Mobile shooting assistant based on intelligent vehicle

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Abstract. Most shooting casinos still stay in a fixed-point shooting state. Some mobile shooting is just laying rails in the shooting range and running by cable. This type of target is too limited and not flexible enough. This kind of moving target is based on smart car. A robotic arm is installed on the smart car to grip the target. Different end points are set in the field. Each time the smart car starts, an end point is randomly generated and the path is identified by the camera. Drive to the end to form a moving target, and design a shock absorption device to prevent the vehicle body from vibrating violently when the target is hit.

1. Introduction

At present, shooting sports are getting closer to ordinary people. For ordinary people, shooting is no longer just a military item and a sports item, it is also an entertainment item. People's interest in shooting is unprecedentedly strong. China's first commercial shooting range was first established in the 1980s. This is the first time that our shooting program has extended from the military field to the economic field, meeting the needs of the people for spiritual civilization in the context of increasing living standards.

Most of the current shooting casinos still stay in a fixed-point shooting state. In addition to fixed-point shooting, there are moving targets in the army’s shooting training, but they only lay guides in the shooting range and run by cable traction. This type of target is too over the limitation, it is not flexible enough, the speed is slow and it is not flexible to change the speed. It is only a way of running in orbit. Although it is simple to implement, the maintenance cost is high and the effect is not ideal. It makes shooting sports less fun. Aiming at the above phenomenon, a smart car-based moving target is designed. A robotic arm is installed on the smart car to clamp ordinary targets or humanoid targets, and different end points are set in the venue. Each time the smart car starts an end point will be randomly generated, and the camera will recognize the path to the end point to form a moving target. And design shock absorption device to prevent the body from violent vibration when the target is hit [1].

2. Research method

2.1. Comparison with existing methods

The goal of this project is to solve the problem of the single shooting entertainment mode and the shortcomings of professional training intelligent mobile target system. In order to improve its fun and
training difficulty in shooting, designing a proper and reasonably intelligent mobile target system is the most important.

At present, in the shooting training of light weapons, a mobile shooting plane target system is mostly used as a training weapon for defense light weapons. For a long time, the simulation of human behavior has been the focus of the construction of light weapons shooting targets. Among them, the more advanced are crowd targets with irregular movements and intelligent people. At present, most of the traditional light weapons shooting training targets at home and abroad use on-orbit operation, that is, laying light rails or profiles as guides in the shooting training range, and arranging hidden facilities such as power lines, control cabinets and operators. The method of cable traction runs on the track. Although this method is simple to implement, the overall construction and maintenance costs are high, the target location is relatively fixed, and the flexibility is lacking. Comparison of more intelligent light weapon shooting training target systems:

| The Way               | Disadvantage                                                                 |
|-----------------------|------------------------------------------------------------------------------|
| Photoelectric detection | Laser arrays are costly, difficult to process, and vulnerable to bullet damage |
| Image recognition     | Need to change the target paper after each shot                               |
| Acousto-optic localization | This method has the problem of mutual interference, and it is easy to miss judgment for continuous targets. |

In this project, a camera is installed on the smart car to identify the driving trajectory, a robotic arm is used to grip the target and move it, and it is connected to a shock absorption device on one side of the robotic arm, which can reduce the impact of the body when receiving a bullet. The generated vibration makes the car more stable and lower cost, and the speed is adjustable. The smart car technology of this project can draw on relevant information in Freescale. Now, Freescale smart cars can already drive on up and down slopes, the speed is also ideal and adjustable, and it has good applicability [2].

In addition, considering that the shooter may miss the target and hit the car body, in order to ensure the safety of the car, the car needs to be placed in the track slot. The existing mobile target also has a dedicated track to let the car only expose the target. Prevent the body from being hit, and the body of the smart car is not large, the dedicated track design is very convenient.

2.2. Master plan
This project takes application innovation and structural innovation as the starting point. In view of the fact that shooting entertainment is gradually popular but the method is single and the mobile shooting training system is not good enough, a smart car that can be used as a moving target is designed to increase shooting. It’s fun and difficult to train, and it’s more challenging. This project mainly includes camera recognition, shock absorption device and so on. The specific content of the project is as follows:

1) Design a reasonable shock absorption device, combining the shock absorption device and the shock absorption pad, to minimize the vibration.

2) The camera uses Hawkeye OV7725, which is the best imaging quality and low-illumination chip in the OV series of 300,000 pixels. It has excellent image processing effect and extremely fast image acquisition speed. It supports both continuous and interlaced scanning methods, VGA and QVGA image formats; the maximum pixels are 664 × 492, and the frame rate is 30fps [3].

3) The steering of the steering gear is controlled by the PID algorithm to control the direction of the car.
2.3. Design goals
According to relevant investigations, shooting entertainment is getting closer and closer to the general public. It is no longer just a sports item and a military item. China is showing a dramatic increase in shooting. However, at present, the method of entertainment is too single, and the method of intelligent mobile target system for professional training is diverse but each has its shortcomings, and is not flexible enough and too limited. Therefore, a smart vehicle-based moving target is designed for this project. The robotic arm on the smart vehicle is used to move the target on a random trajectory, which increases the fun of designing entertainment and the difficulty of shooting training, which can play a better role.

2.4. Overall structural design
The mobile shooting assistant is composed of a mechanical gripper, a dual-drive differential wheel chassis structure, an intelligent camera recognition, and a shock absorption device. As the picture shows, this project uses camera intelligent recognition technology, grips the target with mechanical claws, the car is driven by two rear wheels side by side, turns through differential speed, the camera is used to identify the road, and the image information is processed and provided to the microcontroller, and then the main control chip realizes the control of the smart car.

