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Obstacle detection in automated driving using stereo vision images

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ABSTRACT

Automated driving system guarantee a protected, agreeable and effective driving experience. The effective and uses in the business of self-driving/driverless/automated/robotized vehicle will reduce the human work. Quite possibly the main highlights for any keen ground vehicle depends on how it is reliable and feasible to get the data about the environment. This paper surveys the critical innovation of a self-driving vehicle. In this, there are four key advancements in self-driving vehicle, to be specific, path planning, environmental perception for vehicle control, are tended to and overviewed. By getting the environmental factors precisely and rapidly is perhaps the most fundamental and testing undertakings for independent framework. Obstacle avoidance information is gotten from highly resolute camera and profoundly exact sensors. The most widely recognized detecting frameworks, for example, RADAR and LIDAR are utilized for insight on self-driving vehicles today give a full 360◦ view to the vehicle making it more educated about the environmental factors than a human driver. In this, a strategy to utilize two 360◦ cameras to see obstacles all around the self-sufficient vehicle. By utilizing vertical direction, instead of horizontal direction and camera displacement. The Key thought for obstacle identification is to focus on the points in the 3D medium dependent on height, width and slope comparative with neighboring points. The obstacle points that are mapped to the planes which helps in planning the motion of the vehicle. And also describes about the robot operating system middleware and its importance.

Keywords— *Obstacle detection, stereo vision, Automated driving, sensors*

1. INTRODUCTION

Computer vision is the important part and complex task in the artificial intelligence as to provide the information for robots and other applications by extracting the information from images and videos in the field of automation. In this perspective the rise in idea of automated vehicle has acquired tremendous attention today in the Artificial intelligence world, basically inspired by the quantity of accidents that happen because of driver mistakes/carelessness. Automated vehicles are intended to detect their environmental factors with strategies such as LIDAR, RADAR, GPS and PC vision. This cluster of sensors working reasonably to notice and record the environmental factors comprise the discernment module of the vehicle. The following stage is the confinement step which lines together the deficient and separated data gotten by the sensors to recognize the position, speed and different conditions of the vehicle and the obstructions.

They generally give a precise full 360◦ view to the vehicle making it more educated related to climate than an ordinary human driver. The disadvantage to these frameworks is the expense associated with conveying them. So, a choice is to utilize cameras and computer vision strategies to apply these frameworks. It has been appeared in a few cases that stereoscopic vision can be applied to remove valuable data about the environmental factors that could help the route of portable robots in any case, much of the time the view is restricted to simply the front of the robot. It is extremely important that the vision framework we are focusing on doesn't settle on acquiring the 360◦ view given by RADAR or LIDAR frameworks. This can be accomplished by utilizing extraordinary cameras that catch 360◦ by 180◦ picture.

However, a vital hindrance to self-driving vehicles in metropolitan conditions is the capacity of those vehicle to work securely in the presence of both static obstacles like curb, hump, objects or moving objects like either different vehicles or people. Along these lines, a key research issue should be the improvement of sensors and algorithms capable of identifying obstacles, such that the vehicle self-rule framework has adequate chance to respond properly. This issue brings a large group of difficulties: the climate is one thing and three-dimensional, this might be completely or incompletely impeded, and one must perceive potential movers in any event, when they are fixed. This last point is that it isn't adequate to just distinguish movement; one should have the option to identify a fixed person or objects and moving objects.

A. Automated Driving Vehicle

Automated vehicles or self-driving cars are having capable of moving by its own by understanding the environmental factors

by sensing it. There are six level of driving automation like No automation means which has manual controls by the human, driver assistance which has single automated system, partial automation which performs partial functionalities, conditional automation which automates and performs under certain conditions, high automation performs all automated functionalities under specific condition and full automation which performs all task under all circumstances.

Autonomous vehicles are depending on sensors, actuators, process, algorithms, machine learning systems etc. Radar sensors identify other vehicles, cameras detect traffic lights, obstacles etc. LIDAR measures the distances, ultrasonic sensors detect the wheel actions like curb, hump. These automated vehicles involve architectures, computer vision, artificial intelligence and many other technologies which build as high-level development in the computer science.

