博士論文（要約）

論文題目　Monitoring System
for Construction Management
on Job shop in Shipyard
(造船所のジョブショップにおける
建造マネジメントのための
モニタリングシステム)

氏　　名　刘　捷

The global economic slowdown in recent years results the even more intense competition in the international shipbuilding market. In order to take more opportunities and to survive longer in the brutal competitive international market, more and more Japanese shipbuilding companies have to use their powers as much as possible to increase their competitiveness, especially in fields of quality, cost and delivery. Construction management is used to manage quality, cost, delivery, etc., because it could provide construction information for understanding present work situation and making decisions in shop floors. But current widely used approach in shipyards has two important problems which are as below.

- First, current work record lacks in visualization and it can not provide enough detailed 5W information, which consist of who, did what, to which block, when and where. It is difficult for engineers to better grasp work situation and construction progress based on current work record.
- Second, current work record is collected and reported manually. It takes a long time for reporting work record by a paper based handwork means.

The main reason caused these problems is that shipbuilding is a job shop production. It requires some conditions, such as a worker transfers frequently, a worker need to do all operations, operations' order may be changed casually, work area is temporary and large, operations' working time are different from each other and so on. It brings on the difficulty of containing enough detailed information for work record, visualization and reporting in a short time.

In order to solve these problems and advance construction management in the shipyard, three very important issues should be well considered. For the sake of differentiating the word work record mentioned in the problem, words of raw work data and work instruction are used. The first issue is how to obtain effective raw work data from a real shop floor. The second issue is how to generate work instruction based on obtained raw work data. The third issue is how to make it visualization for analyzing generated work instruction and understand current work situations for construction management.

In the world of advanced information and communication technology, technologies of collecting vast amounts of diverse data, integrating management, visualization and its utilization, as well as various useful concepts and methods have been the focus of attention. These technologies, especially visual surveillance technology, wireless local

network positioning technology, etc., are expected to solve current problems mentioned above and realize advancing construction management to supply competitive vessels for Japanese shipbuilding companies.

The motif of how to introduce information and communication technology and use devices which are on the market for realizing advancing construction management motivates this research. The purpose of this research is to construct a monitoring system for advancing construction management in the shipyard. First, it means to introduce information and communication technologies to collect detailed raw work data from the construction shop floor as soon as possible and as automatic as possible. Second, it means to construct a visualized virtual job shop to generate work instruction using collected raw work data for understanding and analyzing current work situations.

In the research, a monitoring system is designed, structured and proposed to solve all problems and issues mentioned above. The monitoring system consists of two sub systems which are data collection system and virtual job shop system. The monitoring system could obtain related construction raw work data of blocks, operations and workers from a real shop floor as soon as possible and as automatic as possible. It could process these isolated obtained raw work data, generate visualized work instruction. It could search and view the specific video clip for analyzing generated work instruction, recognizing current work situations and doing construction management in shipbuilding. The results are expected to help to improve the situation of efficiency, progress, quality, safety, etc for advancing construction management in the shipyard.

In monitoring system, data collection system introduces some information and communication technologies for its construction, such as visual surveillance technology, human positioning technology, and so on. It could obtain and record isolated raw work data of locations and time histories of construction modules (blocks), several kinds of operations (welding, heating, grinding, gouging, etc.) and workers from the real shop floor.

In monitoring system, virtual job shop system proposes many methods for processing collected raw work data, generating the work instruction and visualization. It has two stages in general which are data integration and data connection. Stage of data integration is mainly used to process isolated raw work data and generate continuous task data. Stage of data connection is mainly used to generate work instruction from task data. A virtual job shop model is proposed in the data connection stage for

understanding construction situation. Virtual job shop system also provides some tools for finding and analyzing the specific video clip which we are interested in from mass video files by the searching item of event, time and so on. It could provide several functions of playing and viewing the specific video clip for analyzing generated work instruction and for understanding current work situations in detail and visually for construction management in shipbuilding.

The input of data collection system is the construction shop floor in a shipyard. Output of data collection system is obtained isolated raw work data and these data are the input of virtual job shop system. Work instruction, visualized information, and work situation management feedback are output of virtual job shop system. It could give feedback to the construction shop floor.

The originalities and innovations of this research are performed as following.

- Information and communication technologies are introduced on job shop of construction management in shipbuilding for collecting raw work data as automatic as possible and as soon as possible.
- A series of new methods and techniques are first proposed for monitoring operations and blocks in the complicated shipbuilding construction environment.
- A virtual job shop model is proposed for construction in the shipyard. It performed to represent shop floor work situations by using the data from information and communication technologies.
- Some new methods are proposed in data integration for processing isolated work data, and generating continues task data.
- Some new methods are proposed in data connection for extracting work result information and generating work instruction.
- Devices on the market are used to construct the system. It ensures the feasibility of widely and largely using in shipyards, and it reduces the development costs.

The framework of the dissertation is generally represented as below.

Chapter 1 is the introduction of this dissertation. In this chapter, the background of the research, the purpose of the research, the approach of the research, the framework of the research and the difficult points of the research are represented.

Chapter 2 is the research review of this dissertation. In this chapter, related researches in visual surveillance, human positioning, fabrication models and behavior analysis are reviewed. General methods and limitation of these researches are represented and concluded. Difficult points of this research are affirmed and validated.

Chapter 3 represents the data collection system which is one of two sub systems of the monitoring system. In this chapter, the data collection system is represented in details. Problems for collecting raw work data are analyzed, methods and techniques of the image processing and object positioning of diverse interested objects in the construction shop floor are proposed. The feasibility and availability of proposed methods and techniques are validated by cases.

Chapter 4 represents the virtual job shop system which is the second sub system of the monitoring system. The virtual job shop is constructed as a suppositional construction shop floor using the computer. In this chapter, the virtual job shop system is represented in details. Problems for processing raw work data and generating work instruction are analyzed. The stage of data integration and the stage of data connection are represented in detail. In these two stages, methods of saving data calculating time, reducing data noise, combining data, etc are represented in detail. A virtual job shop model is proposed to represent the job shop constructing in the construction shop floor. Methods of connecting data, extracting information, etc are represented in detail. The feasibility and availability of proposed methods are validated by cases.

Chapter 5 introduces the prototype system of the monitoring system. In this chapter, at first, devices which are used in the monitoring system are described, their parameter and setting are given. Then integrated development environment of the system is represented. And then, the prototype system is represented in detail. Windows and functions are described, experiments' pattern is depicted, and some cases are studied, analyzed and discussed. The feasibility and availability of the prototype system are validated.

Chapter 6 is the conclusion and future work of the dissertation. In this chapter, the conclusion of the research is concluded, the future work and prospect of the research are represented.