Maze Solver Using Image Processing

Devesh Soni(B17040)*, Dheeraj(B17041)†, Kanika Gupta(B17047)‡,
Khushi Gupta(B17048)§, Anwesh Das(B17116)¶ Ashu Chandeliya(B17119)‖
* b17040@students.iitmandi.ac.in † b17041@students.iitmandi.ac.in ‡ b17047@students.iitmandi.ac.in
§ b17048@students.iitmandi.ac.in ¶ b17116@students.iitmandi.ac.in ‖ b17119@students.iitmandi.ac.in

***Abstract*- The problem of solving maze using image processing includes finding a possible path between a source and a destination through a surroundings consisting of numerous obstacles and then, further, making a mobile robot follow the discovered path. Processing the image and finding the suitable path by direction envelope algorithm proves to be much better than a former way of solving the maze by making the robot follow each and every path till it finds the appropriate one. It reduces time consumption as well as makes the robot more reliable. It also prevents the robot to fall in loops. It can be used at places where human effort is not required or are inaccessible for humans.**

I. Components

TABLE I
COMPONENTS USED IN THE ROBOT

Sr. No	Components Used	Quantity
1	Raspberry Pi 3 Model B	1
2	Motor Driver (L298N)	2
3	Breadboard	1
4	100 rpm 2 Nm Motor	4
5	2200 mAh LiPo Battery	1
6	Jumper Wires	Approx 20
7	Tyres	4
8	Chassis	1

A. Raspberry Pi

Raspberry Pi 3 Model B is a small single-board computer. The Raspberry Pi 3 Model B uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache. It runs at 1GB DDR2 RAM. Its power rating is 700mA (3.5W).The Raspberry Pi has a set of GPIO(General Purpose Input Output) pins which can be programmed using the python library GPIO. We can take inputs, give outputs using these GPIO pins.

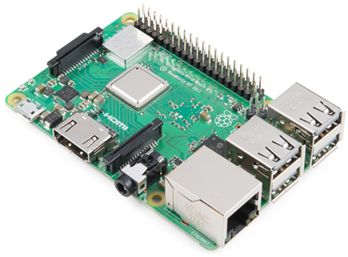

Fig. 1. Raspberry Pi 3

B. DC motors and Motor driver(L298N)

The microcontroller sends signals to the DC motors(100 rpm) via a L298N motor driver which provides the power required to the motors.

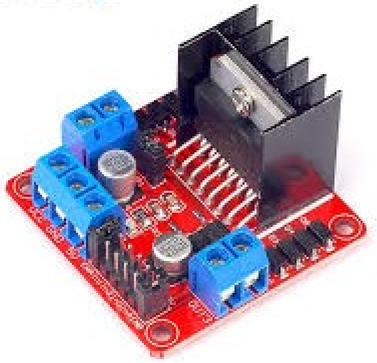

Fig. 2. Motor Driver

II. Introduction

THE technology of developing an autonomous vehicle to do the desired task in a great demand these days due to its various applications in the areas impossible for humans to work at. The algorithm uses processing image, approximating pixels in form of coordinates, joining distant coordinates using straight lines, finding the required path, converting it into machine language and giving instructions to the bot using raspberry pi.

III. Proposed approach

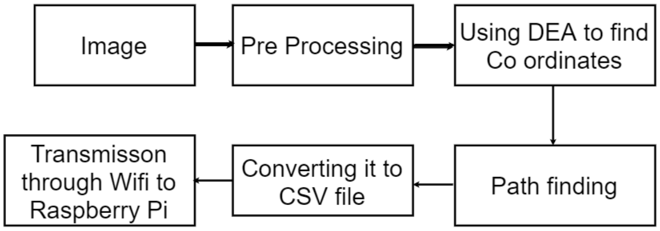
Image
Pre Processing
Using DEA to find Co ordinates
Path finding
Converting it to CSV file
Transmisson through Wifi to Raspberry Pi

Fig. 3. Block Diagram-Proposed Approach

A. Capture and Transmission of image

The top view of the image is obtained by a mobile camera and is stored in the PC for further processing.

B. Preprocessing of image

Initially the image of the maze is taken as input. It is then converted to B/W (or binary image). Every pixel can be denoted as 0 or 1. Each connected component is shrinked to get lines having width 1 pixel(also known as Skeletonization). At this stage, the image will look like a tree, a stem and many branches. Now, all we need is the stem or the main branch which connects source and destination. Thus by using the pruning process i.e, by cutting away useless branches we get a single path from source to destination.

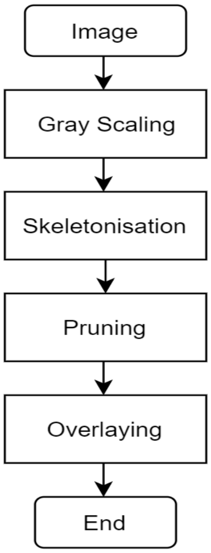

Fig. 4. Flow Chart of Pre Processing

C. Direction Envelope Algorithm

From the pre processed image, we take first ON(1) pixel starting from top left corner and traversing in row wise manner. We take that point as our source and use Depth First Search(DFS) on an explicit graph and store visited pixels and their coordinates, taking top left corner as (0,0). Thus we have our source, destination and the path to be followed in 2-D plane. Now, we should avoid going pixel by pixel in order to prevent time consumption in the process of turning(every turn will be multiple of 45).So, we trade off precision against time consumption and skip 9 out of every 10 pixels. This data of coordinates is then transferred to Raspberry Pi. On Pi, we set current position as the first coordinate, and current angle bot is facing is taken as 0. Then according to the required angle, the bot turns. The distance it has to travel is taken proportional to the distance between current and next coordinate. This way, the bot can travel from source to destination using the coordinates of the Pixels. Thus we can solve the given maze by using image processing.

