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Obstacle Detection in Multi UGV Environment Using Trajectory Planning Algorithm

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Abstract--Unmanned ground vehicle (UGV) is a smart autonomous vehicle that mainly capable to do tasks without the need of human operator. The automated vehicle works during off road navigation and mainly used in military operation i.e. detecting bombs, detecting obstacles, border patrol etc.There are many techniques used to overcome the problems of UGV and can detect obstacles during off road navigation. So in this paper, we proposed an unmanned ground vehicle i.e. based on the Trajectory Planning Algorithm(TPA) to identify the obstacles i.e. cars, trees, human that come in the path of UGV and used some parameters to calculates the move of it during on road navigation. The algorithm will take the required decision for situations such as obstacle detection which will further control the automated vehicle.

All the results are represented in the graphical forms. Different graphs; velocity versus time, obstacles identified and distance evaluation, Comparison of experimental and computational results are all plotted. These results are very useful for application of UGV having detecting the obstacles.

Keywords----Unmanned Ground Vehicle, Autonomous, Trajectory Planning Algorithm, sensor, and camera.

I. INTRODUCTION

UGV is a smart autonomous vehicle that is capable to do tasks in structured or unstructured environment without the help of human operator. It use different type of sensors to sense the structured or unstructured environment then based on sense it take the action and then pass the sensed information to the different computer operator at the different location through the communication links. Trajectory planning (path planning), obstacle avoidance schemes for autonomous UGVs have been investigated extensively for their wide applications including search and release operations, observations, space examination, and defense operations [1]. The UGV system includes a graphical user interface (GUI) to allow invigilate and simple monitoring of the UGV operations. Our main objective is to improve the autonomous system of the UGV, reducing the energy consumption and could be easily extended to other commercial UGV platforms. Unknown territories propose risks to autonomous unmanned ground vehicles (UGVs) during operations. Any information that could be used for navigation of obstacles detection will have to be examined in real time. Successful functioning and monitoring of the navigation routines requires high adaptability to detect obstacles, both static and moving. The main aim is to develop an algorithm for an environment that can detect an obstacles velocity given a limited range of detection[2,3]. In multi UGV environment used for calculate the distance, velocity and time for detecting the obstacles.

UGV system generally consists of these parts such as vehicle control and monitoring system, navigation system, and obstacle exploring system and traffic signal monitoring and detection system. This UGV technique was used to simulate acts examined by ground environment which include navigation, obstacle avoidance, collision avoidance between of two roads, lane detection. A Unmanned Ground Vehicle (UGV) is represented and processed for some application specific operations to operate usually in unsafe surroundings.

The rest of the paper is organized as: In section 2, literature survey is discussed. Section 3 introduces the proposed methodology. In section 4 we discuss the results and comparisons including brief description on dataset collection, preprocessing, identified the obstacles and evaluation of distance and main result is shown in graph. In section 6 contains the conclusion of research work & future work.

II. LITERATURE SURVEY

This section gives an overview of the related research that has been done regarding autonomous navigation for unmanned ground vehicles. Some of these are as following:-

