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Application of Construction Management using Robotic Total Station and BIM Technology

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Abstract
With the rapid development of IT, the construction industry has been faced with a changing environment that requires BIM(building information modeling) to conduct integrated management of information that occurs during the whole life cycle of structures. In recent years, BIM has been introduced to the domestic construction industry after the announcement from the Public Procurement Service that promotes mandatory application of BIM to all construction projects with 50 billion won from 2012 in Korea. In addition, BIM software has been recognized as an essential tool for utilizing and managing the vast amount of construction information available during the whole life cycle of structures, which have recently become larger, diversified and more complicated. In this study, BIM system for the construction management was performed. In addition, applicability estimation of the BIM system was performed.

Keywords: Building Information Modeling, BIM System, Robotic Total Station, Construction Management

Introduction

Construction project pre-design phase is highly influential in setting the directions for the whole business and in project to proceed. Thus, it is essential to collect and analyze enormous amount of data related to construction project[1].There has been a change of paradigm of plan, design, construction, and maintenance technology simultaneously with the word of "irregular shaped building", "super-tall building", and "smart" throughout the construction industry[2]. BIM is a digital representation of the physical and functional characteristics of a facility[3][4].BIM is a computable representation of all of a building's physical and functional characteristics and related lifecycle information and serves as a repository of information for building owners and operators that is used and maintained throughout the lifecycle of a building[5][6].BIM is an emerging visual communication tool in the architecture, engineering, and construction industry[7][8]. Recently, various BIM applications have been applied during design and construction phases[9][10].

It is a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life cycle, from earliest conception to demolition[11].BIM technology makes it possible to integrate all information occurring to the process of construction has been leading[12].As a result, BIM technology that makes it possible to integrate all information occurring to the process of construction has been leading this paradigm[13]. Vast amount of construction information requires integrated management. Also, due to the changes of nonlinear design, the existing 2D design presented its limitations and it lead to new 3D design method[14]. Until now, BIM has been vigorously used in architectural field but construction field doesn't show much response to BIM[15].The purpose of this study is to apply BIM system for the construction management and to analyze applicability of the system.

Construction Management System

Execution of building works is most expensive field labor in construction and cost of rework is very high because impact on project schedule is greater. So, effective construction management is needed. In this study, BIM system MEP (Mechanical Electrical Plumbing) and Layoutby robotic Total station were used for the applicability estimation. The system consists of robotic Total station, tablet controller and prism pole. Figure 1 shows robotic Total station and tablet controller and Table 1 shows specification of robotic Total station[16].

Figure1: Robotic Total station and tablet controller

Table 1: Specification of robotic Total station

Model	RTS633
Horizontal Angle Accuracy	3”
Vertical Angle Accuracy	2”
EDM Accuracy	2mm (prism mode), 2mm (DR mode)
EDM Range	2, 500m (prism mode), 400m – 800m (DR mode)
Laser Pointer	Class 2
Radio Type	2.4 GHz
Radio Range	700m

Work flow of the system is as follows. The robotic Total station is setup in a convenient location on site. Two known locations are measured to determine the position of the instrument.

The robotic Total station measures to and tracks the prism on the Inverted Layout Rod to determine the operator’s location on site. Locations to be laid out are selected and the Trimble Field Link for MEP guides the operator to the location with Forward/Back and Left/Right information. The operator records the staked locations for as-built records while performing lay out. Figure 2 shows main screen of system and Table 2 shows the system’s main function.

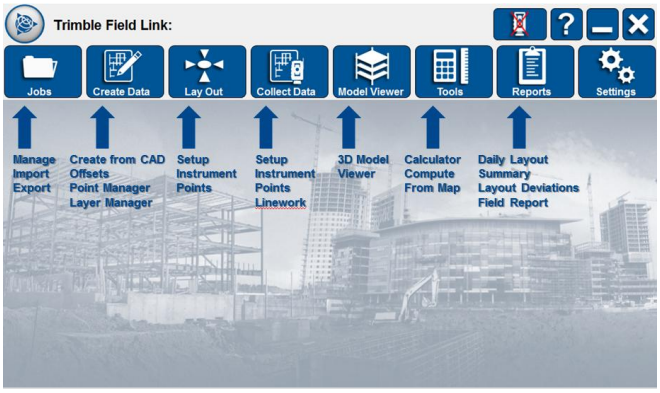

Figure 2: Main screen of system

Table 2: System’s main function

Function	Description
Lay out of points	- Equipment bolt down locations - Underground piping - Floor penetrations for piping - Wall penetrations for piping & duct - Anchor and hanger locations for suspended systems
Lay out of lines and arcs	- Underground piping - Wall penetrations for piping & duct - Anchor and hanger locations for suspended systems
Measure points	- Locate existing floor penetrations - Locate existing anchor and hanger locations for suspended systems
Measure lines and arcs	- Locate existing equipment boundaries - Locate existing piping & duct

Applicability Estimation of the System

In this study, the system was applied to the construction management for the application estimation. 2D and 3D CAD design drawing was imported to the tablet. Figure3 shows 2D CAD design and Figure4 shows 3D modeling design.

