A Development of 3D Simulator Program for Performance Valuation of Port Transportation Systems

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Abstract: Due to the fast growing rate of the global container trade, every major port is under the pressure of meeting the projected capacity demand. As a result, alternative solutions have been sought for improving capacity and meeting the growing demand for container storage area and terminal capacity. Moreover, material handling process re-engineering is now a critical issue for logistics and supply chain managers of airline, shipping lines, terminal and warehousing enterprises around the world. Therefore, the purpose of this paper is to develop the 3D simulator for executing performance valuation of port transportation systems. The developed 3D simulator system is to measure the effectiveness of the proposed total system and compare it with existing practices. The performance analysis variables are also defined for these comparisons

Keywords: Automatic Guided Vehicle (AGV), Linear Motor-based Transfer Technology (LMTT), Port Automation, Transportation System, Navigation Algorithm.

1. INTRODUCTION

Material handling process re-engineering is now a critical issue for logistics and supply chain managers of airlines, shipping lines, terminal and warehousing enterprises around the world. While creating place and time utility, material handling is considered as a non-value-added activity. Distance and time of material handling, times of re-handling, and the amount of Work In handling Process (WIHP) play a substantial role in the final cost of goods. Estimates of up to 50% of the cost of goods are attributed to material handling and logistics. Maritime container terminals are now faced with higher volume of traffic, limited land, larger vessel sizes, and lower profit margins.

Due to the fast growing rate of the global container trade, every major port is under the pressure of meeting the projected capacity demand. As a result alternative solutions have been sought for improving capacity and meeting the growing demand for container storage area and terminal capacity. Moreover, material handling process re-engineering is now a critical issue for logistics and supply chain managers of airlines, shipping lines, terminal and warehousing enterprises around the world. It is believed that the current container handling processes result in misallocation of expensive and scarce land in maritime sites, waste of capital in inventory, long waiting time of road- trucks and ships, and a larger fleet size of yard-trucks.

Recently, the term Automated Guided Vehicle Systems (AGVS) and the term Linear Motor-based Transfer Technology Systems (LMTTS) have become a keyword in publications and conferences addressing horizontal handling of containers in maritime terminals. The European Container Terminal (ECT) in Rotterdam, the Netherlands is the most automated container terminal in the world.

The purpose of this paper is to develop the 3D simulator program for executing performance valuation of port transportation systems to be used in next generation. Also, the 3D simulator system is developed to measure the effectiveness of the proposed total system and compare it with existing practices. Finally, the performance analysis variables are defined for this comparison.

2. SIMULATOR SYSTEM

In this section, we will explain the differences between the current simulator program and 3D simulator program developed in this research about port container terminal.

2.1 Limitation of former simulation system

The Former container terminal simulation system is executed with modeling an existing container terminal. Therefore, this kind of system has some disadvantages of not modeling of equipments which are under development or planed to be developed – AGV (Automated Guided Vehicle), LMTT (Linear Motor-based Transfer Technology), TTEC (Two Trolley Elevator Conveyor Crane System), etc. The basic problem of these kinds of simulation systems is that simulation model and the object is tightly coupled structure, so it can not reflect the new model.

Therefore, in this paper, the developed simulation system makes it possible to reflect the involved models dynamically, and to be composed with loosely coupled structure.

2.2 3D simulator system

The simulation system developed in this paper uses 3D graphic in order to improve the qualities of realism for users.

Especially, 3D graphic is very useful to express real mechanical mechanism in order to be quick of apprehension for users. The 3D crane model and 3D LMTT model for 3D simulator system developed in this paper are shown in Fig. 1 and Fig. 2, respectively.

Fig. 1 3D configuration model of TTEC crane system.

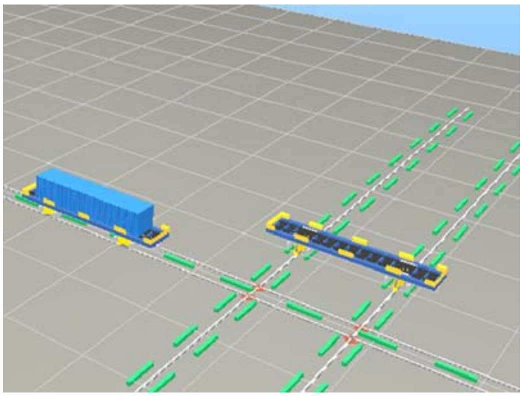


Fig. 2 3D LMTT model.

