the construction site**

A study on the possibility of applying RFID technology to the construction site in the fields of concrete casting, maintenance and material control was started in 1995 in the USA suggested by Prof. Jaselski. In 2003, this technology was applied for material

warehousing inspection as a demonstration case by Prof. Jaselskis by using an active RFID at a refinery plant of Becthel.

**Table.2.** Local RFID research status of the construction industry.

Applied field	Researcher	Main contents
Total field	Choi,Chul-Ho (2004)	Application case study on RFID system at the construction field
	Lee,Hae-Hyeon et. al (2006)	Suggestion of constructional disaster reduction method by using RFID technology
	Ju,Hyeon-Tae et.al (2007)	Applicability analysis of RFID technology at the construction site and suggestion of its direction
	Jang,Sang-Heok et. al (2007)	Evaluation of local RFID technology application status and suggestion of trend
	Yoo,Jae-Min et. al (2008)	Suggestion of construction automation system by using RFID/USN
	Yu,Hoi-Chan et. al (2008)	Suggestion of problems and improvement method for utilizing RFID technology at the construction site
Labor Control	Yoo,Hoi-Chan et. al (2008)	Suggestion of improvement method through satisfaction degree survey for RFID technology at the construction site
	Kim,Tae-Geom et. al (2004)	Suggestion of efficient labor control method by utilizing information management technology at the construction site
Material Control	Han,Jae-Gu et. al (2007)	Development of labor control system of the construction site by utilizing RFID technology
	Lee,Min-Woo et. al (2006)	Basic research on applicability of RFID in rebar works
	Han,Jae-Gu et. al (2006)	Establishment of material control system by using RFID technology
	Ryu,Jeong-Pil et. al (2007)	Suggestion of material real-time monitoring system by utilizing RFID/USN linking system
	Gu,Do-Heong et. al (2008)	Evaluation of main material features per each work types for assessing applicability of RFID technology

Kim, Yong-Bae et. al (2008)	Evaluation for applicability of RFID technology in curtain wall materials
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In the local case, relevant research was started later than the foreign case but practical use of RFID is being progressed very rapidly in the local construction site in reality. IT D middle standing construction company is employing RFID based system in labor control and soil transport control at 40 number of local construction sites and in 2004, D company and S construction company together with Sungkyunkwan University had applied a control system linked with the concept of RFID and 4D CAD at the construction sites.

Current research status on RFID utilization at the local construction industry is as follows(Table. 2).

Research on RFID technology application for the overall fields of the construction site has been carried out actively at the initial stages and currently research on RFID technology for the segmented fields of labor control and material control is under progress. In addition, as the case of actually applying RFID technology at the construction site is getting increased, research on utilization method of RFID application, problem evaluation and improvement method is being implemented actively.

**2.3. Status of Biometrics Technology**

Biometrics is to recognize identification automatically based on physiological or behavioral features and this method is being utilized as an alternative method for existing PIN or password and various identification cards that is exposed to easy forgery, theft and missing.

The system based on this biometrics is a kind of pattern recognition system that recognizes individuals by determining its authenticity through comparing the result of measuring any specific physiological or behavioral features that is the inherent property of the users with the features previously measured. Currently diversified biometrics system including fingerprint, iris, retina scanning, voice, facial/hand configuration is being utilized in real time recognition.

In the construction industry since the latter part of 1990, diversified system including the systems recognizing fingerprint, iris and configuration has been applied and operated at the construction sites of the large construction companies in order to implement material/labor force control efficiently, owing to the active development of electronic recognition system.[4]

However, fingerprint recognition system was failed in its operation as the fingerprint wearing condition of about 20% of the total laborers was too serious to be recognized and configuration recognition system was not successful in its site application as hand configuration of laborers is changing differently depending on the labor severity and working time, resulting in significant error in the process of accuracy adjustment.

In case of iris recognition, required time for recognition was somewhat long and retina scanning was faced with emotional rejection. Site application for this system proved to be unsuccessful due to high cost of relevant equipments as well.

Currently hand vascular pattern system that is confirming personal identification by evaluating vascular information distributed in the hyperdermia of the back of the human hands is in the limelight of the relevant industry as well as the construction sites owing to its features including high serviceability, fundamental forgery prevention and psychological stability of the users.

