Trajectory Planning and Motion Control of Unmanned Forklift for Efficient Operation in Automated Warehouse

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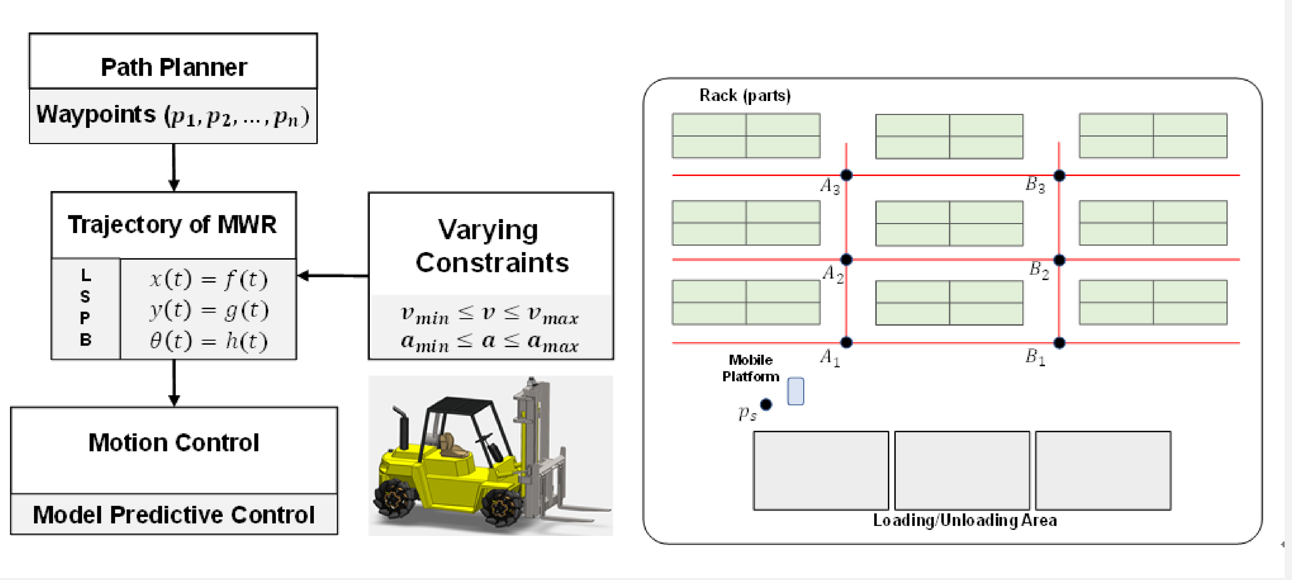
INTRODUCTION

- Development of an Autonomous Mobile Robot System for an automated warehouse
- Simplifying the movement of a Mecanum wheel robot
- Proposing a path planning method for the Mecanum wheel robot(MWR)
- Applying of advantage of the MWR to move in various directions uncomplicated [1],[2]
- Utilizing Linear Segment with Parabolic Blends (LSPB) algorithm to plan robot path [3]
- Applying Model Predictive Control(MPC) algorithm for motion control of MWR
- Providing a robot navigation simulation on MATLAB in a warehouse-like environment



< Navigation algorithm and simulation environment >

METHODOLOGY

- Path planning: **LSPB**
  - ✓ Utilizing the advantages of Mecanum wheels to define LSPB path planning algorithms to create a robot trajectory
  - ✓ Simplifying the MWR movement by assuming robot movement in 8 directions as shown in Fig. 2 (b)
  - ✓ Defining the waypoint from starting point P1 to endpoint P4 as shown in Fig.2 (c)
- Motion control: **MPC**
  - ✓ Using the MPC algorithm to control the robot
  - ✓ Derivative of MWR kinematics to generate robot wheel speed
- Simulation
  - ✓ Simulation tool: MATLAB, Simulink, MATLAB Mobile Robotics Simulation Toolbox
  - ✓ Simulation environment: Warehouse
  - ✓ Robot model: Four-Mecanum Wheel Mobile Robot

