Simulation Based Logistics Automation using ROS

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Abstract:

Conventionally, lots of logistic transport system use different kinds of methods for taking packages from a place and delivering it to another. Almost all of them use vehicles as a medium of transport which are driven by humans. Almost 90% of warehouse accidents related to vehicles happen due to human error, automating these vehicles can eliminate this error factor completely. With new technology and advancements in robotics and automation it's become easier to automate processes. Robot Operating System (ROS) is such technology it is a framework with set of libraries that makes it easier to build robotic applications.

Keywords – Logistics, Automation, Robot Operation System, Robotics, Gazebo

1. Introduction:

When you hear the term “transportation logistics,” what comes to mind? Many people mechanically link the term with offer chain management. whereas this is often true, it’s simply a tiny low portion of a comprehensive offer chain method. to place it merely, offer chain management encompasses each facet of fabric handling and distribution. This includes sourcing, producing, and therefore the final delivery.

Transportation supply is completely regarding managing material because it moves through the availability chain. This is often directly associated with however freights arehauled. whether or not it’s via truck, through the air, or by boat, this distribution model helps guarantee all product are being transported safely and expeditiously[2].

Automation of transport logistics means automating the medium I.e., the vehicle. This removes the dependency of the vehicle on humans at the maximum extent. This is done by providing the delivery vehicle with capability of decision making.

For the automating process, Robot Operating System (ROS)[5] is being used that not only provide a set of libraries that ease the whole process but also provide networking interface so communication and coordination between multiple systems is possible,

As this is a simulation-based study, Real world simulating software are used. There exists a bunch of software like Unity 3D, Coppelia Sim, Gazebo etc. Each one has its own speciality and works good for specific domains. We are using Gazebo as it comes tied with ROS and have good number of plugins available to use. It supports 4 physics engine ODE, bullet, simbody and dart. ODE is the default engine which is used for thisproject.

2. Literature Review

Dr. A. Pasumpon Pandian published a research paper called Artificial Intelligence Application in Smart Warehousing Environment for Automated Logistics " This study proposes use of the sensor networks to gather the information about the number of the items entering and leaving the warehouse and the artificial intelligence in properly handling them inside the store house."

In 2018, Renardo Baird published a research study by the name An Autonomous Forklift Research Platform for Warehouse Operations. " The project's goal was to give researchers a vehicle platform to experiment with advanced autonomy and push the limits of AGV capacity."

Tuan Le-Anh and M.B.M. De Koster published a research paper named A review of design and Control of Automated Guided Vehicle Systems. "This study showed a discussion on issues like guide-path design, estimating the required number of vehicles, vehicle scheduling (dispatching), idle vehicle positioning, battery management, vehicle routing, and conflict resolution for an AGV."

Suman Kumar Das published a research paper called Design and Methodology of Automated Guided Vehicle "This study showed the application of an AGV using a guided tape mechanism for movement".

Intellectualization of Logistics and Supply Chain Management proposed "A positive effect was found when implementing the digitization of logistics processes of transportation and distribution on the example of existing companies".

N Andiyappillai published a research paper An Analysis of the Impact of Automation on Supply Chain Performance in Logistics Companies where "The paper adds to the evidence that points to the successful use of automation of internal supply chain operations, the outcomes are recognised as being influenced by various choices and working characteristics".

Nor Rashidah Mohamad, Muhammad Hafidz Fazli Md Fauadi, Siti Fairus Zainudin,Ahamad Zaki Mohamed Noor, Fairul Azni Jafar , Mahasan Mat Ali published research paper by name Optimization of Material Transportation Assignment for Automated Guided Vehicle (AGV) System "This paper proposed a genetic algorithm with dispatching rule to implement. In order to perform with the effectiveness of genetic algorithm consideration of machine distance, dispatch waiting time was needed".

Satoshi Hoshino and Jun Ota published Design of an AGV Transportation System by Considering Management Model in an ACT "In this paper, the focus was on the design of a highly efficient AGV transportation system.They designed a highly efficient management model and clarified the need to consider an efficient system management.

Fernando Almeida, B. M. Terra, Gil Manuel Gonçalves, Paulo Sousa Dias published Transport with automatic guided vehicles in the factory of the future "This study shows the special requirement on AGV Transport intelligent units is the capability of carrying several products at the same time from different production cells to others. This means the position of each product carried by the AGV at the same time must be followed by a tracking system which manages the delivery process and provides quality data to the Quality Manager".

Luís F. Rocha, A. Paulo Moreira Américo Azevedo published Flexible Internal Logistics Based on

AGV System's "In this paper they proposed some possible solutions that could be used, in which conveyor-based transportation systems and AGV-based logistics were compared. It was proved that AGV-based systems are a powerful tool for the industry of present and future".

S. G. M. Hossain, Muhammad Yakut Ali, Hasnat Jamil, Md. Zahurul Haq published Automated guided vehicles for industrial logistics - Development of intelligent prototypes using appropriate technology "In this study the AGVs developed in the research were lightweight and, in some cases slow speed. These could be modified easily to meet the industryneeds and made heavy duty as well as fast operating robots.

3. Simulation

A simulation imitates the operation of real-world processes or systems with the utilization of models. The model represents the key behaviours and characteristics of the chosen method or system whereas the simulation represents however the model evolves beneath totally different conditions over time.

Simulations area unit typically computer-based, employing a software-generated model to supply support for the choices of managers and engineers still as for coaching functions. Simulation techniques aid understanding and experimentation, because the models area unit each visual and interactive.

