An AGVS Management Model Utilizing 3D Animation Techniques

Young-Jun Lee, Koo-Rack Park, Dong-Hyun Kim

Abstract: *Background/Objectives: The AGVs used in the manufacturing sector for all types of material transportation related to manufacturing process are highly effective in the environments equipped with repetitive transportation patterns. However, since the User Interface of the AGVs management systems is mostly using a 2D system, it is quite difficult for the general managers to use. Accordingly, in this paper, we intend to propose a 3D animation styled management model which may be easily used by the general managers to enhance the efficiency of the AGVs management.*

Methods/Statistical analysis: Recently, the development of the semiconductor integrated circuit has sped up the performance of computers, and the processing speed for graphic work has also been accelerated, whereby the application industry is growing, including games and virtual reality. HMI, which is used for industrial purposes, is still generally used in 2D, and a system is operating for some parts to the extent of making them look in 3D with gradation effect. In This paper, we propose a management monitoring system using 3D animation for existing AGVs management system which is represented and managed in 2D. It is expected that AGVs can be used more easily and conveniently because the working conditions of the logistics robot can be directly observed on site through the proposed system.

Findings: As the need and level of interest related to the logistics technology have grown, researches on the automation and efficiency of the use of logistics have diversely been performed. However, the previous studies of the AGVs have largely been limited to those related to their own functions and performance improvement, and moving path, while the systems for managing the AGVs are mostly a 2D system. This is because only the users trained to operate the management system are eligible, and since it requires such a considerable amount of training time and effort to control for the general users, we have implemented a transport robot management system enabling motion via a 3D substantive animation whose form is almost identical to that of the onsite situation. The proposed model can create an animation environment as per the requirements of the manager and devise an AGVs operation plan as per the user's work requirements, further to directing the simulation performance for the actual operation and the operation of the AGVs directly. In order to design the optimal AGVs system, the user can create the same environment as the site in advance, validate the design of the AGVs system via inspection through simulation, and supplement and offer alternatives for issues based on the results of the validation process.

Improvements/Applications: Following the steep growth of smart factory, future studies would need to be performed on effectively connecting with the manufacturing execution system (MES) in connection with the network within the factory.

Keywords: 3D Animation, AGVs, IoT, Control System, Automatic Drive

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I. INTRODUCTION

Given the sophisticated advancement of the modern industrial society, the use of automated guided vehicles (AGVs), an unmanned material handling system used for the horizontal movement of the materials, is growing at the production factories. It is also used for the transportation of all types of materials related to the manufacturing process in the manufacturing field, and the use of the AGVs is highly effective in the environments equipped with repetitive transportation patterns [1].

AGVs are a material handling system [2] used to transport goods and materials in the automated areas such as loading, storage, and production stations, which is widely used following the accelerated development of sensors and IoT devices designed across each area of work where a series of work was performed by humans at the advent of the fourth industrial revolution. Furthermore, with the introduction of the conception of Industry 4.0 , the production, logistics and equipment industries are being upgraded overall, and many manufacturing companies are adopting intelligence, flexibility and automation concepts. With the development of the semiconductor integrated circuit, the performance of the computer is rapidly growing, and the processing speed for the graphic work requiring a large quantity of memory use is further increased, whereby the application industry such as game and virtual reality using the complex graphic is developing.

It is increasingly becoming common that the user interface works previously expressed in 2D are now expressed in 3D animation. However, 2D is still generally used for the human machine interface HMI) used for the industries, and the user interface is used to the extent some parts of the 2D HMI are displayed in 3D by the effect of gradation.

In this paper, we propose a system that can manage the AGVs management system, which is rapidly spreading along with the 4th industrial revolution, as 2D display and management through 3D animation. It is convenient for ordinary users to utilize AGVs even if they are not experts on AGVs by creating an environment in which the

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work situation of the logistics robot is directly observed on the actual field through the monitor of the management system.

The proposed system is wireless data communication between AGVs that are actually driven and the 3D animation management system, so that the two systems can be synchronized and the general manager can easily manage the AGVs system through 3D animation.

II. RELATED WORK

The AGVs systems, which are performing logistics related operations at factories and various industrial environments [3,4], are generally used directly to perform the transportation of products at various locations of the industrial environment [5]. The AGVs' movement and performance of work are called "mission," which can be performed in various types. In general, they are processed as a centralized controller called the warehouse management system (WMS)," which plays the role of assigning each mission to specific AGVs [6].