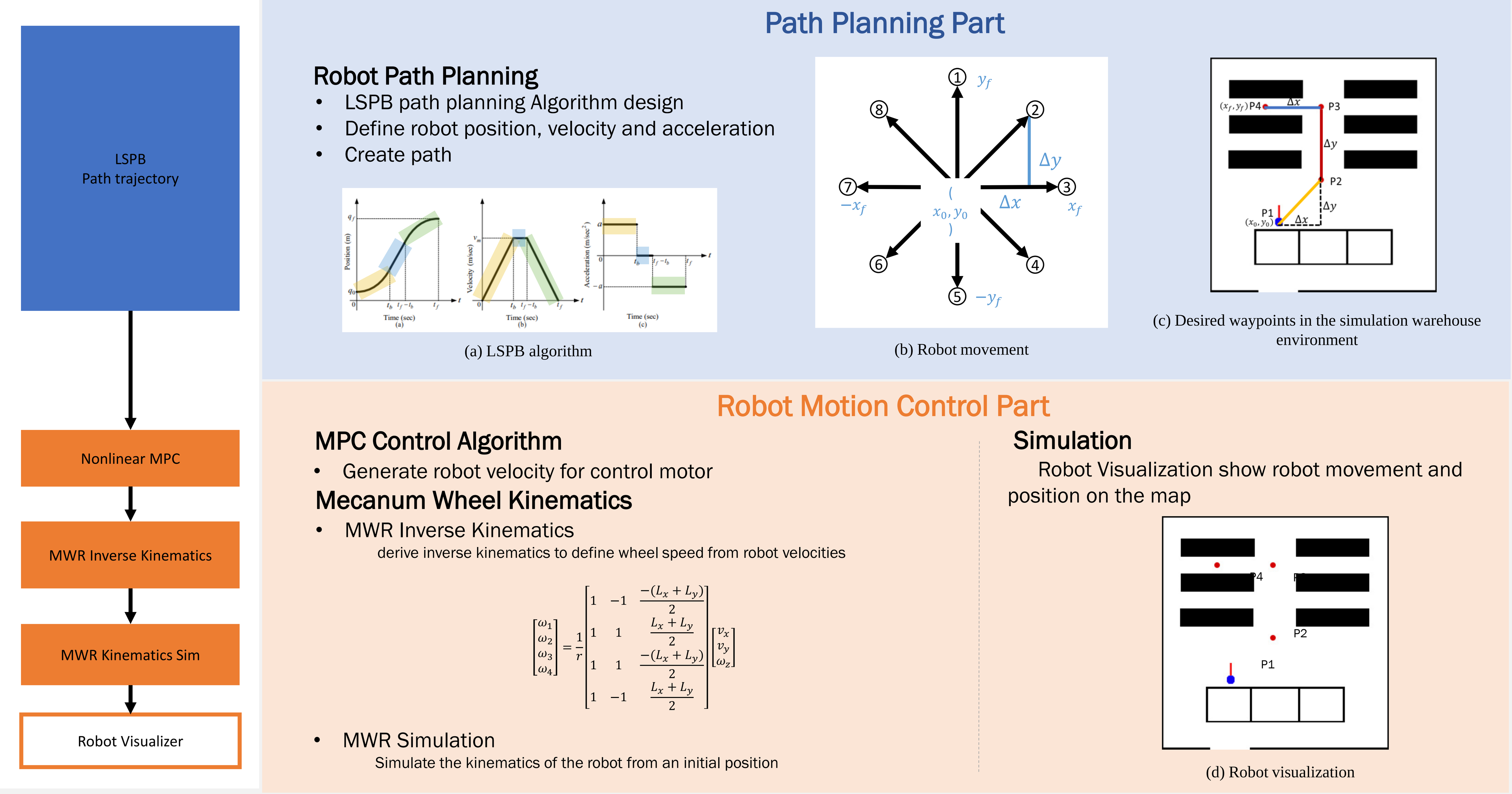
