BIM+ Robot Creates a New Era of Building Construction

Xiaoying Chen, Qianwei Chen, Zhixiao Zhang, Yvting Cheng and Zhichun Qi
Zhejiang Gongshang University
Email:15268752285@163.com

Abstract. BIM, namely the Building Information Model, though has made up for the shortage of CAD 2D drawings in the design and exhibition stage, there are still some vulnerable spots in building construction such as the inaccurate positioning of basic components. BIM robots effectively solve the practical construction problems of BIM. This paper briefly describes the application and shortcomings of BIM in the construction industry, and then introduces the BIM robot through practical cases such as bridge, decoration and underground pipeline construction, and summarizes its advantages and disadvantages, and points out other development directions of robots in the field of construction engineering.

1. Introduction
As the second revolution of construction industry, BIM technology has the characteristics of high visualization, high data integration, simulation and synergy; these greatly accelerate the process of the design stage. However, in the construction stage, there are still many issues, such as difficult positioning, a large number of constructors, difficult construction, and tough management and so on. The emergence of BIM robot can not only accurately locate components, achieve seamless connection between simulated data and construction sites, but also can compare on-site data with simulated data, improve construction efficiency and speed up the progress of the project.

2. BIM

2.1. A brief Introduction to BIM
BIM is based on the information data of construction projects, and simulates the real information of buildings through digital information, and uses 3D building models to realize visual design, equipment management, engineering management and so on[1]. It has the eight characteristics of information completeness, coordination, simulation, optimization and drawing. Its core modeling software is shown in the following Figure 1. The core modeling software:
2.2. The advantages of BIM
(1) Intelligent control. The core technology of BIM is intelligent control, which plays a role in planning and design, bidding control, cost control, schedule control and construction simulation, and it improves work efficiency and increases economic benefits [2].

(2) Collaborative work. Using BIM technology in the design stage, all design specialties can design in collaboration with each other, in order to reduce the gaps in touch design defect missing [3].

2.3. The defects of BIM
(1) Large scale engineering has many structural components, and the structure is complex. So it is more difficult to combine the design model with the construction site.

(2) It is difficult to solve the difficult issues of design, construction and management caused by too many participants and constructors.

3. BIM+ Robot
The comprehensive use of BIM and robot in engineering projects can not only give full play to the advantages of BIM, but also make up for its shortcomings, so that its value can be maximized.

3.1. Overview of BIM Lofting Robot
The BIM lofting robot is an intelligent electronic total station that can automatically search, track, locate and acquire information of angles, 3D coordinates and images instead of manual. This instrument is a collection of modern high-end technologies. The BIM lofting robot can identify, analyze and locate the target points in the realistic world by means of CCD image sensors and other sensors, realize self-control, and automatically accomplish alignment, reading and other operations, so as to completely replace human manual operation and reduce construction cost. When measuring, the BIM lofting robot can be combined with BIM's plan, control, data processing and analysis software system to complete the measurement task instead of man [4].

3.2. Working Principle
(1) From the BIM model, we set the field control point coordinates and the building structure point coordinate components as the BIM model composite contrast basis, and create the lofting control points in the BIM model [5].

(2) In the approved electromechanical BIM model, the arrangement of the point position of the mechanical and electrical pipe hangers are set up, and all the layout points are introduced into the
Trimble Field Link software.

(3) Enter the scene, the BIM lofting robot is used to collect the data of the site layout control point, and instantly locate the site coordinates of the robot.

(4) Select the loifting point in the BIM model by the computer, and command the robot to launch infrared laser automatically collimation reality point, and realize “what you see is what you get”. Thus, the BIM model is accurately reacted to the construction site.

3.3. Characteristics of BIM Lofting Robot

(1) With its fast, accurate and intelligent advantages, BIM model can transform the data into the precise location of the construction site.

(2) Instead of using CAD drawings, operation mode and volume of infrared ink paper, greatly save time and labor.

(3) The precision of the equipment at millimeter level reduces the human error.

4. Practical application of BIM robot

4.1. Location of Ceiling of Ornamental Project

Traditional methods: Before the construction, according to the drawings, on the basis of the field axis, the main line of the main keel is released on the ground by using the tools such as tape and theodolite. Then the positioning point map of the hanger derived from the BIM model shows the location point of the hanger on the ground. Finally, use the infrared tool to reflect the point on the floor and mark it with the oil paint.

Robot positioning: The surveyors can reduce it by half, set up instruments, and debug equipment. Then the point in the BIM is directly reflected on the floor with a lofting robot, which is marked with paint, and halve at the time of usage.

With the same other conditions, the robot positioning method can greatly shorten the operation time, increase the efficiency at least 2 times, and improve the accuracy significantly.

4.2. Underground Pipeline Construction

The robot measuring and setting system is mainly composed of soft and hardware. The software selects layout coordinates and data from a variety of graphics software such as CAD and Revit. The hardware consists of a robot, a tablet computer and a prism rod. After the robot is in position, its suspension system can be automatically leveled automatically to avoid human operation error. And automatically pointing to the setting direction and launching a 360 degree omnidirectional laser to capture the mirror prism rod and automatically pair it, greatly simplifying the alignment operation and reducing the error of the reflector. The tablet computer and robot interconnect through wireless signal, control the steering and direction of the robot, and display the in place deviation between the prism and the target point in real time. Compared with the traditional total station, the robot total station does not need to be erected repeatedly, the whole process is single person operation, and the efficiency of setting up is increased. The docking of underground pipelines and other segments has been solved well. And can take more accurate measurements and real-time preservation for the tube wells, cable wells, electric valves, pipe and other completion point for, and effectively avoid the collision and conflict, improve the efficiency of acceptance.

4.3. Bridge Construction

Use lofting robot lofting large cross railway bridge pier pile and cement: ① Transform the BIM model into DXF format, and import data into CAD, add lofting points to pile cap and pier. The measuring robot is set up in the right position, and the post rendezvous method is used to set up the direction, and the graphic layout is carried out. ② To scan the pier after construction by lofting robot, and compare it with the original model [6].

5. Technical Summary

(1) The measurement robot can make up for the insufficiency of the accuracy of the BIM model
applied to the actual construction process, and can make the component layout accurately and ensure the safety of the quality of the project.

(2) Measuring robot greatly saves labor cost and saves time.

(3) The measuring robot can assist the management of the cost, progress control and cost control of BIM in the stage of design and construction.

6. Other Applications of Robot in Construction

Building robots can not only be combined with BIM and carry out efficient measurement and lofting, but also have other applications. For example, the super high rise surface spraying robot can not only solve the problem of high altitude operation safety, but also improve the speed and precision of construction; The full position welding robot can be used in the field installation and welding of super high rise steel structure, improving the quality of welding and ensuring the safety of the construction; The large board installation robot can be used for installation of marble wall panels, glass curtain walls, ceiling and so on for large venues, railway stations, airports, no scaffolding is needed, and two operators can accomplish large-scale mobile operation.(7)

7. The Significance of BIM+ Robot

The difficulties in the construction of BIM have been solved, and a new way is opened for the fine construction and management of the construction project. With the maturity of BIM+ robot technology, it will not only play a role in decoration, bridge construction, pipeline construction and other projects, but also will have some breakthroughs in other fields, and achieve efficient management and control of quality, cost and time.

8. References

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