Once each mission is assigned a command to move for specific AGVs, the central controller should control the operation of the AGVs until the mission is completed, and in the case of single AGVs, various strategies can be used for single robot path planning [7]. Multiple AGVs sharing the same environment require a control strategy for optimizing the traffic, and while the central controller generally plays the role of controlling the movement of the AGVs [8,9]. However, there are instances where movement is performed following the road set which is called a predefined path map intended to simply the control and enhance the operation safety [6]. As the need for and level of interest in the logistics related technology increases, researches related to urban logistics, logistics transfer, efficiency, automation, unmanned technology, and eco-friendly technology have been actively conducted [10,11]. There has been a research on an RFID tag in which a signal strength is controlled when a moving object moves using a continuous movement CRR (Communication Range Recognition), which is an estimation algorithm that allows the user to recognize the current position together with the unique ID of the RFID tag [12,13,14]. Research on automatic algorithm of obstacle avoidance that creates a new trajectory with leaving the road map as it is [15] and AGVs equipped with exterior sensors, while executing the path of the segment, the robot sensor and input There has been research on automatic correction of paths to estimate calibration parameter variables using only commands [16]. In addition, the study of the optimal design method of the AGVs transport system using the transport network system of queue network theory [17], and the concept of transport control such as AGVs system design and track layout, number of AGVs required[18]. However, most of the previous studies have largely been limited to the function, performance improvement and movement pathway of the AGVs themselves.

III. RESULTS AND DISCUSSION

The following [Figure 1] is a commonly used AGVs management system, which is being monitored based on 2D. Each path is marked with lines like a subway map.

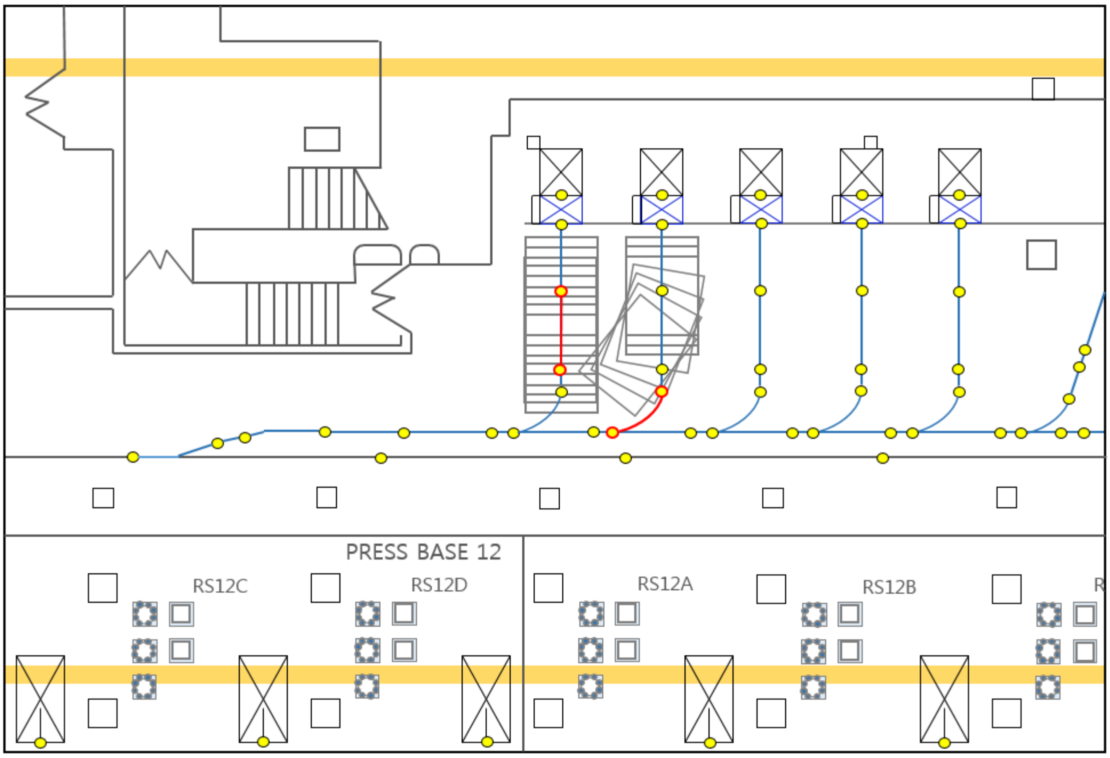

Figure 1. 2D AGVs Management System

Multiple landmarks are noted in the middle of the path in which mobile robots move, and are mixed with the positions of the transfer origin and destination for the objects.