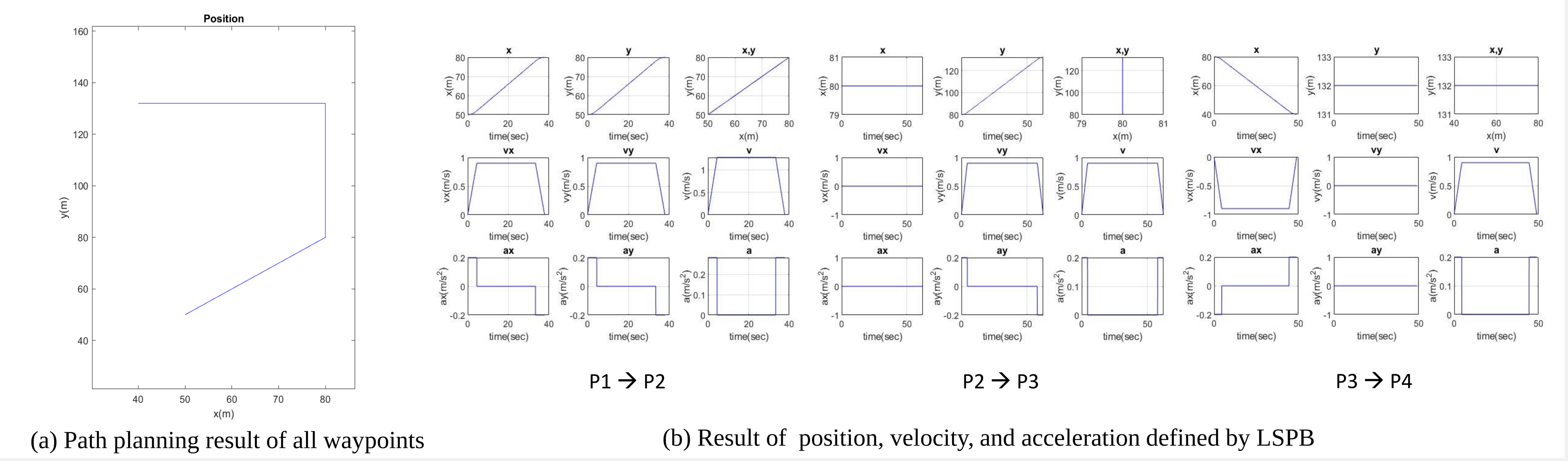