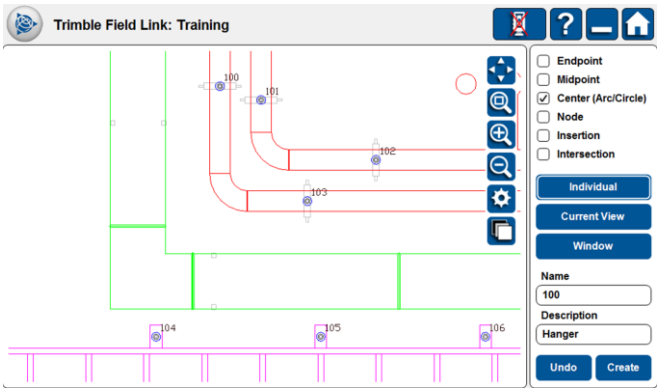

Figure 3:2D CAD design

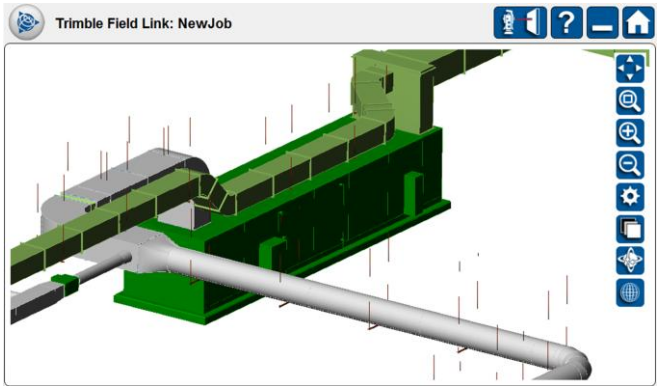

Figure 4: 3D Modeling design

User could measure the points in the drawing and check the error in the field at real time. So, it is possible to prevent an incorrect construction. Figure 5 shows the management report and Figure 6 shows construction error.

Daily Layout Summary

Date	
Time	
Contractor	
Trimble Field Link Job	

First Point Laid Out	8:36 am
Last Point Laid Out	3:46 pm
Total Points Laid Out	683
Average Points / Hour	96
% In-Tolerance	92%

Point Name,	Description,	ΔH,	ΔV
A100,	Sleeve,	¼”	½”
A101,	Hanger,	6”	½”

Figure 5: Management report

The report summarizes the day's layout with performance and quality metrics include of time stamp of first and last point laid out, total number of points laid out, average points laid out per hour, percentage of points laid out in-tolerance, list of points laid out with deltas. And the report is written as *.pdf file.

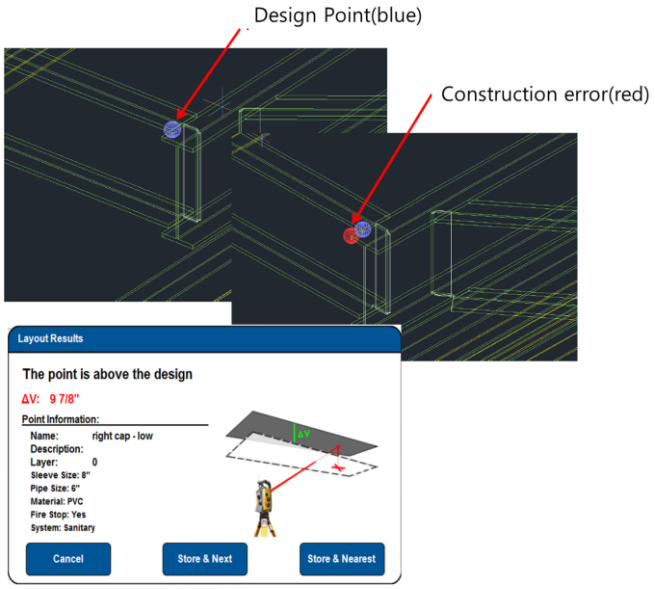

Figure 6: Construction error

The BIM system enable one person to handle layout faster and more accurately than two people using the traditional "yard stick" method, reducing labor costs and eliminating mistakes that lead to costly rework.Also benefits of the system is less required manpower because of no need to have an operator behind the instrument. The BIM system for the construction management would save the time and cost and utilization of the system is expected for improvement of productivity.