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Such type of transfer robot management system is limited to the situational recognition for the movement of each of the AGVs for monitoring purposes, and it is difficult to know the details of how each individual AGV operates, so the AGVs management system is operated only by professionally trained users. A considerable training time and effort is required for unprofessional users to understand and effectively control the management system. Therefore, it is necessary to hire high quality human resources, and they should be trained for a considerable period of time after gaining precise knowledge about the situation of the site, and they must be maintained in order to operate the system at all times. The proposed system is a transfer robot management system which moves with the 3D substantive animation of the form almost identical to the situation on site as a management system. In addition, availing due diligence with ease and accuracy in the operation of each of the transfer robots while enabling easy recognition of the situation on site for the transfer robots for anyone by developing the transfer robot management system to another level in the form of planary monitoring.

The following [Figure 2] illustrates the AGVs executed within the automated production process.

It must be connected to the network for management, and a simply connected network can easily extend the AGVs system to a large extent with greater ease.

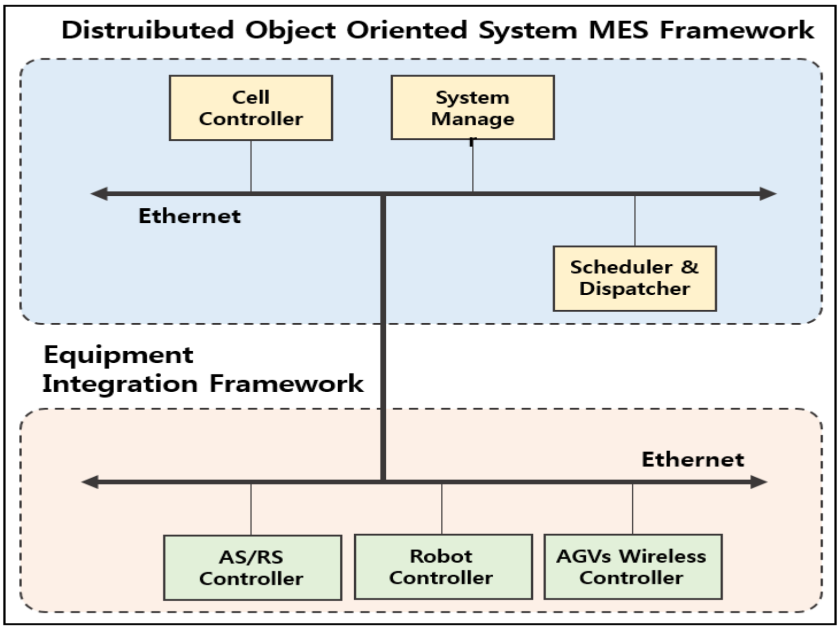

Figure 2. AGVs System within the Automated Production Process

The following [Figure 3] illustrates the architecture of the 3D animation AGVs management system, the proposed model. The 3D animation AGVs management system is consisted of three steps: create an animation environment as per the requirements of the manager, devise an AGVs operation plan as per the user's work requirements, perform simulations to actually move the AGVs, and direct the operation of the AGVs directly.

