Vision-based Target Tracking Technology in Autonomous Vehicles

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Abstract. This paper makes an in-depth study of vision-based target tracking technology, discusses the practical and specific applications of Visual Object Tracking in autonomous vehicles, and discusses the progress and challenges of Visual Object Tracking in autonomous vehicles. The ability of autonomous vehicles to accurately track targets in real time is critical to ensuring safe and efficient navigation. Using computer vision algorithms and deep learning techniques, the researchers developed complex systems capable of detecting and tracking objects such as vehicles, pedestrians, and traffic signs. This paper first introduces the background and principle of current target tracking technology, summarizes the current research status of Object Tracking Technology and the practical application and development prospects of visual target tracking technology in autonomous vehicles, and introduces the latest methods and future improvement directions. Overall, this technology has the potential to greatly improve the capabilities of autonomous vehicles, leading to safer and more reliable transportation systems.

Keywords: Target Tracking Technology, Autonomous Vehicles, Navigation.

1. Introduction

Along with the rapid progress of computer vision, pattern recognition, and artificial intelligence, target tracking technique has found wide application in various areas. Nowadays, the development of computer vision, pattern recognition, computer graphics and AI has been rapid development. And vision achieved more than 80% of the information in this technology. So vision-based target tracking technology is based on object detection, presented which is used for detection, extraction, recognition and tracing of moving objects in image sequence. Through extracting and tracing, the parameters can be reached. Then these can be dealt with and analyzed so that behavior of the moving object can be known [1]. The technology of vision-based target tracking has been spread around the world. And according to different scenarios and ways, this technology has different applications such as intelligent video surveillance, video compression/encoding, intelligent traffic system and so on. Still there is a lot of value in this field that needs to be developed and exploited.

Nowadays, autonomous vehicles are gradually advanced, which is inextricably linked to vision-based target tracking technology. Compared to sensors like IR, SONAR, LASER, RADAR, etc., Visual sensors provide a novel approach to the creation of an environmental picture for autonomous vehicles. Combined with a special computer vision algorithm, a video image can be used to give high resolution information on the form or degree of surrounding objects and surroundings. With the increase in computational ability, visual sensors are not only appealing but also accessible in real-time [2]. The technique is capable of detection, tracing, and prediction of moving objects around a car. These cameras play a vital role in sensing their surroundings, identifying potential obstacles and tracking their movements. In addition to object detection and recognition, it also helps with critical tasks such as collision avoidance, path planning and decision making in autonomous vehicles. By understanding and analyzing these applications, researchers and engineers can better design and optimize autonomous vehicle systems.

Firstly, the foundation of target tracking technology based on vision is studied in this paper. And based on different algorithms and principles, the categories are divided. Secondly, the practical use of VFD in AUV is studied, and the challenges of VMI are studied.

2. Target Tracking Technology

Object tracing technique has found wide application in the field of computer vision. For example, smart Video Monitor, a real-time monitoring and inspection of the object's actions. Similarly, other applications such as video compression and smart transport systems are also outstanding. There are two kinds of methods in this paper: Generation Method, Discrimination Method, etc. The Kernel Correlative Algorithm is a kind of Principal Discriminant Algorithm. In the realization principle, the classifier is substituted with the Follow the destination position. Positive In this case there is always a negative pattern Training of a classifier, i.e. a Positive and Negative Pattern Training. Destination region This is normally regarded as a positive sample and use the target region as a negative sample. This means that the nearer the picture is to the destination, the more likely it is that the adjacent region will be a positive sample [3].

Colour detecting is one of the most important methods for object tracking. Typically, it involves scanning the pixels of the picture until a match (with an allowance) with a predetermined destination colour is found. Colour tracing has many merits such as ease of realization, no large amount of processing time, high speed and excellent effect under favorable illumination. The disadvantage of this approach is that it is sensitive to changes in light. Moving from a light point to a dark one changes the detected color thereby losing the coloured target. So a coefficient of tolerance is going to be added. Another disadvantage is that if you have an object that has been tracked in your environment, it can lead to a false discovery. Then the posture estimation of the independent vehicles will be false [4]. In order to overcome the limitations of the colour tracking approach, several works were inspired by an augmented reality application. The Computer Supported Collaborative Work (CSCW) is a meeting system in which the participants are represented on a virtual screen. Moreover, it is free to locate within a user's space. The user has Head Mounted Display (HMD) on which he/she can view co-workers' faces overlaid on a particular label. This approach is open to the public and is called ARToolKit. This approach has also been applied in, in which the authors proposed to provide visual feedback for pose estimation in the control loop of autonomous vehicles. Another interesting feature based approach for multi-robot location is the black-and-white mode. The proposed approach makes it possible to monitor multiple characteristics at once with low-cost cameras, and employs the same type of vision marking as in ARToolKit. This approach has been published in the form of a library named ArUco. You can also see the other AR marking which is used by a down-facing camera installed on the aircraft (quadrotor) to float it on the surface of the earth (Augmented Reality Indicator). The data collected from the visual field was merged with an inner sensor (IMU) to create the required motion to remain on the surface of the surface. In this paper, the library introduced in is referred to. Two AR marks are illustrated as Fig. 1a and 1b, which will be applied to the autonomous vehicle pose estimation.