Fig. 2 Mecanum Wheel Robot Simulation Workflow

RESULT OF PATH PLANNING

- As the advantage of MWR, omnidirectional movement os possible including vertical, horizontal motions was shown in Fig. 3 (a) and (b)
- The planned trajectory shows that the robot's path can travel along all waypoints



(a) Path planning result of all waypoints (b) Result of position, velocity, and acceleration defined by LSPB

Fig. 3 LSPB path planning result

RESULT OF ROBOT MOTION CONTROL

- The result of the proposed path planning algorithm was used as an input reference for the MPC robot control model
- Robot motion control was defined by deriving Four-Mecanum Wheel inverse kinematics to navigate the robot pass through the desired trajectory
- Demonstrating the robot's navigation through the robot visualizer as shown in Fig. 5

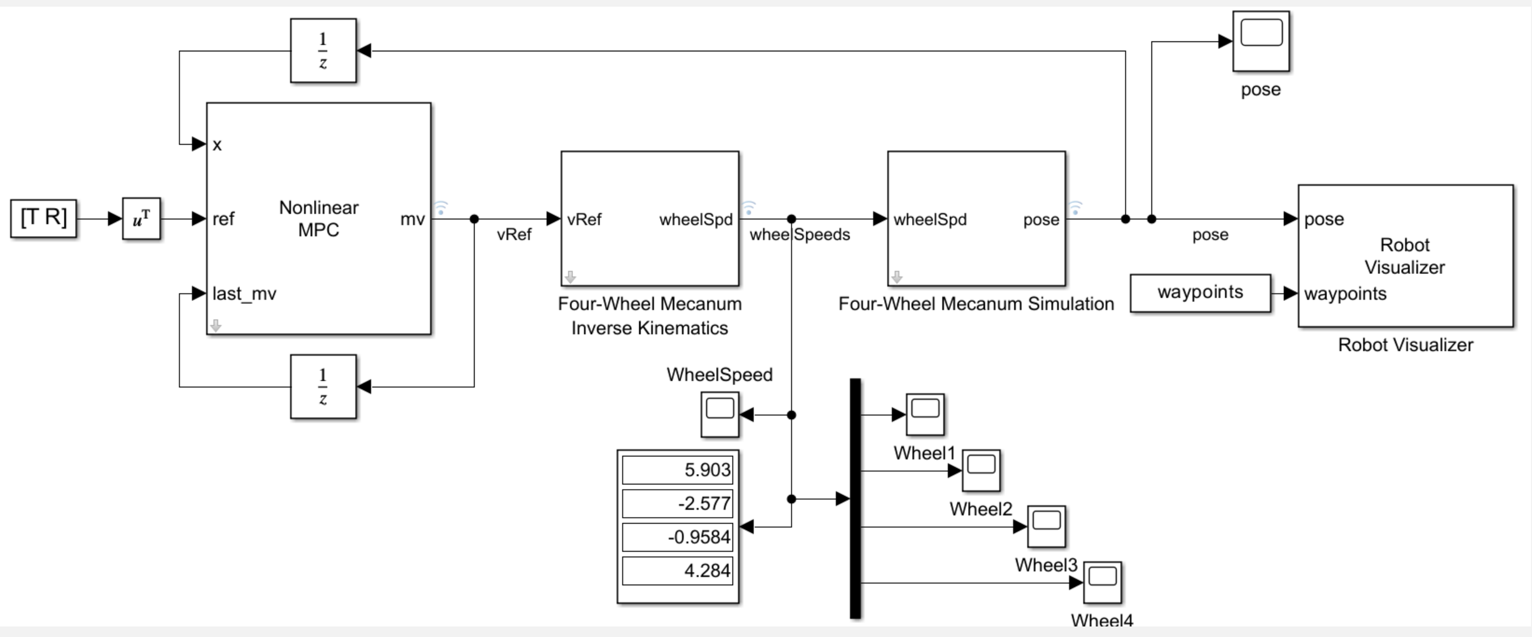


Fig. 4 MPC Simulink model

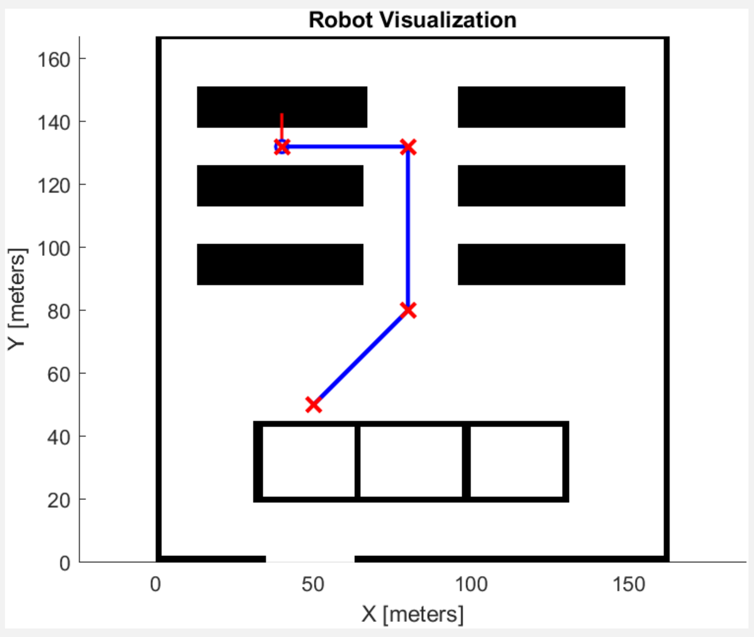


Fig. 5 Robot navigation simulation result

CONCLUSION

- Simplifying the robot path planning and making the most of the advantages of the MWR platform
- Linear Segment with Parabolic Blends(LSPB) was adapted to design the path planning algorithm
- Proposed path planning algorithm can offer a path where the robot can pass all desired waypoints
- The result of the navigation simulation show that the proposed algorithm can reach the robot at every waypoint
- The proposed algorithm will be used in future work on the MWR experiments

References

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