Visual Intelligent Simulation For Railway Container Yard Based on Agent

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Abstract

Being aimed at the characteristic of voluntariness and dynamics of handling machinery working in railway container yard, the structure of simulation system based on data-base and model base is put forward. Architecture of agent and process of system simulation are created for visual intelligent simulation for railway container yard according to agent technology. The simulation scene modeling, kinematics modeling, collision detection and other relative technologies are analyzed and discussed. A visual simulation platform is developed with Visual C++ at last.

Keywords: Container yard, Handling operation, Agent, Visual intelligent simulation

1. Introduction

Railway container yard which is a complex stochastic service system has great influence over operation efficiency of the whole railway container transport network. Being improved operating efficiency and reduced the cost of business, planning and decision-making should be scientific and effective for the yard layout, equipment and process.

Computer modeling and simulation are main analysis mode to the complex stochastic service system at present. It is necessarily to choice reasonable programs by modeling and simulation for save money, time and manpower. Many studies have been applied to the planning and process of the container yard at home and abroad so far. For example, animation modeling and digital simulation are applied to confirm the yard layout, handling equipment and handling process. These methods have obvious shortcomings despite the achievement. As a result of fuzzy result of the digital simulation user can not understand easily. Also result of the animation simulation is rough and third dimension lacked except for understandability. But visual intelligent simulation based on digital simulation and animation modeling integrate the advantage of both successfully[1][2][3]. Technology and method based on visual intelligent simulation are put forward for railway container yard simulation in text.

2. Configuration of Visual Intelligent Simulation For Railway Container Yard

2.1. Railway Container Yard System

The professional function of railway container yard includes transacting, loading, unloading, transit, change trains, safekeeping, delivery business etc. Its basic form consists of four parts such as railway loading and unloading line, truck operations corridor, container yard, handling machinery. Hardware environment of the logistics operation for the container yard is made up of these four-part which purpose is to handle, transfer and conservation. Handling machinery is a pivotal node that integrates yard logistics system into a whole in environment. Train group, trucks and container yard are linked together by handling operation for maintain running of the entire yard logistics system. Thus handling machinery is the primary study object in container yard simulation because efficiency of it has decisive influence over capacity and efficiency of the entire yard to a large extent. Operation flowchart of the railway container yard is shown in figure 1.

2.2. Structure of Visual Intelligent Simulation System

Characteristics that incarnate the complexity of railway container yard simulation are make up of the complexity of system structure, numerous related factors and influence by random factors. Pivot of simulation is not only handling operation but also the randomicity of system according to logistics process of container yard. Operation process, speed and time

should be control accurately when simulating at the same time. According to above-mentioned the simulation system based on data-base and model base is put forward for visual intelligent simulation for railway container yard. In this system data-base shares itself with the graphics data, digital simulation and graphics simulation are performed simultaneously, digital simulation is applied to analysis of system and graphics simulation is applied to representation of digital simulation. Structure of the simulation system for railway container yard is shown in figure 2.

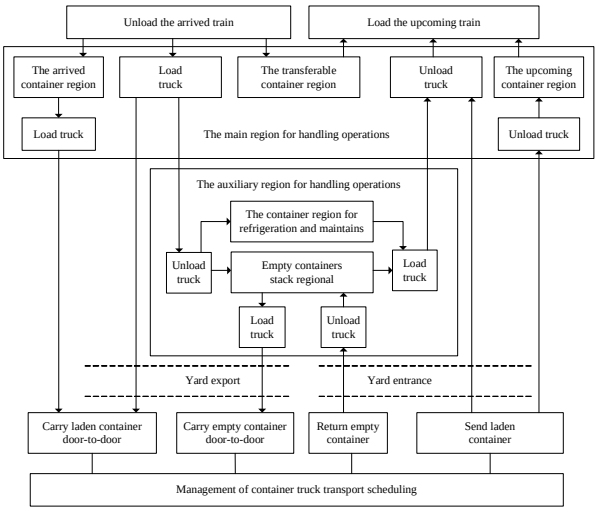

Fig. 1: Railway container yard work process.

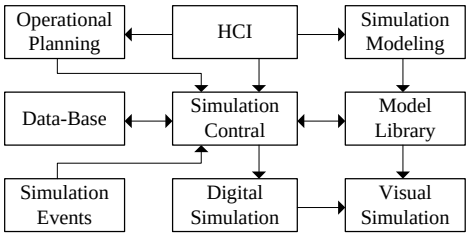

Fig. 2: Visual simulation system structure.