3. THE CONFIGURATION OF 3D SIMULATOR SYSTEM

The configuration of 3D simulator system developed in this paper is shown in Fig. 3.

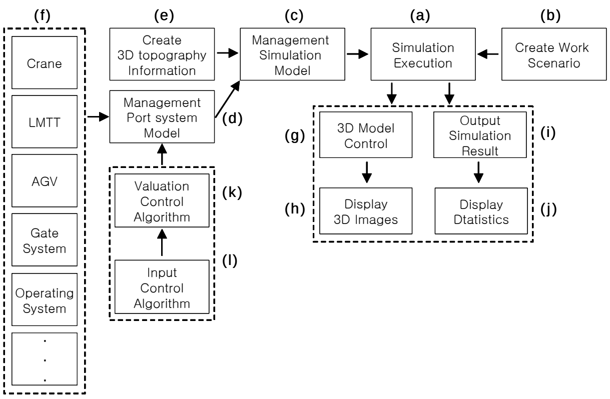


Fig. 3 Schematic configuration of 3D simulator system for a container terminal.

In Fig. 3, the composition of a developed 3D simulator system is composed of several modules and each module is also designed to be satisfied with interface. Therefore, although the newly port handling equipments are developed and required in further port surroundings, the 3D simulator system developed in this paper is composed of open type system that is possible without additional modifications.

Especially, the each module shown in Fig. 3 is organized as follows:

(a) Execution of simulation:
This module is main module to execute simulation using simulation model and working scenario. It also output the simulation result to be satisfied with simulation interface.

(b) Generation of working scenario
When accomplishing a shipment and a cargo work from the actual harbor, it happens and process the chain scenario anger and simulation accomplishment addition it is a module which creation carries through the script file it will be able to control. Work scenario the system user will create and directness it will be able to input, it will be able to select the scenario which it provides basically from simulation system.

(c) Management of simulation model
It is the management module for simulation and this is the control module for the model of port system which is managed by each module.

(d) Management of port system model
This part is the control module that manages only port system model, control server system or instrumental system. In case of request harbor and bay system model's information in simulation achievement department by module that take charge connection between simulation achievement department and harbor and bay system model, act role that pass relevant model's information.

(e) Generation of 3D topography information
It is paper mold of container terminal, work that design position light of contrariety, loading's dimension, gate of yard that user wishes to do simulation. And it is also able to heighten believability of simulation manufacturing topography such as actuality terminal.

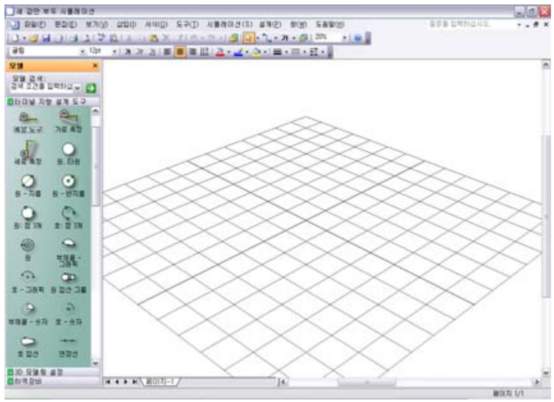


Fig. 4 An execute screen of topographic information map.

(f) Port system model
This is the characteristic modeling module that all systems used to container terminal are represented by shipment and cargo work equipment (carne), yard transfer equipment (AGV, LMTT), gate system, operating system, respectively.

(g) Control of 3D model
This is the control module of 3D image model using the output information of 3D images to be displayed by simulation results.

(h) Display of 3D image

This module represents the display screen about 3D model.

