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Fully Automated Industrial Segregation Robot

Automated Industrial Bot

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***Abstract*—This paper is aimed at creating a customized robotic vehicle or a platform, which can be used for industrial segregation applications. The object is picked up and delivered it the appropriate destination area based on the color detected. The GPS Framework is loaded onto the robot and the it has to navigate through pathways using accurate degrees of base rotation, following certain back pointers and virtual beacons to reach the correct destination area and deliver the object.**

***Keywords*—GPS Framework; Path Planning; Grid; Back Pointer; Virtual Beacons**

I. INTRODUCTION

An autonomous robot is a system that performs a task or behaves with a high degree of autonomy. Some modern factory robots are "autonomous" within the strict confines of their direct environment. The robot makes use of the color sensors to detect the color of the object and deliver it to the specified destination specified by GPS coordinates. The IR sensors are used to keep the robot on track. It should be able to adapt to the industrial environment by selecting proper pathways to navigate and drop the object at the desired location. The exact orientation and position of the next object of work and (in the more advanced factories) even the type of object and the required task must be determined.

II. METHODOLOGY

A. Mapping The Environment

First, a floorplan of required dimensions is created, depending on the site plan of the production plant or an industry[1][3]. This is known as GPS Framework. The internal representation of the map can be either metric or topological. It will be a two dimensional space in which the starting point, objectives and destinations are placed with the help of GPS coordinates. Mapping is done using NMEA format (Fig.1).

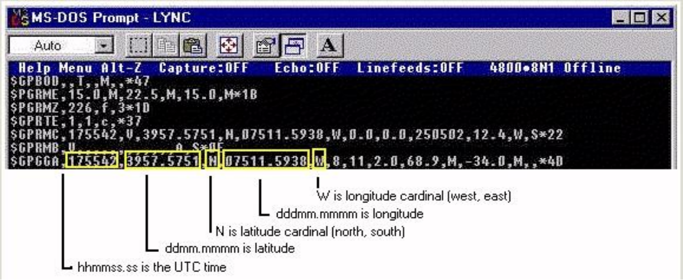

Fig.1: GPS readings in NMEA standard format

B. Path Planning

The robot will have to choose the correct path in order to reach the required destination. Difficulties often arise when there are errors during localization and are still incorporated onto the GPS map. This can obstruct the movement of the robot in an unvisited environment. This problem however can be solved by using electronic beacons i.e., by highlighting the entire pathway up to the required destination. The feasibility of real-time motion of the robot is dependent on the accuracy of the accuracy of the floor plan, robot localization and number of pathways.

III. BLOCK DIAGRAM

The block diagram (Fig.2) consists of an Arm/PIC microcontroller board with the required peripherals. There is a power source, which is used to drive the robotic vehicle via DC motors.

Sensor outputs are fed to the controller. Sensors comprise of one color sensor (TCS230) and 3 IR sensors. A GPS module is attached for loading GPS coordinates of the destinations.

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The robot can be controlled manually on a computer with the help of a RF communication module or with a mobile phone via GSM module.

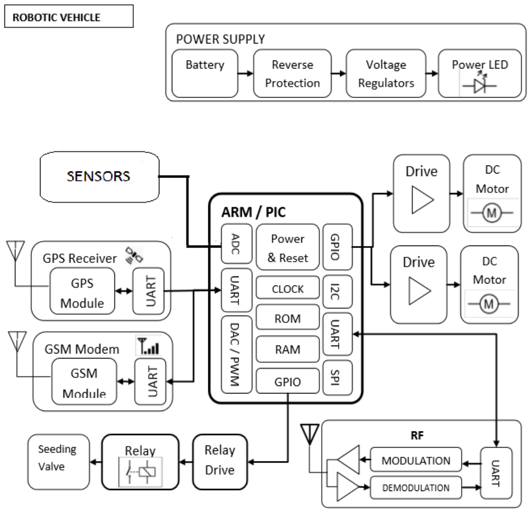

Fig.2: Block Diagram of Robotic Vehicle

IV. WORKING PRINCIPLE

The objective of the robot is to perform material segregation depending on the color of material and deliver it to required destination. The GPS framework is divided into grids, comprising of cells, rows and columns.