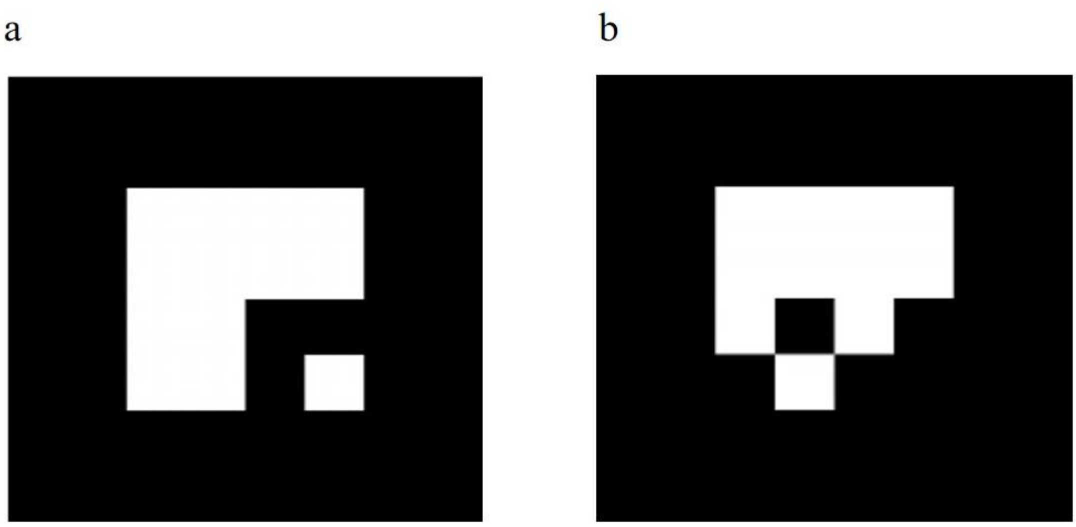

Fig. 1 Two AR marks

Just as with colour detection, every picture that has been received must be examined to see if it exists. Algorithm 1 shows the steps for estimation of the central coordinates of a 2D independent vehicle [4].

3. Application of vision-based target tracking technology in Autonomous Vehicles Navigation

The location and speed of a moving target can assist the automatic car, and it will also decide what kind of environment it is in, as well as what to do when needed. This kind of vision object tracking system has the potential use in the following fields: the construction of the map and the positioning of the robot, the route planning, the obstacle avoiding, the monitoring system, the smart transport system, the moving robot soccer and the person assisting the moving robot [5].

The path planning of autonomous vehicles is a real-time planning. Route planning is one of the basic issues of robot robot, which requires the robot to learn about the objects in its surroundings. Complete cover route planning (also called area filling or area covering) is a particular type of application for path planning in 2D (2D). In this case, it is possible for an automated vehicle to move across every part of the working space to avoid obstructions. The Patent discloses the layout of the obstacle detecting system for the auto driver's car for two significant data manipulation. It will also offer more precise reading of hidden barriers, which is helpful for the efficient running of AR cars. A moving robot has a range finder and a stereo system in the patent. The mobile robot can move around the city on its own, create a map from the range finder's data, and pass it on to the operator as part of a number of surveillance missions [2].

The extracting and tracing of the target is a precondition to develop an AI or a mobile robot in an intelligent transport system. Visually following a moving target can assist in detecting a possible collision hazard in a forward-facing scenario by considering its relationship with the expected route of the vehicle. In addition to these applications, visual target tracking can also provide assistance to human drivers. One such application can be in the driver warning systems. Moving objects in the vicinity of the car can be used to warn drivers about possible collisions and hazards. Another use in ITS may be to design an optimum path for one car in normal circumstances so that it can pass a single, slower car on a pre-determined path.