Massimo Bertozzi.et.al [2] presented a paper in which they have proposed a terromax vehicle which could move autonomously only up to 68kmph and it can't work during the night and its performance is not impressive because of vehicle size and height. In this paper algorithm detect the obstacles and avoidance of the detection lane. Saurabh Trikande.et.al [3] proposed visualization technique for UGV using 3D point cloud which give depth information, uses 3D scanner which scans environment in front in one plane and perceive the output in 3D point clouds. The Cluster extraction enables to extract the cluster in the point cloud which is mainly help to identifying the objects of interest i.e. Bomb but it is mainly used in unmanned ground vehicle for home hand security. 3D point cloud is also used in unmanned ground vehicle for home hand security. Simulation and experimental results are verifying the effectiveness of those algorithms. Sumin Zhang, and YuWang et.al. [1], This paper, presents a novel method for trajectory planning, based on a "curvature matching" technique. This method quickly generates a path connects the end of the path generated by a hazard avoidance. Trajectory planning algorithm has been applied in intelligent driver model to control the unmanned ground vehicle in complex environment. That algorithm also takes in to the lane and road configuration and obstacles detection. It takes decision making process through simulation to determine the optimum path to follow safely based on the traffic rules. In this paper, focus on the trajectory planning and decision making module. And the best trajectory is determined in terms of the parameters. The experimental vehicle attained speeds of 8 m/s (18 mph) on flat and sloped terrain and 7 m/s (16 mph) on rough terrain. Larry Matthies, Alonzo Kelly [4] Main focus in this paper is laud upon identification of different terrains the paper gives a rational approach behind the choice of sensors paper also submerses the last five years of research and development in this field. The work has been seriously undertaken to sure reliable performance with simple and fast algorithms. Limitations: In mountain terrains this is of least application. Simulation and experimental results are verifying the effectiveness of those algorithms.

As per discussed in literature, there are different types of techniques are used in the field of unmanned ground vehicle to detect and avoidance of obstacles but there are many problem in existing techniques:

- Local Difference Probability (LDP)-Based Environment Adaptive Algorithm is only used to for road –area detection and recognition [11].
- Visualization Technique for UGV Using Point Clouds is used to identifying the objects of interest i.e. Bomb etc but only used for home land security [9].
- Constraint-Based technique became impossible for the controller to turn the wheels fast enough to avoid collisions and controller system can avoid hazards during off road navigation [13].

So these types of automated vehicles are required even in driving road vehicles where human errors cause Major fatal loss of life and property. For this purpose the functionality of unmanned ground vehicle can be enhanced by using region based image segmentation which will help to identify the obstacles that come in the path of UGV.

III. PROPOSED METHODOLOGY

- ➢ Sampling of different frames of front view of a UGV to see the number of obstacles.
- ➢ Implementing the trajectory planning algorithm in more than one vehicle to set up an automated multi vehicle environment and check the simulation results.
- ➢ Forming a decision making algorithm which can accurately calculate the moves of the vehicles. The obstacles detection in the path way of the vehicle is important part of the algorithm but it's useless if vehicle can't plan the best possible way out.

In this paper, below figure shows the proposed method for Unmanned ground Vehicle.

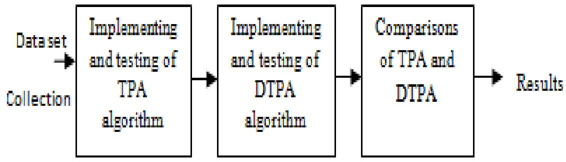


Fig 1. Proposed Method For Unmanned Ground Vehicle

Trajectory Planning Algorithm

The Trajectory Planning Algorithm takes the surrounding environment; surrounding obstacles and a decision making procedure that assess the road situations [21]. It determines an optimal track to follow the path safely. The aim is to Trajectory Planning to control an unmanned ground vehicle (UGV) in complicated conditions. When generates trajectories, the proposed approach need some useful information as following:

- The travelable region of the front road. The area can been decided by the geometrical characters of the front road. They are including the width, distance, the curvature of the front road and the obstacles avoidance information, etc.
- Human factors, such as driver physical burden, driver driving skills and the knowledge and handling degree of the vehicle dynamics, etc.
- Vehicle state, such as position, velocity, time and the heading distance of the vehicle at present.

IV. WORK DONE

A. *Dataset collection*: Collection of images of different situation images where probable collisions might occur by human errors.

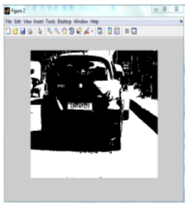
B. *Binarization:* before Binarization the RGB images is converted into gray scale images and then Binarized.

C. *Decision Frames*: In this decision frame when distance is 60 units then using of this algorithm apply breaks and slow down. All these steps are taken in the UGV decision procedures that are based on the distance.