3. Modeling and Simulation based on Agent

3.1. System design method based on Agent

Railway container yard system concerns disposal of random factors, control of moving object and cooperative work between the machinery because of its dynamic characteristic and randomicity. The traditional modeling has not described such the complicated system properly. And yet Micro-Behavior and macroscopical phenomenon of the complex system could combine to form an organic whole by establishing model for the basic elements and interaction among the elements according to modeling method based on Agent. This modeling method which analyze from top to down and synthesize from bottom to up suits modeling and simulation of complex system. Especially it is beneficial to the interaction, intelligent behavior, parallel behavior and system control and so on. According to numerous research literatures and the need of container yard simulation, it is necessarily to adopt Agent technology when creating the simulation system.

3.2. Structure of Agent in Visual intelligent Simulation System

Agent in visual intelligent simulation system is described as follows. Agent running in a particular environment has the higher self-regulating capacity. It is capable of accepting the commission from another entity such as user, program, system or machinery and provide services for return. And it adopts the multifarious necessary action such as sociality and learning on its own initiative for apperceiving the environment change and making adjustment. In a word Agent in system has the commonly characteristics such as self-mastery, communications, response and cooperation[4].

Not only movement parameter such as speed and rev but also interaction such as restriction and collision should be considered for definition of object attribute such as color, material and shape and so forth in visual intelligent simulation. Structure and logic relation of Agent is shown in figure 3.

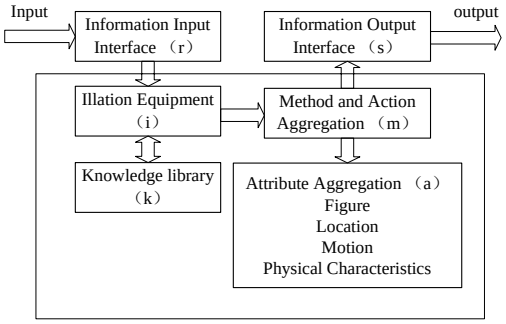

Fig. 3: Agent structure of visual simulation system.

3.3. Process of Visual intelligent Simulation Modeling based on Agent

The main process of visual intelligent simulation based on Agent for container yard is shown in figure 4.

Emphasis and kernel of simulation modeling based on Agent must be on establishing hiberarchy and model of the system in process.

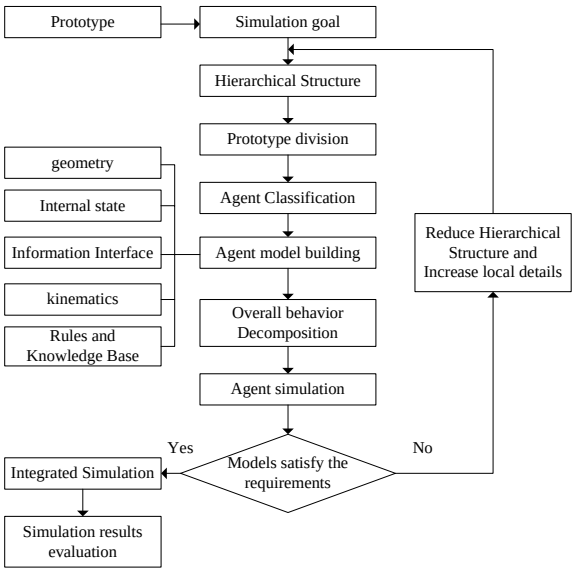

Fig. 4: Modeling process based on the Agent.

4. Pivotal technology and Solution

4.1. 3D Scene Modeling

3D scene modeling has two main methods at present. The first technology is based on computer GUI and texture technology. The second technology is based on modeling and production of image. The both have the technical difficulty which unable to overcome temporarily except for the respective advantage. The former influence the real-time of system because the mapped rate slowly despite HCI easy. The latter has some difficulties such as data integration and HCI performance despite the vivid image[5][6][7][8].

3D modeling based on computer GUI and texture technology is applied to visual intelligent simulation for real-time control of the target in scene. Real-time problem could be improved by special disposal and predigestion of the scene model. Detail means as follows. Above all the scene graphics profile should be created by establishing the 3D model of object one by one. And then the scene simulation could accomplish by fusion of the pre-installed the texture and map.