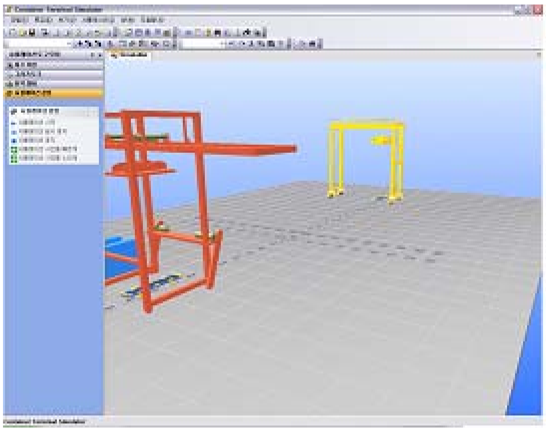


Fig. 5 The execute display of 3D image.

(i) Output of simulation result

As the output of numerical result for simulation result, this module displays the various information using numerical datum for users.

(j) Statistics display

This module is the schematic step using statistics results of various numerical data. As this module, the users can understand the simulation results easily.

(k) Evaluation of control algorithm

This module is to evaluate the control algorithm for input and generate script from simulation model.

(l) Input of control algorithm

This is the input module of control algorithm to express the characteristics of simulation system. Also, it generates the execution script through grammatical errors in input part of control algorithm.

4. EXECUTION OF 3D SIMULATOR PROGRAM

The practical execution steps of 3D simulator system developed in this paper are show in Fig. 6 and it gives a full detail of each step as follows:

(a) Start

As step for user to start program, this is state for the education about the program to end.

(b) Information input of terminal configuration

In the map information manufacture, this step is step to enter terminal map information as utilizing 3-dimension map manufacture program of fixed facility of arrangement and size of yard, and situation and size of terminal shipment

(c) Information input for handling equipments

This is the information input step of handling equipments for the initial conditions of port handling equipments and the quality of goods transported in port such as canes, AGV, LMTT, etc.

(d) Input of algorithm

This is the step to grasp an input condition of control algorithm based on the scenario of the quality of goods transported in the case of automation equipments.

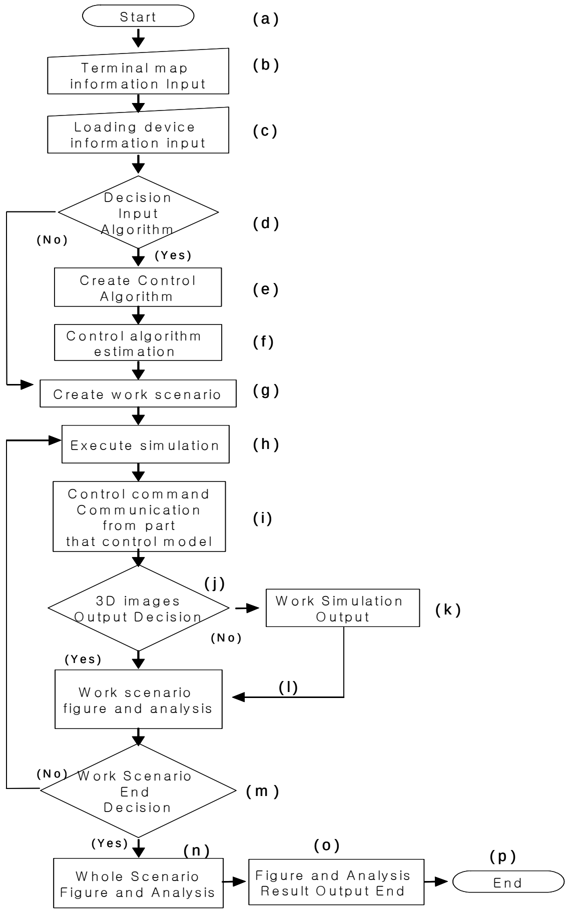


Fig. 6 The simulation flowchart of 3D simulator system.

(e) Creation of control algorithm

It is the step to create control algorithm of automation equipment in programming language such as C or C++ through the input of control algorithm.

(f) Evaluation of control algorithm

This is the input step of control algorithm for automation equipments after evaluating the effectiveness of control algorithm through the evaluation step of control algorithm.