B. Obstacle detection

Obstacle detection is the process of finding the objects or obstructions in the road environment using some sensors, data structure, algorithms or process.

Obstacle detection (OD) is one of the primary control frameworks for independent automated vehicles since an real impression of this in present reality is a key which include for any obstruction identification framework for dynamic condition. From few years the greater part of the major methodologies has been focused on rearranged in the system of stereo vision techniques and other 3D technologies such as LIDAR and RADAR significant outcomes have been given by a few examinations on self-driving vehicles. To accomplish an object detection execution, few pre assumptions about ground, objects and free space is required. An accurate obstacle detection is considered with a stable and reliable output regardless of weather conditions.

C. Stereo Vision Images

Stereo vision camera is a special camera which has two or more sensors with the separate image sensors, it has an ability to capture 3D images. The images captured by using stereo camera is stereo vision images where it uses two cameras to capture the same object to get the accurate image which is separated by the baseline. Those two captured images are analyzed for further processing.

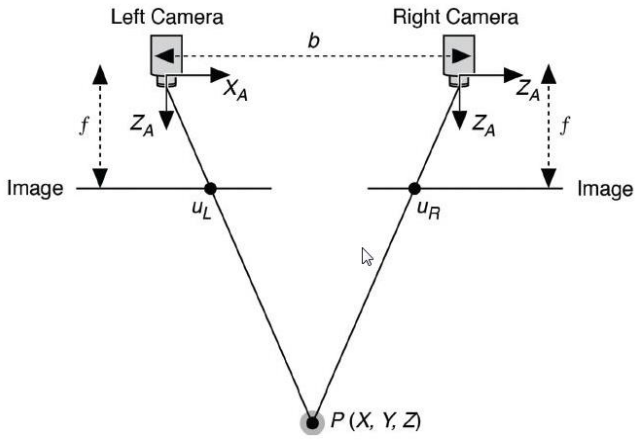

Figure 1: Stereo Vision Model

The figure 1 explains the orientation of the cameras and disparity information between two corresponding points in two images. The stereo vision images used for the obstacle detection and stereo matching is used for distance measurement.

2. ROBOT OPERATING SYSTEM

Robot Operating System (ROS) plays an important role in the field of robotics and its applications. This can be used in all robotic applications which gives good performance and feasible. Robot operating system can look like framework, can work like operating system but it is a middleware. Middleware is a software that gives service to the application like an operating system, it also provides extra functionalities than operating system like authentication, service, messaging etc.

Robot operating system acts as low-level framework based on relayed operating system, This middleware is supported in ubuntu operating system. Robot operating system consists of two main components one is core with communication tools another one is set of plugs and play libraries. This software is responsible for handling communication between sensed and analyzed information to vehicle actuators. This can be the tool that can be used by working robot.

The main communication tools of robot operating system are topics, services and actions. Robot operating system topics are used to send the data in the flow between nodes. Services are the process that allows to start or create communication. Actions are similar to topics but used for complex tasks. The main task of robot operating system is to publish and subscribe the topics to provide the required output by using services as shown in figure 2. Topics acts as data, data can be text, numbers, special characters or images etc. Nodes are the process that is responsible for the computation in the program, each code written in the application is considered as single node, it will provide graphical representation also.

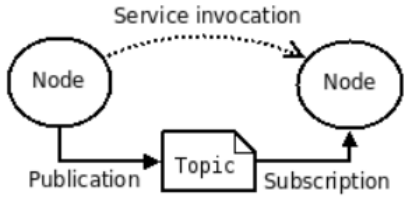

Figure 2: Robot Operating System Flow

The inputs for this can be provide as topics or else with the help of bags, bags are collection of topics. The output of this can be viewed by using some tools called rqt image view and rviz. Rqt image view is a Qt-based system for creating graphical interfaces for your robot, it can modify the interfaces by making and arranging the broad library of inherent rqt modules into selected, split-screen, and different formats. By using this output is viewed in two-dimensional view. Another visual tool is rviz it is used to provide three-dimensional output of the robot.