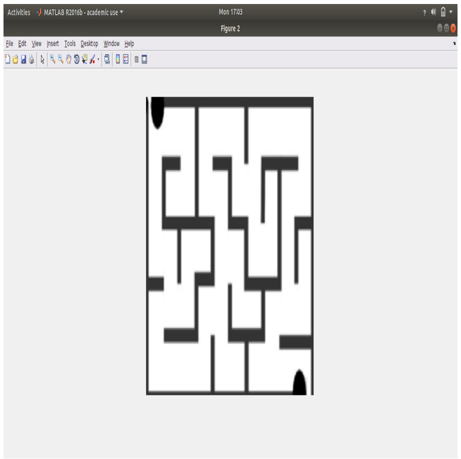
Activities
MATLAB R2016b - academic use
Mon 17:03
Figure 2
File Edit View Insert Tools Desktop Window Help

Fig. 5. Image before Processing

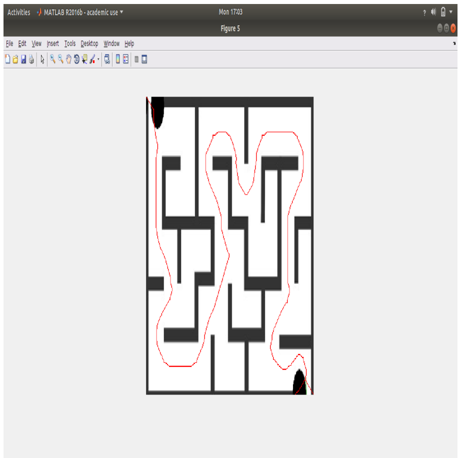
Activities
MATLAB R2016b - academic use
Mon 17:03
Figure 5
File Edit View Insert Tools Desktop Window Help

Fig. 6. Image after Processing

D. Conversion to CSV file

The obtained coordinates cannot be directly passed to the bot. It is converted to corresponding chain codes and is passed to raspberry pi to control the motors and drive the bot.

IV. Results And discussions

This project can solve any unique path maze and make the bot follow the obtained path efficiently. The entire procedure can be considered to be a combination of three basic steps. First, the image of the maze is processed by shrinkage of the traversable path to get the pixels corresponding to the only possible path. Second, the respective coordinates of the pixels obtained in the previous step are calculated. The coordinates are then sent to the raspberry pi connected to the robot which further assists the motor drivers for the locomotion of the bot. All these processes collectively enable the successful working of the project.

V. Motivation

We got the motivation to work on this project by observing the increased traffic on Indian roads. The increased number of vehicles on the road contribute to frequent jams in all major and populated cities of the country. The maze runner can use images taken by the large number of remote sensing satellites of India and process them to get all possible paths and choosing the most suitable one. The maze runner can also be used to transport items from one place to another in manufacturing industries quickly and efficiently. It can be used tremendously in the war situations to transport military reinforcements. In hospitals, the maze runner can be used to transport medical equipments and medicines to reduce rush and maintain a healthy soothing environment for patients. The bot can be made to move inside the sewer system, given we have map of the system and remove any obstructions or perform cleaning task, as per the requirement.

VI. Conclusion

The applied approach, if compared to the previously existing approach of traversing the complete maze and then, reaching the destination, eliminates time consumption and reduces the usage of hardware. This method can be modified or integrated with other existing technologies to develop a more real life usable product. In instances of specific complex mazes, the bot may get off track due to lack or drawbacks in the pruning process of this project.

Acknowledgment

The authors would like to thank Dr. Kunal Ghosh, for mentoring the project. The authors are also grateful to Mr. Kushagra Singhal for providing valuable guidance, whenever required. Finally, this project might not have been succesful had it not been for the efforts of Robotronics Club, IIT Mandi. Hence, the authors would like to thank Mr. Suryavanshi Virendrasingh for arranging the necessary components.

References

[1] Omkar Kathe, Apoorv Jagtap, Varsha Turkar and Girish Gidaye, Maze Solving Robot using Image Processing, 2015 IEEE Bombay Section Symposium (IBSS)

[2] Behnam Rahnama, Atilla Elci and Shadi Metani, An Image Processing Approach to solve Labyrinth Discovery Robotics Problem, 36th International Conference on Computer Software and Applications Workshops, 2012

[3] https://in.mathworks.com/matlabcentral/fileexchange/54971-maze-solving-robot-using-image-processing

[4] http://wiki.seeedstudio.com/RaspberryPi3ModelB/

[5] https://www.amazon.ca/Raspberry-Pi-RASPBERRYPI3-MODB-1GB-Model-Motherboard/dp/B01CD5VC92

[6] https://www.aliexpress.com/item/L298N-Module-Dual-H-Bridge-Stepper-Motor-Driver-Board-Modules-for-Arduino-Smart-Car-FZ0407-Free/1761850243.html