To replicate an industrial environment, the robot has to travel passages, following certain pathways according to the destination where is has to reach and return back to the starting point after the objective is delivered at the specified destination area[2].

The gripper/arm picks up the objective and places it down when the robot reaches the destination area.

A. *Sensing the material*

Initially the robot is facing the starting point. As the first material arrives, the color sensor determines the color of the material. The color is detected based on the different voltage values obtained when under the color sensor. The destination coordinates are loaded depending on the voltage level obtained.

The color sensor used here is a TCS230 and the color intensities are as follows:

```
R Intensity:11 G Intensity: 17 B Intensity : 18 - (Red Color)
R Intensity:11 G Intensity: 17 B Intensity : 18 - (Red Color)
R Intensity:11 G Intensity: 14 B Intensity : 18 - (Red Color)
R Intensity:11 G Intensity: 12 B Intensity : 18 - (Red Color)
R Intensity:12 G Intensity: 18 B Intensity : 19 - (Red Color)
R Intensity:12 G Intensity: 17 B Intensity : 18 - (Red Color)
R Intensity:11 G Intensity: 17 B Intensity : 18 - (Red Color)
R Intensity:11 G Intensity: 17 B Intensity : 18 - (Red Color)
R Intensity:11 G Intensity: 17 B Intensity : 18 - (Red Color)
R Intensity:11 G Intensity: 17 B Intensity : 18 - (Red Color)
R Intensity:11 G Intensity: 17 B Intensity : 18 - (Red Color)
```

Fig.3: Red Intensity Range, Voltage: 1.8-2V

```
R Intensity:32 G Intensity: 26 B Intensity : 28 - (Green Color)
R Intensity:37 G Intensity: 29 B Intensity : 32 - (Green Color)
R Intensity:37 G Intensity: 29 B Intensity : 32 - (Green Color)
R Intensity:54 G Intensity: 50 B Intensity : 56 - (Green Color)
R Intensity:65 G Intensity: 57 B Intensity : 66 - (Green Color)
R Intensity:65 G Intensity: 59 B Intensity : 66 - (Green Color)
R Intensity:65 G Intensity: 59 B Intensity : 65 - (Green Color)
R Intensity:66 G Intensity: 59 B Intensity : 66 - (Green Color)
R Intensity:66 G Intensity: 59 B Intensity : 65 - (Green Color)
R Intensity:65 G Intensity: 58 B Intensity : 65 - (Green Color)
R Intensity:67 G Intensity: 60 B Intensity : 68 - (Green Color)
```

Fig.4: Green Intensity Range, Voltage: 2.1-2.2V

```
R Intensity:44 G Intensity: 76 B Intensity : 43 - (Blue Color)
R Intensity:47 G Intensity: 71 B Intensity : 41 - (Blue Color)
R Intensity:44 G Intensity: 68 B Intensity : 40 - (Blue Color)
R Intensity:46 G Intensity: 72 B Intensity : 42 - (Blue Color)
R Intensity:46 G Intensity: 73 B Intensity : 42 - (Blue Color)
R Intensity:45 G Intensity: 64 B Intensity : 40 - (Blue Color)
R Intensity:44 G Intensity: 68 B Intensity : 33 - (Blue Color)
R Intensity:43 G Intensity: 67 B Intensity : 38 - (Blue Color)
R Intensity:40 G Intensity: 61 B Intensity : 34 - (Blue Color)
R Intensity:38 G Intensity: 59 B Intensity : 32 - (Blue Color)
R Intensity:40 G Intensity: 61 B Intensity : 33 - (Blue Color)
```