Simulation systems embody distinct event simulation, method simulation and dynamic simulation. Businesses might use of these systems across totally different levels of theorganization.

The model utilized in this simulation is made using solidworks. The model characterizes a four Wheel differential drive vehicle with capability of traversing the setting on its own. It's conjointly equipped with a camera. The structure of the model isn't the perfect; it's created to induce the algorithmic rule operating within the simulation. Additional analysis is done to create the structure a lot of economical and capable of handling weighted packages.

Sensors Used:
Following sensors are used in this paper.

LiDAR: Lidar is a range-finding technique that involves using a laser to target an object and measuring the time it takes for the reflected light to return to the receiver. Lidar shown in fig.1, can also be used to create digital three-dimensional models.

Fig 1

Optical Sensor / Camera: The model scans the package for product ID for database and post processing. It needsa camera shown in fig 2 module to do its task.

Fig 2

Encoders: Odometer is used as motor encoder to generate the position and orientation of the vehicles.

4. Methodology

The very first step is to spawn the robot model in the gazebo along with a map. Obstacle and the package. This is done using the launch file that ros used to boot ros master and nodes. This launch file contains information about the basic setting of gazebo and spawning entities in the world.

The next step is to start the perception pipeline, the main aim of using the perception is to detect the marker on the package which tells us where the bot will deliver the marker. For the perception pipeline OpenCV, a python library was used which comes with a built-in Arcuo marker detection class as shown in fig 3.

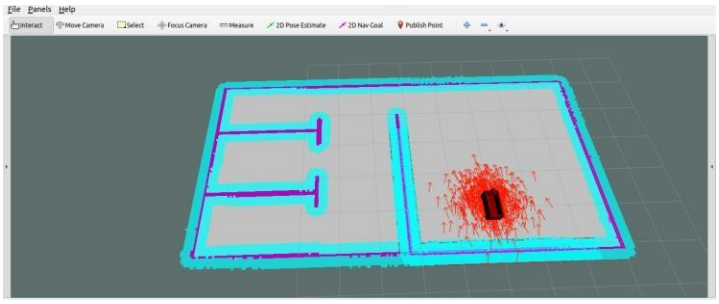

Fig 3

Once the marker is scanned, the robot finally gets its delivery location, which is predefined in the python script. The python scripts connect to the action server which forms a server-client relationship between nodes.Fig 4 shows the coordinate goal is then sent to the 'move base' action server and then the whole system waits for the server status on whether the bot has reached the delivery position. If the bot has reached the delivery position, the node will shut down itself, else the bot will keep trying to reach the destination.

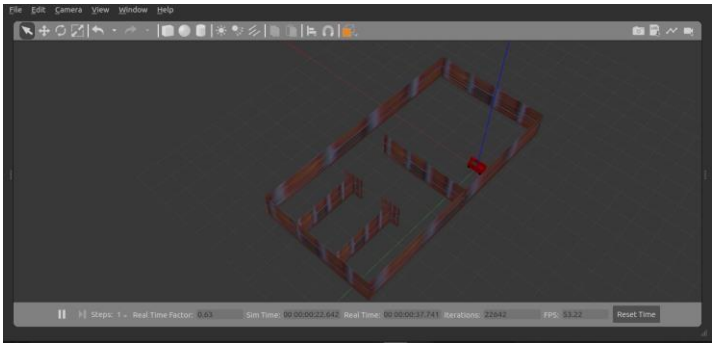

Fig 4

5. Conclusion

After the simulation of the automatic guided vehicle, we concluded that this system could be used for faster and more efficient ways of transportation of goods and products in the required space. The intelligent mapping system and avoiding the collisions with the help of LIDAR proves to be a key point in this system. However, the physical prototype might require consideration of speed limits and changes in load accordingly for smooth functioning of thevehicle.

6. References

1. Dr. A. Pasumpon Pandian "Artificial Intelligence Application in Smart Warehousing Environment for Automated Logistics" 2019.

2. Renardo Baird "An Autonomous Forklift Research Platform for Warehouse Operations" published in 2018.

3. Tuan Le-Anh and M.B.M. De Koster "A review of design and Control of Automated Guided Vehicle Systems", Published in May 2004.

4. Suman Kumar Das "Design and Methodology of Automated Guided Vehicle", April 2016.

5. Intellectualization of Logistics and Supply Chain Management, May 20

6. N Andiyappillai " An Analysis of the Impact of Automation on Supply Chain Performancein Logistics Companies" 2021

7. Nor Rashidah Mohamad, Muhammad Hafidz Fazli Md Fauadi, Siti Fairus Zainudin,Ahamad Zaki Mohamed Noor, Fairul Azni Jafar , Mahasan Mat Ali "Optimization of Material Transportation Assignment for Automated Guided Vehicle (AGV) System" 2018.

8. Satoshi Hoshino and Jun Ota "Design of an AGV Transportation System by Considering Management Model in an ACT" Jan 2006.

9. Fernando Almeida, Gil Manuel Gonçalves, Paulo Sousa Dias, B. M. Terra " Transport with automatic guided vehicles in the factory of the future" Sept 2010.

10. Luís F. Rocha, A. Paulo Moreira , Américo Azevedo "Flexible Internal Logistics Basedon AGV System's: A Case Study" Sept 2010.

11. S. G. M. Hossain, Muhammad Yakut Ali, Hasnat Jamil, Md. Zahurul Haq "Automatedguided vehicles for industrial logistics - Development of intelligent prototypes using appropriate technology" Feb 2010.