Composition of the simulation scene is shown in figure 5. 3D program is applied to modeling for the simple object. But modeling for the complex object requires two types of technologies. The first based on LOD could approach the real target gradually by establishing different model copies of the same target. System choose model which has different level automatically according to view distance. So vivid image could be achieved from the different sight and system running speed could be improved too. The second is applied to hiberarchy modeling of the moving objects. Moving object is decomposed into basic movement components according to transitive relation of the kinematics chain and each moving parts can be control independently.

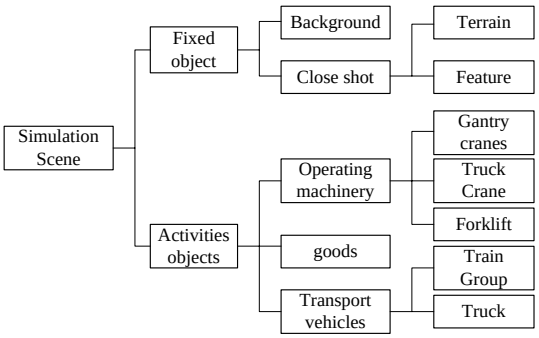

Fig. 5: Simulation scene composition.

4.2. Kinematics Modeling

Container yard simulation concern kinematics modeling of the two types of object. The first type is all types of transport vehicle which has simple movement such as train group and truck etc. It just needs to control the vehicle's speed and direction during the simulation. Another type is handling machinery which has complex movement. It moves not only itself but also its parts. For example, not only the syntheses but also its parts complete the unloading, transport and stacking when gantry crane unloading a container from train to yard under the restriction such as speed, acceleration, time, constraints and other conditions. So the complicated moving object should be decomposed into the unattached moving parts according to the relative movement. Then not only transform relation between the whole scene and the moving object but also relative movement among the moving parts could be found [9].

(1)Establish hiberarchy model of the moving object. Hierarchy would be established between syntheses and parts after the moving object has been decomposed into parts according to transitive relation of the transmission chain. Not only every individual parts of this hiberarchy model which is influenced by the syntheses movement could operate under the movement restriction independently, but also it could be assembled as the integrated object. For example, hiberarchy of forklift is made up of carbody → mast→ cargo fork; hiberarchy of gantry cranes is composed of moving machine →lifting machine →spreader.

(2) Set up transformation matrix of the movement which described by actual movement parameters. Three types of reference frame are applied to system such as World reference frame, syntheses reference frame and parts reference frame. Layout of the whole simulation scene and orientation of simulation object are described by World reference frame that is one and only in the whole simulation scene. Syntheses reference frame represent the machinery operating position in the World reference. Its change reflects the machinery operating position and dimensional azimuth in simulation scene. Parts reference frame reflect the inheriting relation of the movement between parts. The dimensional position of sub-parts is correlative with not only its movement but also the dimensional position of root parts because of the relative movement relation between the parts. So transform relation between syntheses or parts and the whole simulation scene could be confirmed according to the rate, way and relative movement relation of the operation machinery based on three types of the reference frame.

4.3. Collision Detection

Two types of problem should be considered in visual intelligent simulation for container yard. The first is collision detection when operation machinery is loading and unloading. The second is collision avoidance when operating machinery is driving.

Collision problem is a traditional problem in such realm as computation geometry, robotics, simulation and virtual reality etc. Some collision detection algorithm that suits the specific question has come true over the years [10]. But it is difficult to implement in general system because of the excessive theorization despite more effective in especial circumstance. Real-time of collision detection is the primary problem to all algorithms in 3D visual simulation. Then two types of collision detection technology are put forward for different types of campaigns simulation system in order to improve the real-time.

(1) The resegmentation detection algorithm based on bounding box technology is applied to handling operation. Bounding box technology combines with HV segmentation technology to form this method. For one thing traditional bounding box technology is applied to cursory collision detection for reduce the scope in which need accurate collision detection. Then object which is possible to collide each other should be separated by HV and detect again. This method not only satisfy the requires of accurate detection but also improve the detection speed

(2) Tidy plane detection algorithm is applied to collision avoidance during the driving of operation machinery. Collision avoidance which demand low detection precision is based on safe distance in container yard. And the movement track of vehicle keep in yard plane basically. Therefore bounding box technology may be condensed into a bounding frame at the plane. Specific steps as follows. Projections that object project on the horizontal plane could be transformed into the rectangle or polygon according to its figure and then transform the rectangle or polygon into the corresponding detection frame. In this way detection algorithm just judge the detection frame whether collide or not for quicken the detection speed.