**3. Problem evaluation of current system and suggestion of improvement method**

**3.1. Problem of RFID system in access management**

Typical problems could be summarized as follows in the standpoint of access management of RFID system currently being utilized at the construction site.

(1) Problem of RFID tag missing

Risk of missing of personal belongings including name card built with RFID chip and cards is very high. Once lost during working, it will be difficult to find it again considering a complicated site features and possibility of damages could be considered. In addition, it will take time for arranging reissue of RFID tag for its processing procedure and the expenses for reissue will be incurred.

(2) Reproduction problem of RFID tag

RFID tag can be reproduced at will and therefore this may create a serious safety/security-related problems directly related with labor control.

(3) Confirmation of proxy attendance

RFID tag can be carried by any other person than its owner. Therefore proxy attendance can represent site access, working/leaving and safety education that required exact information.

(4) Decline of carrying RFID tag

Though RFID chip is being used in a diversified form, decline of carrying this tag is occasionally observed due to living pattern and recognition of the laborers

(5) Problem of RFID recognition rate

Currently at the construction site. the system using the frequency of 13.45Mhz is mainly applied considering construction cost budget. However the system using this frequency has its limitation in miniaturizing the chip size and more than anything else its recognition distance of 0.1-1m is too short and tag should be contacted with reading machine directly.

**3.2 Suggestion of improvement method**

**Table.4.** Comparison between hand vascular and RFID systems

features	Hand vascular system	RFID system
Consuming	-	RFID tag

efficiency		
Carrying efficiency	-	low
Proxy checking	impossible	possible
Recognition speed	0.4sec.	between 1 ~ 5sec.

Hand vascular based access management system has its own features that can solve the problems of RFID based access management system as explained previously. The following table.4. is summarizing the features of RFID recognition system and hand vascular pattern system and in terms of consuming efficiency, carrying efficiency, proxy checking, hand vascular pattern system is showing somewhat more superior quality in its function. Therefore control for labor, security and safety could be realized through more efficient site access management by using hand vascular-based access management system and furthermore it is expected that the exact data required for labor control could be obtained.

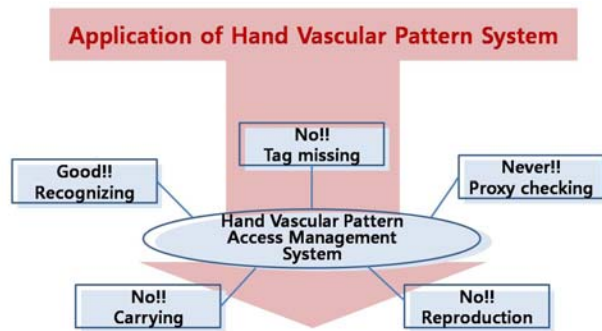


Fig.2. Suggestion of improvement method for hand vascular pattern system

#### 4. Design of Access Management Automation System for the Construction Site

##### 4.1. Design of Access Management Automation System for the Construction Site

Basic concept of hand vascular-based access management automation system is as following Fig. 3. The system was developed in a form of ASP and its structure was designed to be operable by the various construction companies for a number of construction sites

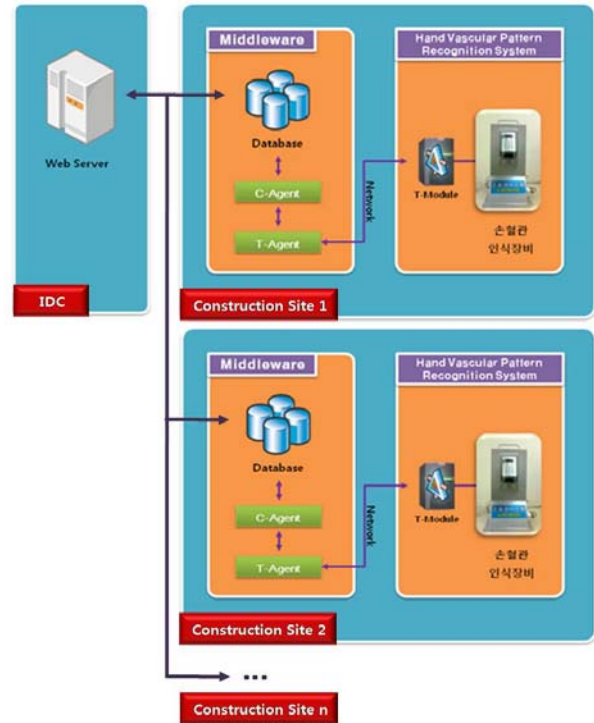


Fig.3. Hand vascular-based system composition.

