Cooperative Autonomous Robotics Transportation System [CARTS]

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Abstract— Cooperation is a very common phenomenon in the Animal Kingdom, allowing the species to perform a task which would be difficult for a single member of the species to perform. Cooperation not only reduces the task done by each individual member but also provides flexibility and robustness to the overall task. A robotics implementation of cooperative phenomenon is described in the paper. The paper aims at describing the methodology by which a group/swarm of robots can be used to transport a provision from one point to another with the help of real-time image processing. Image Processing allows the robots to monitored and also make necessary changes in the path and alignment due to the variation in the terrain.

Key words: GPIO, CARTS, HSV

I. Introduction

Transportation is basic need for our human life. We use transportation in our lives on day to day basis. Transportation is the most important element of industrial revolution as transportation is the root on which industries are built. All industries are dependent on the fact that they have to move their products/packages from source place to destination place in minimum amount of time at affordable cost. The paper reports the way to make Cooperative Autonomous Robotics Transportation Systems (CARTS) with the well-coordinated robots for handling the product/packages. This approach is more effective in security and safety of the product during transportation as compared to the transportation which involves human labor. Use of cooperative autonomous robotic transportation system would increase the security of the product, chances of damage are reduced and effective time of transportation is reduced which results in increased productivity of industries. CARTS can be used for transportation within industries but can be further developed for roadways and seaways transportation.

II. Experimental Setup

Robots such as Firebird V are intended to provide preinstalled actuators and sensors due to which it acts as a great platform to build on different projects. This robot contain an Atmel Atmega 2560 as Master board and Atmel Atmega 8 as slave board along with GPIO (General Purpose Input Output) pins for the Ease of Access which makes it a fun to interface with servos for axial moment and Zigbee modules for wireless control.

The generic form of basic experimental setup of CARTS is shown in 'Fig.1

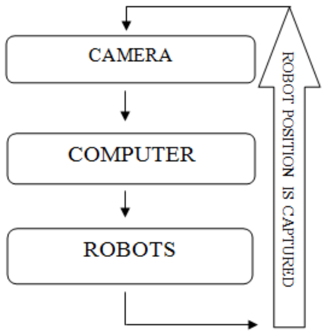

Fig. 1: Generic Experimental Set Up, Using Firebird V For Cooperative Autonomous Robotics Transportation System.

As shown in "Fig. 1",the images of the robots position are captured by the camera at certain frames/second and are sent to computer in which developed algorithm is stored. It then sends commands to the robots so that they keep aligning themselves leading to transportation of the product/package to the destination address.

III. Methodology

Transportation plays a very important part in industries. Since the errors during transportation which involves human element arises due to misunderstanding between the two or group of person. This error can be removed by automating the job with the help of robots as there is no need of understanding between automated robots as they will perform every instruction given to them.

1) The Image is captured and then blue contour is detected using the Hue Saturation Value (HSV) of the Blue color. Similarly the Orange color marker on the second robot is detected using the HSV of Orange color. The contour with the largest area is selected to eliminate the minor errors in the captured image.
2) The centers of the two contours are found and a condition is implemented so that the distance between the two centers is always a fixed constant ensuring proper distance is maintained between the two robots and thus preventing the object from displacing.

3) Whenever a change in distance is encountered, the robots and the servo of the robots align themselves so that the ideal position of the package remains intact and the product/package remains in the position.

A. Determining Position of Robots With Respect To Each Other and Product/Package:

For a complete understanding of how the robots will move in coordination to transport the product/package, the experimental setup is as shown in figure 2.

At the start point (green area), the product/package is placed on the robots deployed for the transportation. A camera is placed on top in such a way that it can cover the area where transportation is taking place. The camera keeps taking pictures at 24 frames per seconds. The picture is then fed into the algorithm that is coded in python and color are detected and the data is wireless fed into robot.

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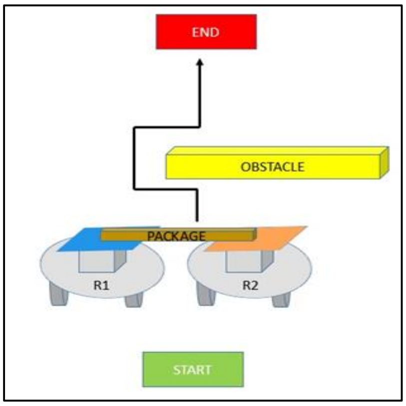

Fig. 2: Schematic Showing A Cooperative Automated Robotic Transportation System (CARTS).

B. Determining the Start and Stop Position:

The robot is placed on the start position (green area) and the stop position is the red area on the map. Camera takes continuous picture at 24 frames per second and red and green contour are found and thus the shortest distance between the green and red positon are found keeping in mind that there is an obstacle between the start and stop position the shortest distance is found.

C. Determining the Obstacle:

The continuous pictures that are being taken, the yellow contour is found as the obstacle and thus the shortest path between the start(Green) position and stop(Red) position is found and fed to the robot wirelessly.

D. Path Planning Algorithm:

The image is passed and a space map is generated according the image with 1 as movable cells and 0 as obstacles.