4.4. Simulation Data-Base

Simulation data-base provides the dynamic and static information of container yard system for simulation and deposit the digital simulation result. The data is divided into three types such as static data, dynamic data and random data according to the data-base composing and railway container yard feature and create data-base for each. Static data which retain constant in a certain period of time describe the system parameter such as types and quantity of the machinery and yard layout etc. Data connect with system state should change when system state changed such as yard state. These changes are described by dynamic data. Random data describe some uncertain factors and influence such as train group and arrival of the vehicle.

5. Example of Software Exploiture and Intelligent Simulation

Simulation platform of the railway container yard is based on PC or graphics work station. It is make up of simulation data-base, model base, random events generator, HCI module, simulation computation and management module and 3D graphics display module etc. Container yard geometry module based on 3DS Max is transformed into OpenGL as 3D graphics interface. Software exploiture platform based on Visual C++ could connect with OpenGL easily and compile various algorithms and program expediently.

A basic process of railway container yard simulation is shown in figure 6. Basic parameters include simulation cycle, step length, original yard state, operating machinery work parameter etc. Affairs scanned by simulation come from two aspects. The first is created through random events generator and the second is appended through HCI. The scene of gantry crane handling operation in simulation environment is shown in figure 7.

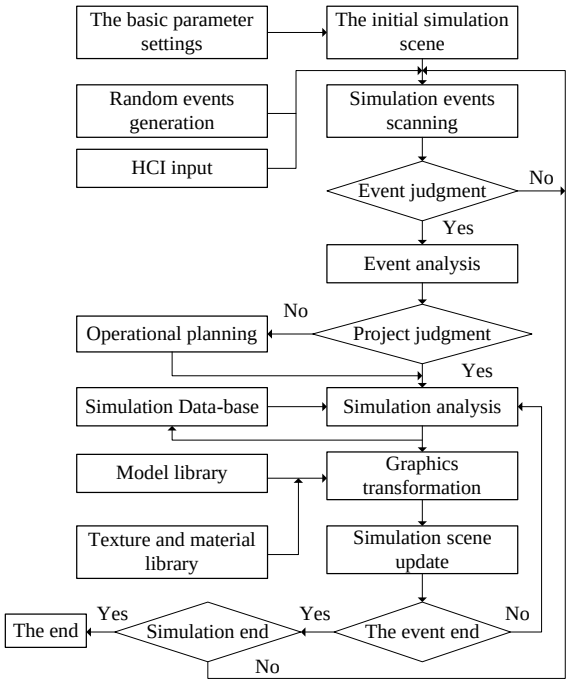

Fig. 6: Container yard simulation process.

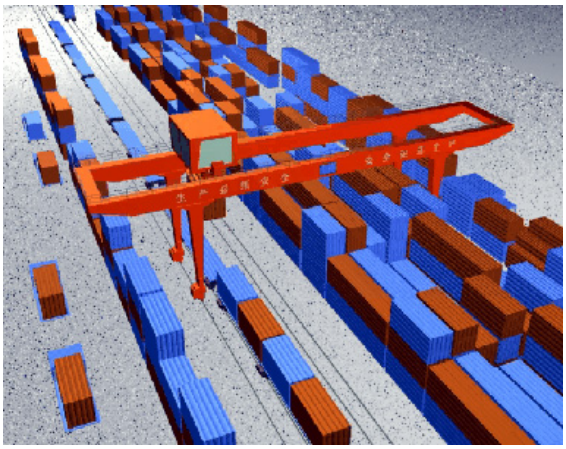

Fig. 7: Example of simulation scene

6. Conclusions

Visual intelligent simulation has been already applied to many realms but seldom to railway container yard simulation at present. Railway container yard simulation based on visual intelligent technology could overcome some shortcoming of digital and animation simulation such as not enough intuitionistic. And its process and result is visual and comprehensible. Analysis and research based on visual intelligent simulation for yard layout, handling machinery selection, operation management of railway container yard could provide reference for decision-making and saving of money, time and manpower. Visual intelligent simulation is one of the more effective method to railway container yard system because the complex system design based on Agent technology become easier and easier to realization.

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