(g) Generation of work scenario

This is generation step of various work scenario creation that includes imperative to deliver to each loading and unloading equipments using collating of all variables such as of loading and unloading equipment that is engaged in container trick that influence to work scenario of way such as condition in actuality terminal from part that create scenario, giving a summary state of yard, work creates various work scenario that is included. If there is no input condition of control algorithm, it creates work scenario justly.

(h) Execution of simulation

This step is the generation step of script that creates loading and unloading equipment information and scenario that is established from part that manage topography information of terminal and loading and unloading equipment model.

(i) Control command communication in model control part

To control the applicable model, this is the step of communication module for transmitting control command in model control part.

(j) Decision of 3D image output

It is confirmation step whether the options is selected in order to display 3D image for users.

(k) Output of 3D working simulation

When users select the commercial work process by seeing 3D virtual image in real time, this is the output step of 3D image for the pertinent work that transfers the scenario to the control part of 3D model through the output part of 3D simulation.

(l) Statistics and analysis of work scenario

As achieving work scenario from part that achieve simulation, this is the step for statistics and analysis such as container throughput of loading and unloading equipment, time that take in loading and unloading equipment, average transfer distance, etc.

(m) The end of work scenario

This is the verification step for all simulation results of work scenario to be created by 3D simulation program.

(n) Statistics and analysis of whole scenario

This is the step for statistics and analysis of whole scenario by syntheses of analyzed datum in each work scenario.

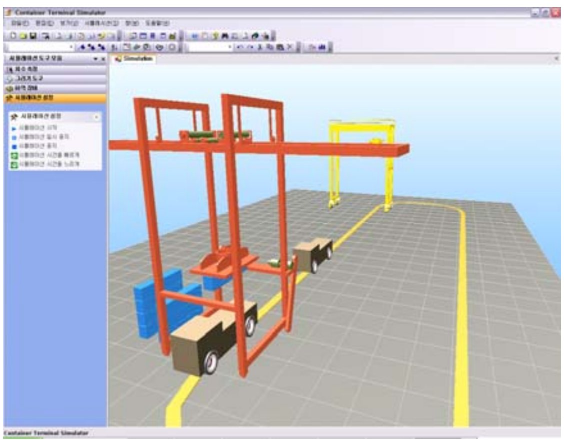
(o) The end of outputs for statistics and analytic results

This step represents the whole simulation results to users using each variety chart and table.

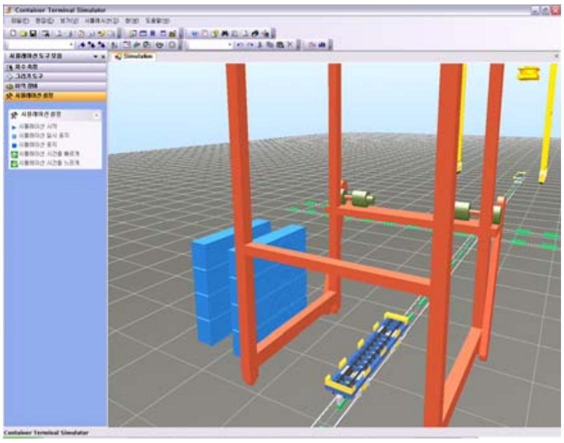
(p) End

The simulation program is completed.

Finally, the execution display of the developed 3D simulator system in this paper is shown in Fig. 7. Especially, in Fig. 7(a), this screen is represented the result of AGV system which is the typical transportation system for container cargo. Fig. 7(b) is the simulation performance result of LMTT that is the handling system of next generation.



(a) with AGV systems



(b) with LMTT

Fig. 7 The execute screen of developed 3D simulator system.

5. CONCLUSIONS

This paper is the development result of 3D virtual simulation system for the operation strategy of the harbor automation system in order to use actual harbor container terminal fields. Also, the developed 3D simulator system is to measure the effectiveness of the proposed total system and compare it with existing practices. The performance analysis variables was defined by these comparisons such as AGV, LMTT, etc.

As the result of this paper, the developed 3D simulator system can use the construction of new harbor transportation system and the development of the current container transportation terminal, respectively. Especially, this system can propose new performance evaluation and the design method compared with the existing method.

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