Fig.5: Blue Intensity Range, Voltage: 3.6-3.8V

B. *Navigation*

- Now that the robot has picked up the object, it has turn 180° around it's center[3][5] in order to face the arena
- This can be achieved by turning both sets of wheels in the same direction, be it clockwise or anticlockwise
- The path selection is done with the help of the 3 IR sensors mounted on the base

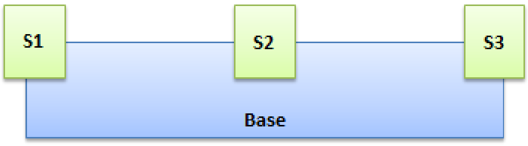

Fig.6: Sensor placement

- S1 is to initiate left turns, S3 is to initiate right turns and S2 is to keep the robot on track

C. *Navigation Algorithm*

The map is divided into grids, comprising of cells, rows and columns. Each row and column are valued and assigned a numerical value[6].

The destination area is known and the cell, row and column corresponding to the destination area is mapped. Here, the rows are assigned to initiate the turning of the robotic vehicle.

This is the row based approach i.e., the rows are assigned in which the robot has to take a turn and the column value will be monitored and compared with the current value.

The surrounding is divided into 8 sectors (Fig.8), each with a sweep angle of 45° and in all directions. The destination is represented as a back pointer[4]. Depending on which sector the back pointer fall in, the turn sequence is initiated to that side.

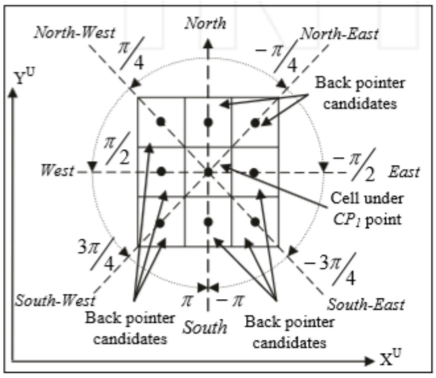

Fig.7: Scan sectors around the robotic vehicle

Each cell is called as a Cartesian Plane cell And the direction of the turn is initiated by location of the Back Pointers among the sectors.

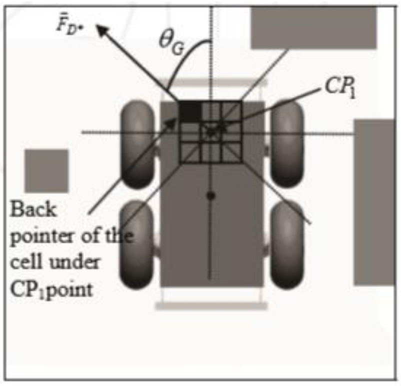

Fig.8: Representation using Virtual Ferry Formation

$F_D =$ Ferry sweep window

$\theta_G =$ Sweep angle (Direction of placement of sensor)

D. Performing the task

- Once the object is picked up, the robot has to turn 180°

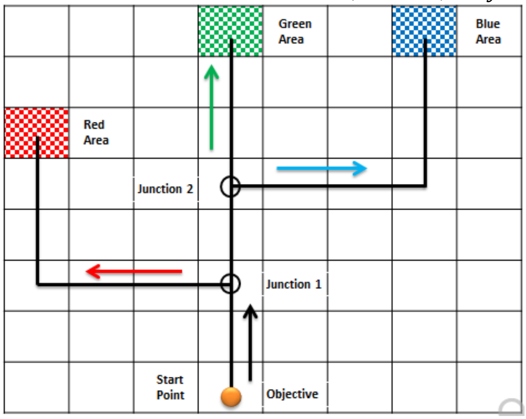

Fig.9: Moving towards the destination

- Depending on the voltage level obtained from the sensor, the color of the object is determined and the destination coordinates are loaded.
- If the color is red, the back pointer of the destination falls to the left of the Cartesian plane i.e., the robot has to make a left turn
- The turn is made at the assigned row of the grid and the column value is compared. When the column value is reached, the row value is compared
- And the robot moves to the north or south according to the destination row value

Similar principle for green and blue colored objects to be dropped at the respective destinations[7].