Hand vascular information recognized at the site will be transmitted to the site server computer passing through a comparing working module and controlled. In addition, the site server computer was connected with IDC and its information could be controlled by the head office as well, not by the site. Therefore various sites could be controlled by one single web server.

##### 4.2 DB Design of Access Management Automation system for the construction site

Hand vascular-based access management automation system will control the following items for system operation.

- (1) Basic code required for the system operation
- (2) Interfaced information required for the effective operation of the site including public notice, notice board, data room
- (3) Laborer's personal history(career), health record, working record, attendance/leaving information, morning gathering attendance information
- (4) Management of information utilized for laborer's daily activity control including violation of safety rule, penalty control and commended laborers
- (5) Disaster control through management of accident report reception status of the laborers
- (6) Education schedule per each sites, control of education attendee and education attendance result
- (7) Management of usage breakdown of safety control cost, daily safety report, safety working schedule, safety inspection-related contract control
- (8) Material requisition control related with safety



control.

For this purpose, following data base was designed and the most important laborer control design is as following Fig. 4 and the role of each table is as follows.

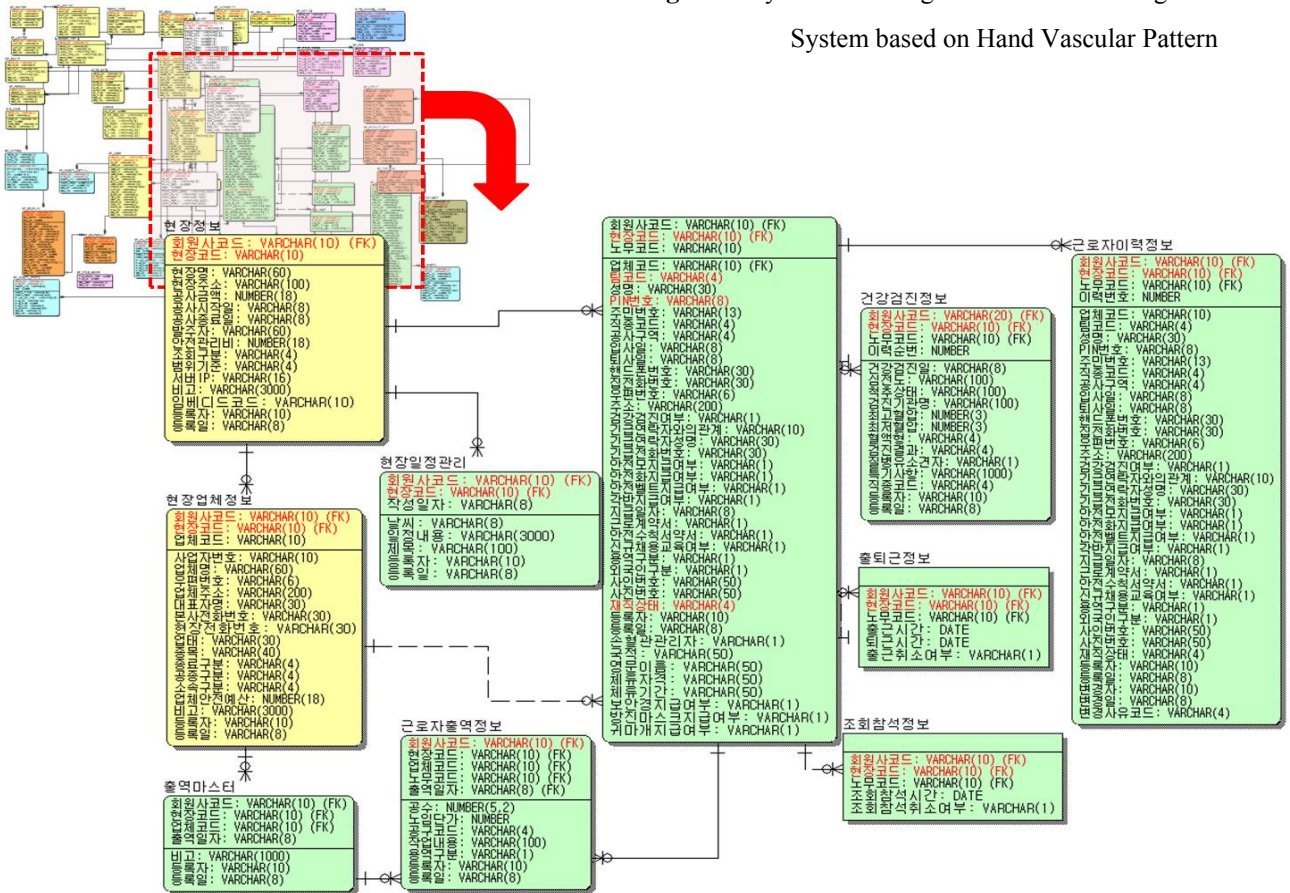
- (1) Site information: As the biometrics-based safety control system is controlled per each sites, control for the information of the relevant sites is required.
- (2) Site daily schedule control: As the working laborer is controlled based on the site daily schedule, information for the schedule is required.
- (3) Information for the sub-contractors: Control of sub-contractors mobilized on site
- (4) Mobilization master: Control of mobilized manpower depending on each sub-contractors
- (5) Laborer mobilization information: Control of labor cost, working hours, working contents
- (6) Laborer information: Basic information required to be controlled for the mobilized manpower on site
- (7) Health examination information: Control of health examination results of the laborers that is the basic factor for site safety control
- (8) Attendance/leaving information
- (9) Morning gathering attendance information : Control of morning gathering attendance of the laborers

