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### Automated Trolley System

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#### Abstract

Automated trolley system is a automated trolley that will move from source to destination avoiding all the obstacles in the path. The objective is to design and implement algorithms which efficiently generate the shortest path in a static and dynamic obstacle environment. The algorithms can be directly embedded into robots which can be used in the real world application. The advances in the capabilities of wireless transfer create an opportunity to control our trolley with the help of computer within the given coverage area with the help of wireless modules.

**Keywords:** Flood fill, Path tracing, white line tracing

#### Introduction

Trolley system has been used since ages to move goods from one place to another, the drawback of the old system is that it is manually guided from one place to another thus wasting human resource. The Automated trolley system will be autonomously maneuvered from one point to another. The system requires no human interference. The trolley will receive the initial set of instructions from the operator wirelessly. Based on this data the system will automatically generate the best possible path to traverse from one point to another. It also takes into account the static obstacles like walls, pillars, machinery etc present in the manufacturing area. The system is capable of detecting and avoiding dynamic obstacles such as people walking, goods etc. A lot of man power needed to push the trolleys will be reduced. The system is highly flexible and can be deployed at any area without the system going through much change. The objective is to design and implement algorithms which efficiently generate the shortest path in a static and dynamic obstacle environment. The algorithms can be directly embedded into robots which can be used in the real world application.

- The system uses white line sensor modules to navigate over the white lines.
- It uses obstacle detection modules to detect obstacles present in its path.
- The system uses shortest path algorithm to find a path between any two points which can be preprogrammed into the system.
- It gives real time output and is capable of demonstrating the actual scenario.

#### System Flow

Automatic Trolley system is a system which is used to move goods from one unit to another in a manufacturing area.

- 1) Initializing the initial and final coordinates: Coordinates are entered in the program.
- 2) Flooding the grid: The grid is flooded where each point is given a value depending upon the flood fill algorithm, taking into consideration the initial and destination coordinates and also based on the location of the obstacles.
- 3) Finding Best path: Based on the values after flooding the least cost path is chosen by the algorithm and stored in the memory.

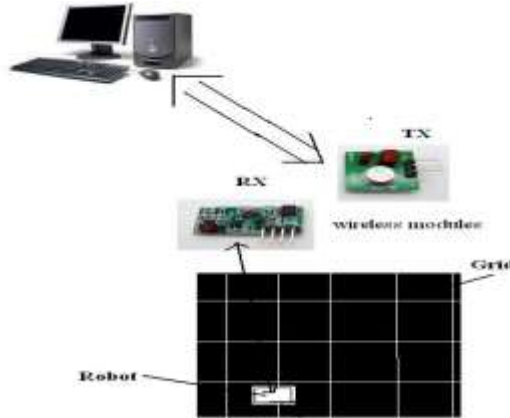
#### Trolley System

- The system will navigate over white lines over black surface that is the floor will be a grid of white lines over black surface.

- 4) Traversing the path: The path is traced by the robot by comparing the present coordinates with the next set of coordinates in the path, based on that it decides whether to move forward, left or right.
- 5) Detecting dynamic obstacles: Based on the input from IR proximity sensor the robot can sense the presence of an obstacle. When an obstacle is detected the system waits for some specified time till the obstacle moves. When the obstacle moves it follows the same path.

## System Architecture

Figure: System Architecture



System Architecture

The architecture diagram shows RF transmitter connected to the computer through COM1 port using RS232 connector and RF receiver placed on the robot that will receive the signals sent by the RF transmitter. Application monitors the data transmission between transmitter and receiver and detects break in data transmission. The main application installed on the computer allows setting source and destination coordinates, by taking these coordinates robot traverses from source to destination using the shortest path considering all the obstacles.

## Flood Fill Algorithm

This algorithm is used to flood the maze using flood fill algorithm. The flood fill algorithm takes three parameters: X coordinate, Y coordinate, value. The algorithm looks for all nodes in the array which are connected to the start node by a path of the target value, and changes them to the replacement value.

**Flood Fill** (X, Y, replacement-value):

- 1) If the value of node is less replacement –value, return.

- 2) If bounds of maze are reached, return
- 3) Set the value of node to replacement –value.
- 4) Perform **Flood- Fill** (one step to the west of the node, target –value, replacement-value).
- 5) Perform **Flood -Fill** (one step to the east of the node, target –value, replacement-value).
- 6) Perform **Flood -Fill** (one step to the north of the node, target –value, replacement-value).
- 7) Perform **Flood -Fill** (one step to the south of the node, target –value, replacement-value).
- 8) Return.

### 1. Tracing Flooded Path:

This algorithm is used to find the path from the maze which is flooded via flood fill algorithm. Based on the orientation of the present block and the next lowest point in the vicinity it goes to that point.

Find path (starting X, starting Y)

- 1) Checks the orientation
- 2) While the present point is not the final point
  - a) If orientation is north moves to the north
  - b) If orientation is south moves to the south
  - c) If orientation is east moves to the east
  - d) If orientation is west moves to the west
- 3) Stores the path in the memory

### 2. Path Tracing Algorithm:

- The robot knows its initial coordinates.
- It picks the next coordinates it has to move to from the queue which stores path.
- It subtracts final coordinates from initial coordinates.
- Depending on the value it decides whether it has to move left of the junction or right or continue moving forward.
- It does this till the entire queue is empty that means it has reached a destination.

### 3. White Line Tracing

The robot has to trace the entire path by following the white line and making sure it follows the coordinates. For white line tracing it

uses the white line sensors to follow the line. When only the extreme line sensors are on black surface it has to move forward. When the extreme left sensor comes on white line it has to turn right. When extreme right sensor reaches white line it has to turn left. At the junction all the sensors show white. That's how we detect a junction and based on junction function we trace the path.

#### 4. Obstacle Avoidance

There are two types of obstacles Static and Dynamic. Static obstacles are fixed in the area e.g. walls, pillars, installed machinery, etc. Dynamic obstacles are not fixed e.g. people walking, goods kept, etc. static obstacles are hard coded in the algorithm thus the program takes care of static obstacles. Dynamic obstacles cannot be determined by the algorithm initially. The obstacles are detected by proximity detection module. When an obstacle is detected it waits for some time till it moves. As soon as the obstacles move out of its way the trolley continues to move forward to the destination.



*Automated Trolley system*

#### Conclusion

The automated trolley system brings a whole new level of productivity to station to station material transfer for manual or automated assembly of large, complex products. The system is capable of choosing a shortest path amongst several possible paths while going from the source to the destination. It ensures an efficient way of transferring goods from one point to another without the need of much man power. The algorithm used is the flood fill algorithm which determines the shortest path.

The further improvement to the system could be:

- 1) We can integrate real time maze solving in the robot with path tracing. This will

enhance the ability of the robot to take on the spot decisions.

- 2) Making use of GPS to trace the route and position of the robot, thus making the robot independent of the computer terminal.

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#### Author Bibliography



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