There are 3 heuristic factors used in the code

1. G=distance of current cell from start cell
2 H=distance of current cell from stop cell
2. F=G+H
3. S=It is the slope between the current cell and the stop point.

There are two lists namely:

Openlist []: It stores all the cells that have been evaluated

Closedlist []: It stores the cells which are not evaluated or are Obstacles.

Pcell [] : This grid stores the parent cell of each cell so that the path can be traced

Map:-To show the path traversed

The search starts with the Start Cell as the current cell (curCellX, curCellY).

```
While (1)
{ NcellX = curCellX #Ncell is the cell in the north of
                      the current cell
NcellY = curCellY + 1
ScellX = curCellX #Scell is the cell to the south of
                    the current cell
ScellY = curCellY - 1
EcellX = curCellX + 1 #Ecell is the cell to the east of
```

the current cell
EcellY = curCellY
WcellX = curCellX -1 #Wcell is the cell to the west
of the current cell
WcellY = curCellY
##The code then checks if each of the Ncell, Scell, Ecell and Wcell lie within the range of the space map to be evaluate.
##Then it checks for the smallest slope and then for the smallest F value. The current cell becomes the parent cell of the New cell (i.e. New cell is the cell with the lowest slope and the Lowest F value).All the cell evaluated are marked as 3 in the open list and all the cell which is a parent are marked with 4.the Stop cell is marked with 5.
##This process keeps on repeating till the Current cell=Stop Cell.
If (current cell=stop cell)
{Showdata () } ->this function is used to return value to Play function.
Then the Play function returns the value
##If no such condition occurs No path is found

1) Flow chart depicting the implemented Algorithm

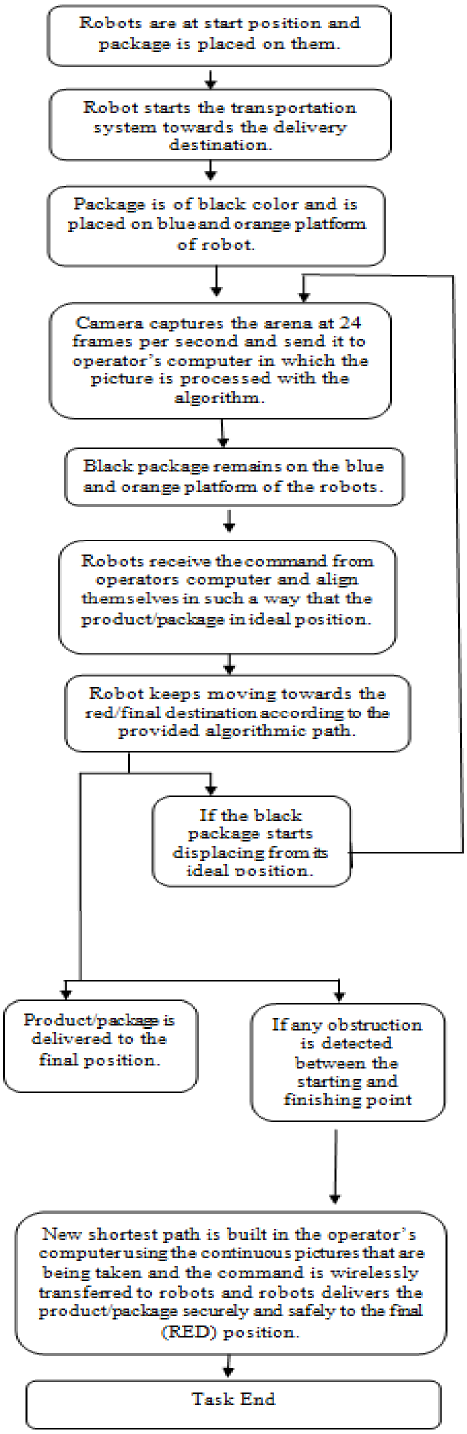

Fig. 3: Flowchart Depicting Algorithm for Cooperative Autonomous Robotic Transportation System

Example Image:-When map is printed this is the output
[1, 1, 1, 1, 1, 1, 1, 1, 1, 1]0 represents the obstacles
[1, 1, 1, 0, 0, 1, 1, 1, 1, 1]1 represents the movable cells
[1, 1, 1, 1, 0, 0, 0, 1, 1, 1]The 4 represents the start and since this location is a parent it is numbered as 4
[1, 0, 0, 3, 3, 3, 0, 1, 1, 1]
[1, 1, 0, 3, 4, 3, 3, 3, 1, 1]
[1, 1, 0, 3, 4, 3, 0, 0, 0, 1]The 4 represents all the parent cell .It is the path traversed.
[1, 1, 0, 0, 4, 0, 0, 3, 0, 1]
[1, 1, 1, 0, 4, 4, 4, 4, 3, 1]The 5 represents the stop cell
[1, 1, 1, 0, 3, 3, 0, 4, 5, 1]
[1, 1, 1, 1, 1, 1, 0, 1, 1, 1]

IV. Conclusion

Proposed system provides an automated approach towards transportation using cooperation as the central phenomenon. The robots designed using this approach are able to transport objects from one point to another with precision and minimum deviation from the shortest and desired path. Such a system will not only reduce human induced error during transportation but also reduce time and human effort thus increasing productivity of the facility.

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