Compared to the traditional way of obstacle detection by laser ranging radar, the application of real time picture captured by camera is much more efficient [6]. With the development of complex traffic conditions, it is necessary to install more sophisticated testing and analyzing modules in order to realize a smooth and secure autonomous operation. Today's state-of-the-art vehicles might be equipped with more sensors and software compared to combat aircraft, but they will not be able to ensure safe driving. For this reason, it is essential to make sure that there is an accurate system for detecting obstacles, which can be easily detected by stationary or moving bodies, which could pose a hazard of collision or collision during the journey. Two approaches can be taken into account: active and passive. In general, an active approach is a kind of sensor that has both a transmitter and a receiver, for example, RADAR/LIDAR or ultrasonic. Frequency and orientation can be controlled by the system or the driver. In contrast, the passive approach is based on passive scene measurements, like cameras. The detector must react based on what is caught and accepted by the camera, but it does not have the option of choosing the subject or the location of the scan.

A reliable barrier detecting system needs to deal with a lot of real time data. For this to happen, an "active" approach is employed and implemented. In particular, a proactive access means an independent system that has the capability to make smart decisions with respect to the collection of images and the collection of data. Here, the main function is to detect the road and detect the obstacle. In general, these processes involve sensing information through sensors, estimating and assessing the risk. Lastly, they can give the driver feedback for further action, if necessary. As far as our vision is concerned, our eyes are moving and our vision is highly sensitive.

An image caught by the eye when it senses the world can hold a few GB of information in a flash if it is transformed from an abstract scale to a numerical value for ease of comparison, whereas the newest IDI can process only MB in a short time. There would be about 300 million dots per square kilometer in an urban space, which is considered too large to store internally [7].

Location and target tracking are two important tasks that can be applied to mobile robot systems. Localization can be defined as determining the position of an object within a reference coordinate system. And tracking involves constructing a trajectory given a collection of spatially and temporally coherent localizations. Location, mapping and tracking of motion targets are the foundation of image recognition. This is an essential condition for real autonomy of robots [5]

4. Challenges of Visual Target Tracking in Autonomous Vehicles

Although target tracking technology is widely and fully used in autonomous vehicles, its limitations are unavoidable. So in the process of research and development encountered a variety of difficulties and challenges.

Firstly, since autonomous vehicles' vision tracking systems operate mainly in unfamiliar circumstances, their particular features are usually not available or cannot be predicted. Furthermore, because the camera is moving along with the movement of the car, the vision properties of the surroundings can also vary continuously. In an open space, for instance, the speed at which the light decreases exponentially as it moves through the atmosphere can cause a bad picture to appear. Under such circumstances, the conventional tracing algorithm will meet with a lot of problems. Thus, it is inappropriate to design a tracking system that relies primarily on specific visual characteristics or patterns of objects.

Then, in the conventional vision object tracking system, the method of estimation of the motion of object with respect to the camera is used. The relative information is not taken into account when the car is moving. This information is not available to other applications in the same environment. Moreover, because of the complicated rotating and shifting motion of the car, the precision of the relative data is very poor, so it is usually neglected during the estimate.

Thirdly, since autonomous vehicles can operate in both structural and non-structural settings, it is not necessarily a good idea to include extra sensors in your surroundings to assist autonomous vehicles in tracking and navigating. Moreover, when driving in unfamiliar surroundings, the autonomous vehicle won't be able to predict the position of the vehicle or the environment. As a result, it is difficult to trace 3D vision objects [2].

5. Conclusion

Vision-based object tracking technology in autonomous vehicles has the potential to significantly improve the capabilities of these vehicles, leading to safer and more reliable transportation systems. Using computer vision algorithms and deep learning techniques, the researchers developed complex systems capable of detecting and tracking vehicles, pedestrians, traffic signs and other objects in real time. These systems are able to adapt to different lighting conditions, making them invaluable tools for Autonomous Vehicle Navigation

This thesis makes a deep research on visual object tracing technique, and reviews its actual and concrete use in UAV, and probes into its development and challenges. Real-time target tracking is the key to the safe and efficient operation of autonomous vehicles. It then investigates the application and potential growth of vision-based tracking in autonomous vehicles, while also highlighting cutting-edge technologies and areas that need to be strengthened in the future. The paper concludes by affirming the revolutionary role of this technology in enhancing the capabilities of autonomous vehicles, thus paving the way for safer and more reliable transportation systems.

To sum up, vision-based object tracking technology in autonomous vehicles holds significant promise for improving the safety and efficiency of transportation systems. Despite current limitations, significant research and development is needed to address these challenges and improve the accuracy, reliability, and robustness of these systems. This research could lead to further development of autonomous vehicle technology and have significant implications for our transportation systems.

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