(10) Personal history information of laborers : If the laborer's information is changed, changed elements are required to be reflected in the personal history. Through automatic control of personal history information, this could be reflected in the labor cost estimation.

**4.3. Realization and application of access management system for the construction site**



**Fig.4.** Entity Relation Diagram of Access Management Automation System based on Hand Vascular Pattern



**Fig7.** Main picture of laborer control

Following result could be obtained as a result of operating the developed system installed at 30-odd number of the construction sites of 9 local construction companies.

- (1) Carrying inconvenience of the users was eliminated as RFID tag recognition chip was disappeared.
- (2) Advantages in terms of management and budgeting was generated as a result of the consumables like RFID chip being disappeared.
- (3) Proxy attendance practice at the time of attendance/leaving and various educational call was disappeared
- (4) Though recognition speed itself was faster than RFID but when data volume is increased, detection speed of the system itself took long time
- (5) Passing speed of security access gate took more time than that of the ordinary access gate.

In view of this, it is judged that the system supplement for enhancing recognition speed of the system itself and a new method of reducing security gate passing time are required in the future.

## 5. CONCLUSIONS

The purpose of this study is to develop hand vascular-based access management automation system that supplements the shortcomings of RFID-based access management system being widely used at the construction sites.

For this objective, theoretical consideration including access management system, RFID utilization status at the construction site and biometrics technology evaluation was implemented and additionally the problems of RFID access management system currently being used was analyzed.

Based on the evaluated result, hand vascular-based access management automation system that has improved the shortcomings of the existing RFID system was established and prototype was set up. As a result of this establishment, carrying rate of the users was enhanced and management/budget reduction effect was felt at the site. In addition, attendance/leaving and proxy checking practice that creates a serious problem for labor control became impossible. However, if the labor data is increased, system detection speed was declined and passing speed through the security access gate was somewhat prolonged.

It is considered that the result of this study would be helpful in developing a new access management system as a prime technology in the IT field for the construction industry and in the future research, efforts will be exerted for improving any matters to be supplemented with a view to contributing to the enhancement of efficiency and practicality of the system.

## ACKNOWLEDGEMENT

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