

Development of a Path Planning Algorithm for a Raspberry Pi-Based 4-Wheeled Omnidirectional Cellular Conveyor System

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ABSTRACT

The Industrial Revolution 4.0 has driven the demand for more flexible and efficient logistics systems. Conventional conveyors, such as roller and belt conveyors, have inherent limitations in accommodating diverse goods distribution routes, prompting the development of a 4-wheeled omnidirectional cellular conveyor system capable of transporting goods in all directions, including diagonally, with eight possible movement directions. This study aims to evaluate the performance of the Dijkstra algorithm in path planning on a Raspberry Pi-based 4-wheeled omnidirectional cellular conveyor system. The system is designed using a centralized control architecture, with Raspberry Pi serving as the central controller, ESP32 acting as a slave unit on each individual conveyor cell, and the I2C communication protocol interconnecting all units within the system. The research methodology encompasses hardware design, implementation of the Dijkstra algorithm through a graphical user interface (GUI) simulation, and simulation testing across three different grid configuration schemes (5×5, 7×6, and 10×8 cells), both in obstacle-free and obstacle-present conditions, followed by actual testing on a physical prototype. Simulation results demonstrate that the Dijkstra algorithm successfully completes the path planning process within a computational time range of 0.047 ms to 0.081 ms, well below 1 ms, with efficient active cell utilization observed across all tested schemes. However, under obstacle conditions, the algorithm tends to generate paths with a greater number of turns, as it optimizes only a single criterion, namely total path length. Actual prototype testing yielded a success rate of 86.67% in Scheme I and 80% in Scheme II, with failures classified into two categories: boxes deviating from the intended path and boxes becoming stuck midway along the route.

Keywords: *path planning, Dijkstra algorithm, 4-wheeled omnidirectional cellular conveyor, Raspberry Pi, conveyor system*