D. *No. of Obstacles identified using TPA*: Different no. of obstacles is identified in each frame and calculates the values. These values are shown in the command window. In TPA these values are repeated but in DTPA values are not repeated.

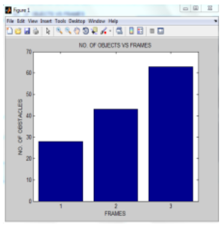
E. *Distances from UGV*: Evaluate the distance from UGV using trajectory planning algorithm and also plot the graph of that distance. These values are also shown in the command window. In TPA these values are repeated but in DTPA values are not repeated. So, in that cases reduce the redundancy

Origional image

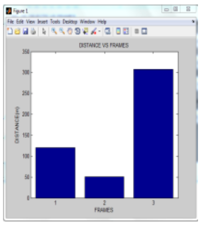


Binarized

Decision Frame



No. of Obstacles



Distance from UGV

Fig2. Steps performed in UGV

V. EXPERIMENTAL RESULTS

a) **Evaluation of Distance Comparison**

In which comparison results are shown in different images between TPA (Trajectory Planning Algorithm) and DTPA (Dynamic Trajectory Planning Algorithm).to evaluate the distance and graph are plotted.

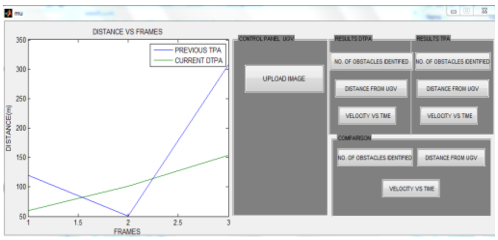


Fig 3 Distance Graph

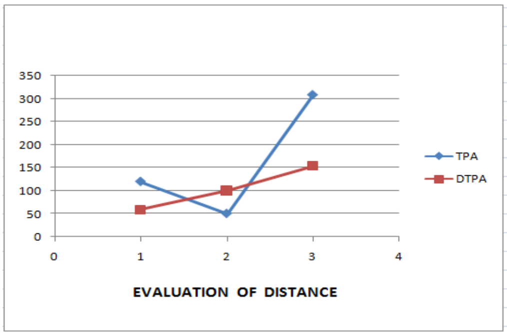


Fig 4 Comparison Results of distance in TPA and DTPA

Size of image	Existing Method (TPA)	Proposed Method (DTPA)
400*300	60	120
259*194	101	50.5
400*300	154	308

Table 1 Values of Distance Evaluation

b) Measuring No. of Obstacles Comparison:

In which comparison results are shown in different images between TPA (Trajectory Planning Algorithm) and DTPA (Dynamic Trajectory Planning Algorithm).to evaluate the no. of obstacles and graph are plotted.

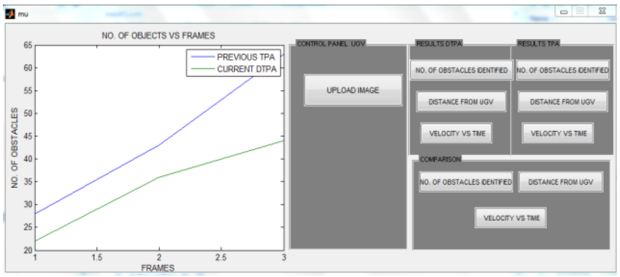


Fig 5 No. of obstacle Graph

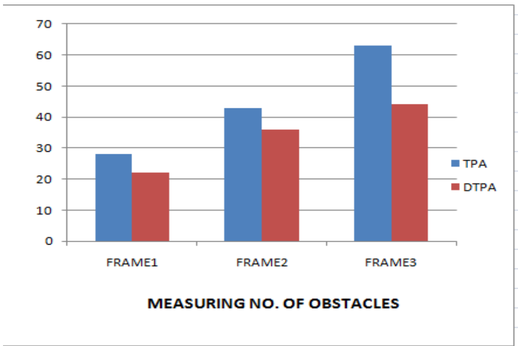


Fig 6 Comparison Results of obstacles identified in TPA and DTPA

Size of image	Existing Method (TPA)	Proposed Method (DTPA)
400*300	22	28
259*194	36	43
400*300	44	63