Conclusions

This study was aimed to investigate and estimate the application of BIM system for the construction management. BIM system using robotic total station was applied. BIM system MEP and Layoutby robotic Total station were used for the applicability estimation.Work flow of the system is as follows. The robotic Total station is setup in a convenient location on site. Two known locations are measured to determine the position of the instrument and 2D and 3D CAD design drawing was imported to the system. Using the system, user could measure the points in the drawing and check the error in the field at real time. And the system provides daily report that contains the day's layout with performance and quality metrics include of time stamp of first and last point laid out, total number of points laid out, average points laid out per hour, percentage of points laid out in-tolerance, list of points laid out with deltas. And the report was provided PDF files. The BIM system enable one person to handle layout faster and more accurately than two people using the traditional "yard stick" method, reducing labor costs and eliminating mistakes that lead to costly rework. Also benefits of the system is less required manpower because of no need to have an operator behind the instrument.So, it is possible to prevent an incorrect construction. The BIM system for the construction management would save the time and cost and utilization of the system is expected for improvement of productivity about construction fields. BIM system is not been put to practical use in Korea. So more study for the adoption of the BIM system is necessary.

Acknowledgments

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References

[1] Park, J., and Park, D., 2015, "Application of Building Information Modeling Solution in the Construction Management", Proceedings of International Workshop Architecture and Civil Engineering 2015, 100, pp.123-126.

[2] G. G. Lee, B. S. Kim, K. H. Ka, H. K. Kim, J. Y. Yoon, J. J. Kim and W. Y. Kim, 2009, "Prototype Development of a Spatial Information Management System for Large-scale Buildings", International Journal of Signal Processing, Image Processing and Pattern Recognition, 2(1), pp.17-26.

[3] Choi, J., and Ryu, H., 2015, "Application and Effects Analysis of BIM(Building Information Modeling)for Construction Management of a Construction Fiel", Journal of the Korea Institute of building construction, 15(1), pp.115-121.

[4] Park, C., and Park, H., 2010, "Improving constructability analysis tasksby applying BIM technology. Korean Journal of ConstructionEngineering and Management, 11(2), pp.137-147.

[5] J. K. Song and K. B. Ju, 2011, "A Study on Information Delivery Manual bout Disaster Prevention in the Facility Management Systems for Super Tall Building", Journal of the Society of Design Convergence, 10(6), pp.91-102.

[6] T. A. Nguyen gia, 2011, "Propose New Structure for the Buildings Model", Intrusion Detection Based Security Solution for Cluster-Based Wireless Sensor Networks, 31, pp.115-124.

[7] Kwon, O., Son, J., and Lee S., 2010, "Study on the application of 3D-basedBIM for school facilities to increase cost management efficiency", Journal of the Korean Institute of Building Construction, 10(6), pp.49-60.

[8] Lu, W., Peng, Y., Shen, Q, and Li, H., 2013, "Generic model for measuringbenefits of BIM as a learning tool in construction tasks", Journalof Construction Engineering and Management, 139(2), pp. 195-203.

[9] Kim, H., and Kim, Y., 2015, "Direction of Policy on Long-term Strategy Development for BIM", Transactions of the Society of CAD/CAM Engineers, 20(2), pp.133-144.

[10] T. Li, J. H. Kim and J. J. Kim., 2010, "Risk Management for Environment Protection in Job Site Utilizing BIM Method", Journal of the Korea Institute of Building Construction, 10(1), pp.111-114.

[11] Han, J., Lee, S., Jo, C., and Kim, G., 2015, "A Study on Development of Framework Based BIM Guideline System", Transactions of the Society of CAD/CAM Engineers, 20(2), pp.210-219.

[12] Seo, J., and Kim, I., 2008, "Development ofIFC Modeling Extension for the Exchange andSharing of Design Guideline Information in theArchitectural Design Phase", Transactions of theSociety of CAD/CAM Engineers, 13(5), pp.352-361.

[13] Seong, J., and Kim, G., 2011, "A Study inthe Development of BIM Guideline", Journal ofKIBIM, 1(2), pp.1-5.

[14] Kwon, O., and Jo, C., 2011, "Proposal ofBIM Quality Management Standard by AnalyzingDomestic and International BIM Guides", Journal of the Korea Institute Building Construction, 11(3), pp.265-275.

[15] Park, D., Kang, I., Jang, Y., and Lee B., 2015, "Prioritizing of Civil-BIM DB Construction based on Geo-Spatial Information System", Journal of the Korean Society for Geospatial Information System, 23(1), pp. 73-79.

[16] www.trimble.com