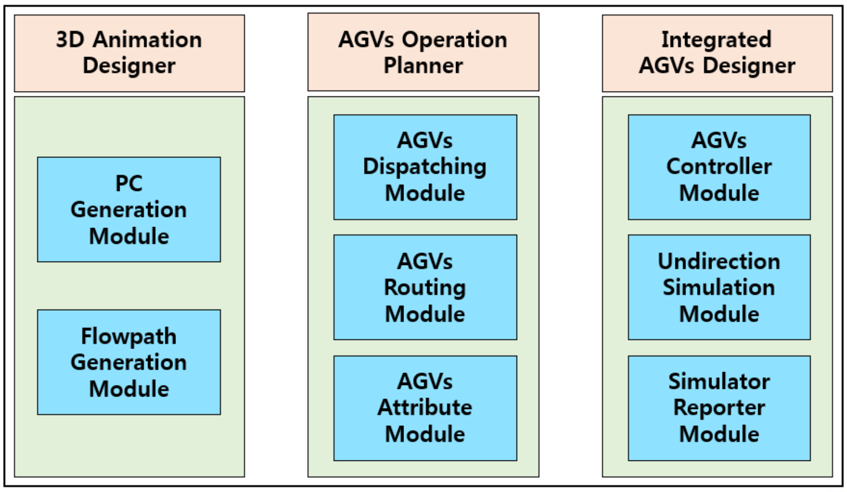

Figure 3. 3D Simulator's Structure

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The 3D animation AGVs management system is consisted of three steps: create an animation environment as per the requirements of the manager, devise an AGVs operation plan as per the user's work requirements, perform simulations to actually move the AGVs, and direct the operation of the AGVs directly.

To design an optimal AGVs system, the user could create the same environment as the site in advance, validate the design of the AGVs system by inspection through the simulation, and supplement and offer alternatives for issues based on the results of the validation process.

The following [Figure 4] illustrates the system process of the 3D animation AGVs management system, the proposed model. Operation begins by the user's start signal, and in the case of the simulation mode, only the simulation operation of the 3D animation is performed, and in the case of the operation mode, the AGVs of the site are simultaneously operated with the 3D animation. This function is intended to prevent the unexpected accidents by performing simulation in advance when the initial operation is designed. If there is no issue with the simulation's operation, the operator can direct the actual operation with the operation mode.

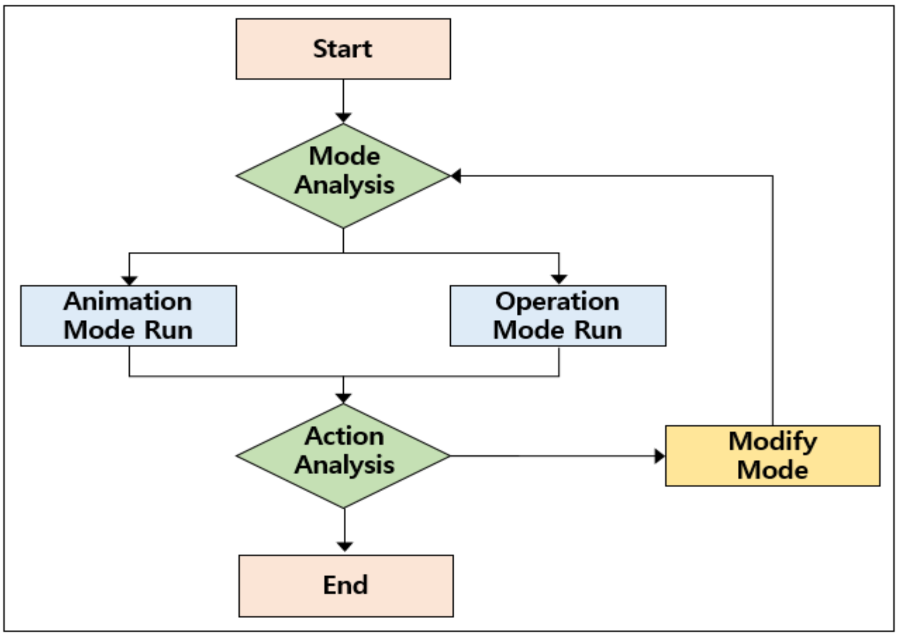

Figure 4. System Process

The following [Figure 5] illustrates the implementation screen of the AGVs management system's proposed model, which can be monitored and operated by the 3D animation method.