Table 2 Values of Obstacle detection

From the experimental results, it is concluded that the Dynamic Trajectory Planning Algorithm is more efficient than Trajectory Planning Algorithm because in case of DTPA frames cannot be repeated simultaneously on separated generated frames [9]. The feature is to improve the autonomous system of the UGV, reducing the energy consumption and could be easily extended to other commercial UGV platforms.

VI. CONCLUSION & FUTURE WORK

The proposed work extends the scope of trajectory planning algorithm (TPA) from detecting a single object to detecting a whole range of objects at varying distance from the vehicle so that the vehicle may plan its path accordingly. TPA is implemented in a multi-vehicle environment which increases interaction. Also the algorithm detects more complex objects than TPA. The scope of TPA has been extended by our work. However, much needs to be done to make the UGV ready for real-world deployment. Obstacle detection can be enhanced such that the UGV is also able to detect any obstacle that comes immediately in front of it in no time and take action accordingly. Also the UGV may also be made to scan its environment so as to detect any obstacle that may come in course of its chosen path.

VII. REFERENCES

1. Zhang, S. and YuWang, "A Trajectory Planning Algorithm for Highly Automated Driving in Complex Environment", in fourth International Conference on Digital Manufacturing & Automation, Vol 32,pp 1-16, china, 2013.
2. Bertozzi, M., Broggi, A., and Fascioli, A., **“**VisLab and the Evolution of Vision-Based UGVs” , IEEE on Computer society, pp.33, dec.2006.
3. rikande, S., “Visualization Technique for Unmanned Ground Vehicles Using Point Clouds”, IEEE international Conference on Advances in Computing, Communications and Informatics (ICACCI), pp.1832-1836, 2013.
4. Matthias, Larry, Kelly, A., Litwin, T. And Tharp, G.,”Obstacle detection for unmanned ground vehicles: A progress report”, Springer London, pp no 475-486, 2000.
5. Hongeng, S., Nevatia, R., and Bremond, F., “Video- based event recognition: activity representation and probabilistic recognition method”, Springer, Computer Vision and Image Understanding 96, pp. 129–162, 2004.
6. Durst, P. J., Goodin, C., Cummins, C., Gates, B., Mckinley, B., George, T., & Crawford, J. (2012, July). “A Real-Time, Interactive Simulation Environment for Unmanned Ground Vehicles: The Autonomous Navigation Virtual Environment Laboratory (ANVEL)”, IEEE Fifth International Conference on Information and Computing Science (ICICS), pp. 7-10, 2012.
7. Pangyu, J., and Sergiu, N., “Local Difference Probability (LDP)-Based Environment Adaptive Algorithm for Unmanned Ground Vehicle”, IEEE transactions on intelligent transportation systems, Vol. 7, no. 3, September 2006.
8. Sterling J., A., Sisir B., K., and Iagnemma, K.,”A Constraint-Based Approach to Shared-Adaptive Control of Ground Vehicles”, IEEE Intelligent transportation systems magazine, pp.45-55, April 2013.
9. Varshney, S.,S., Rajpal, N., Purwar, R.,“Comparative Study of Image Segmentation Techniques and Object Matching using Segmentation”, Proceeding of International Conference on Methods and Models in Computer Science, pp. 1-6, 2009.
10. Sezer, V. , Dikilita, C. , Ercan, Z. , Heceoglu, H. , bner , A. , Apak, A. , Gokasan , M. and Mugan, A. , “Conversion of a conventional electric automobile into an unmanned ground vehicle (UGV)”, Proceedings of the IEEE International Conference on Mechatronics, April 13-15; Istanbul, Turkey, 2012.