Once the object is dropped at its destination, the robot has to trace back its path to the starting point to collect the next object (Fig.10).

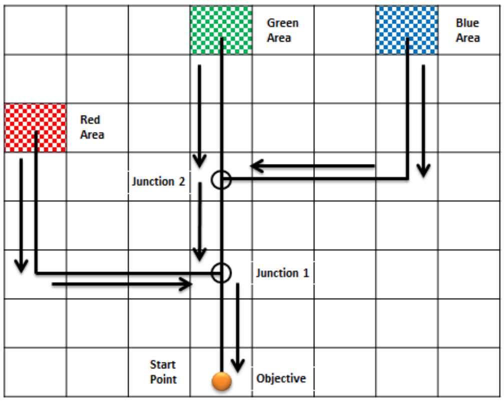

Fig.10: Trace back towards the starting point

DC motor control values for Robotic base: (A B C D)

Forward – 0 1 0 1

Backward – 1 0 1 0

Turn Left – 1 0 0 1

Turn Right– 0 1 1 0

Halt – 0 0 0 0

Voltage regulated to 5V, controlled using L293D driver.

Servo motor control for Robotic arm: Control from PWM outputs from microcontroller

Shoulder: **0° - 90°**

Gripper: **0° - 180°**

V. RESULTS AND DISCUSSION

The GPS framework is done and is loaded onto the microcontroller. When the object is picked up by the robot, the destination coordinates is set according to the voltage levels from the color that is sensed.

If the voltage is 1.8-2V, Red area coordinates are loaded

If the voltage is 2.1-2.2V, Green area coordinates are loaded

If the voltage is 3.6-3.8V, Blue area coordinates are loaded

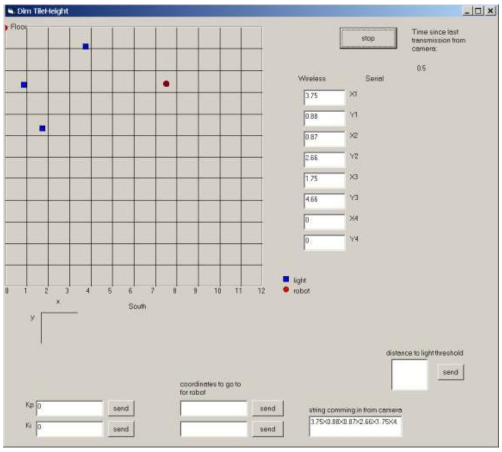

Fig.10: GPS Framework

After the robot travels to the required destination, the gripper opens and the object is place at the destination. The robot then turns around and back traces its path towards the starting point to pick up the next object.

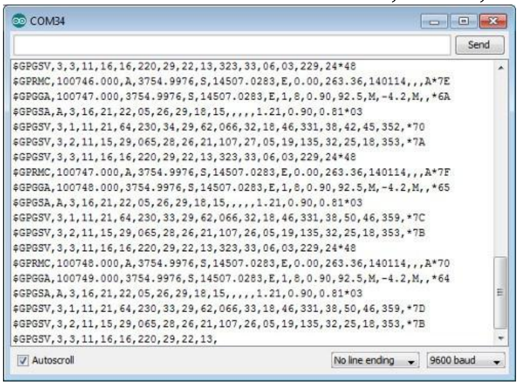

Fig.11: GPS coordinates being monitored

As the robot moves, the GPS coordinates are continuously checked and compared for accurate navigation.

VI. CONCLUSION

This paper offers an effective way to implement fully automated industrial robots. These robots don't need constant monitoring and most of all, no human intervention since the GPS floor plan is made and the robot systematically follow protocols. The design can be customized to suit different industrial needs like material segregation, delivery between sectors, load transportation, etc. Further, power consumed by this mechanism is very low compared to the sophisticated robotic machinery. Maintenance is cheap and cost effective.

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