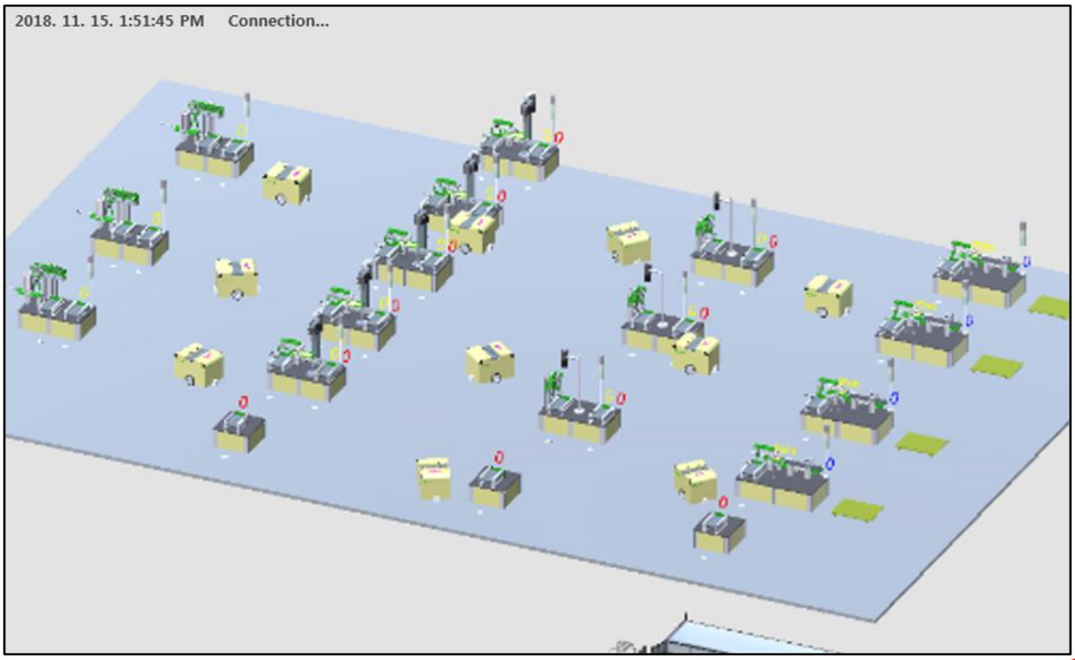

Figure 5. 3D AGVs Management System

The production equipments and the AGVs whose appearances are identical to those on site were modeled by using Solid-Works based on the drawings of the actual production equipments and AGVs on site, and the animation of the operation identical to reality was created by using Unity for the modeled object. The actual sensor signals and operational status for each production machine and AGVs are connected via the Ethernet wirelessly to transmit and receive data to and from the management system, thereby configuring the AGVs management system which operates in a synchronized manner with reality.

As each of the AGVs moving in the workspace identical to the industrial site for the whole is synchronized with reality and monitored in the form of animation, even the users without professional training could easily recognize each current situation, enabling effective operation of the AGVs.

If one intends to inspect the work situation in advance, simulation can be performed for the animation which underwent due diligence, so the movement interval of each of the AGVs is zoned, enabling to set the path for preventing collisions by and among the AGVs in advance.

As the management system can effectively share the roles of each of the AGVs, the cost entailed for various sensors intended to prevent high cost collisions invested in the AGVs performing the actual work can be saved, so the cost of the AGVs can be saved, which can facilitate the introduction of the entire AGVs system. If and when the operator needs to monitor each individual work situation for specific AGVs, it is possible to monitor the detailed appearance of the AGVs by enlarging each individual AGVs only. In particular, it is a management system enabling effective recognition for the work performed by the AGVs by identically implementing the movements of loading and unloading logistics beyond expressing movements.

IV. CONCLUSION

Recently, the use of the AGVs system has been rising in the material transportation related to manufacturing process in the manufacturing area due to the sophisticated advancement of the modern industries. The development of IOT through the fourth industrial revolution has sped up the progress of smart factory in the industrial field. AGVs are the material handling equipments used to transport goods and materials in the automated areas such as loading, storage and production station.

However, the AGVs currently undergoing development are subjected to the studies by which each of the AGVs strengthens functions to perform autonomous driving, avoids collision by using highly priced sensors such as radar sensors, reads obstacles and positions by mounting cameras to each of the AGVs, and avoids obstacles thereby. In this paper, the AGVs management system, which is monitored by 3D animation, can be used with ease by any average people untrained professionally by identifying functions required for the operation of the AGVs, while simplifying the hardware functions for the chassis of the AGVs growing in price due to the high performance sensors. The AGVs management shares most of the functions performed by the AGVs to enable lowering the price of the AGVs, through which anyone can introduce AGVs. Moving forward, studies will need to focus on making effective connection with the MES in connection with the network within factory.

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