3. METHODOLOGY

An automated vehicle is capable of understanding its environment and act accordingly to avoid the obstacle and for safe driving. To identify the obstacle, it will collect the data from the camera and sensors by using these combined data and also with the help of analysis or decision-making process the obstacle is detected and control the vehicle. For this so many methodologies can be used but the stereo vision method is one of the powerful process which identifies the depth information and also gives the details about the object like it is stationary or moving.

In this method, two or more cameras are used which helps in controlling in all the conditions where other type of cameras cannot do. Here cameras can set in different angles to get spherical view on the same object, this will help in increasing

accuracy of identifying the object. This can compute the 3D point from multiple 2D images. One camera is connected vertically in the known height to capture the first image, another camera is placed horizontally in the second position is adjusted to capture the second image. These two images are separated by thin baseline and compared to get the accurate information. Sensors also connected like GPS used to track the vehicle, RADAR are used to measure the speed, LIDAR used to get depth perception for longer distance.

The original image captured by the camera as shown in the figure 3 is converted to disparity map image as shown in figure 4. This image will provide the difference between the two image pixels by measuring the apparent pixels. This disparity map image undergoes triangulation and form depth map image as shown in the figure 5, this helps in providing the distance of the object surface from the view point. This image undergoes gray scale mode to produce gray scale image, this will reduce the complexity of the process applied to color images. Gray scale image is converted to binary image to decrease the pixels and set black as 0 and white as 1. To this binary image, can draw contour to find the shape of the object.

Figure 3: Original image captured by stereo camera [1]

Figure 4: Disparity map image [1]

Figure 5: Depth map image [1]

After finding the depth map, Obstacle are defined in the two points P1 and P2, And the minimum height of the object as H_T, maximum height of the object as H_{max} and the slope as θ_T are calculated by using difference between the elevation of two points. These point pairs are examined by using naïve algorithm and this is more efficient algorithm which compare and gives result in minimum executions. These points form trapezium, and these point pairs for each point from the base point as shown in the figure 6

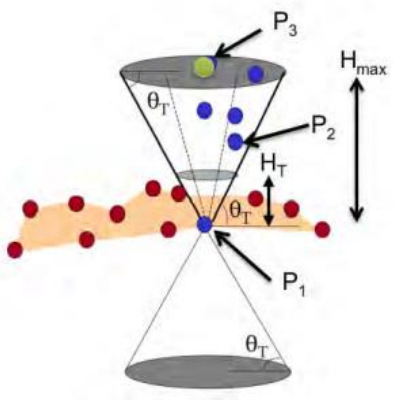

Figure 6: Cone formed in the 3D space to detect the obstacle points [1]

Further these steps are followed to find the obstacles, first all the points are considered as non-obstacle points, then find the pixels to determine the set of pixels in the 2D image, then determine all the points in the trapezium and determine obstacle points that is compatible with the pixels.

4. BENEFITS

Autonomous vehicles are the intelligent vehicle system which can sense its environment and perform functionalities and also it helps in controlling road accidents, traffic etc. To capture the image and to analyze various techniques can be used but by the usage of stereo vision camera helps in taking 3D images from two cameras, quickly identifies the region of interest, shape of the object and track it, this gives high accuracy, reasonable cost and effort and also detects the object when vehicle is in motion. To perform this process robot operating system is used. This is very feasible for all kinds of robotic applications, it will also manage the hardware, memory and process, it follows peer-peer connection, it is tool based, free to use and opensource.

5. CONCLUSION

In this paper, it has a brief summary about the obstacle detection technique in automated driving using stereo vision images. Obstacle detection can perform in three stages like sensing, detecting and avoiding. Obstacle detection methods used are disparity map, depth map, gray scale image, binary image and OD techniques to identify the object in the image with increased accuracy, robustness and reliability. This technique can be used in full automation conditions. And robot operating system is used to support modular and tool-based robot software that can be helpful in various hardware platforms, researches and runtime requirements.

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