Mechanical grippers are widely used in the blessing and collection of various items. Due to their good mobility and high degree of freedom. The mobile shooting aid of this device also uses mechanical claws to grip the target, as shown in the figure. If the player wants to experience different difficulties, the above mechanical claws can also be turned randomly to increase the difficulty of the game and make the player have a better experience.

The mechanical claw can be used as a reference for the car body, and it can rotate 360 degrees around the Z axis. It has better flexibility. It is considered that the rotatable part above the robot arm becomes loose. When receiving an impact, it can better use a shock absorber to lower the bullet. The shock caused by the impact force prevents the severe vibration of the smart car.

The side of the mechanical arm relates to the shock absorbing device. The shock absorber spring is outside the cavity of the shock absorber. The shock absorbing spring can filter the vibration generated by the impact of the bullet on the mechanical arm, but the spring itself will also have a reciprocating motion. This is the shock absorber formed by the cavity that works. The shock absorber uses a bi-directional barrel shock absorber. After the spring absorbs shock, a reciprocating movement occurs. When the spring squeezes the shock absorber, the shock absorber is compressed, and the piston inside the shock absorber moves downward at this time. The volume of the lower chamber of the piston decreases, and the oil pressure increases, and the oil flows through the flow valve to the chamber above the piston [4]. The upper cavity takes up a part of the space by the piston rod, so the increased volume of the upper cavity is smaller than the reduced volume of the lower cavity, so a part of the oil is pushed to open the compression valve and flow back to the oil storage cylinder. The oil savings of these valves create the damping force of the suspension under compression. When the shock absorber is stretched, the piston moves upward, the oil pressure in the upper cavity of the piston rises, the flow valve is closed, and the oil in the upper cavity pushes the extension valve into the lower cavity. Due to the existence of the piston rod, the oil flowing from the upper cavity is not enough to fill the increased volume of the lower cavity, and the main cavity causes a vacuum in the lower cavity. Currently, the oil in the oil storage cylinder opens the compensation valve and flows into the lower cavity to supplement it. Due to the throttling effect of these valves, the suspension has a damping effect during the extension movement.

Whenever the smart car completes a task from the starting point to the end point, the car stops running, and the target gripped by the robotic arm is replaced by a new one manually, and the remaining power of the smart car power supply is checked. battery.
3. Software system design

The image acquisition unit used in this project is the CMOS image sensor OV7725. Because CMOS is a highly integrated large-scale integrated circuit, the photosensitive element is used as a photosensitive device, and the voltage signal is directly generated by photoelectric conversion. The voltage signal has high sensitivity, only requires a power source, low power consumption, and power consumption is greatly reduced compared to the CCD. The CMOS chip provides a series of control registers. Functions such as balance control, simple programming and flexible control.

In the area of designing entertainment or training, the driving of a smart car necessarily requires a track. The track can be in Freescale form. A black line is laid on the edge of the track. After the camera captures the image, the position of the black line is obtained through image processing and then calculated correctly. Track, the position information is returned to the STM32 microcontroller to realize road recognition. Because the captured image is very large, it is grayed out first, the formula is as follows:

$$Y = 0.3R + 0.59G + 0.11B$$  \hspace{1cm} (1)

After the graying process, the picture is still relatively large, and it needs to be binarized. During the binarization process, a threshold is set to set the color of the track to white and the ends of the track to black. Then start analyzing the processed images, identifying valid elements, and providing as much information as possible for decision making.

After the image information is binarized, each line of the image is processed, and the position of the black line in each line of the image can be obtained. The edge extraction algorithm is adopted, which is sensitive to the black line, has high accuracy and strong anti-interference ability. The edge extraction algorithm flow is as follows:

1. The rising or falling edge is continuously detected by the control loop statement. When the difference between the A/D value of the i-th point and the A/D value of the i + 2 point is greater than the set threshold, it indicates that a falling edge has occurred, and the value of i is read at this time.

2. Once a falling edge occurs, start to continuously judge whether the difference between the A/D value of the i + 2 point and the A/D value of the i point is greater than the set threshold. If it is greater than that, a rising edge is detected, and the value of i is also read at this time. With the value of i twice, the number of points corresponding to the black line can be obtained, and the relative position of the black line can be obtained.

The relative position of the black line is calculated by judging the position of the falling edge and the position of the rising edge, and the error is reduced by judging whether the data after the rising
edge satisfies the phase difference is not greater than the threshold to accurately calculate the relative position of the black line.

When processing each line in the image, the near image is more reliable than the far one, so the edges are extracted from near too far. In order to reduce the search range and save time, the following lines use edge tracking to dynamically determine the search range of the black line of the line based on the position of the black line of the previous line. Searching for the black line saves time and continues processing until the entire image is searched. The determination of the smart car's driving trajectory is relatively simple. You only need to add the position coordinates of the black lines on both sides of the track after image processing and then divide by 2 to get the position coordinates of the centerline of the trajectory. With the real-time control of the servo controlled by PID Adjust the direction and drive the smart car to the end.

4. Project research basis and feasibility analysis

4.1. Research basis
The key of this project lies in two points: image recognition: used to identify the trajectory route; shock absorption module: when the player shoots, in order to reduce the vibration caused by the impact of the bullet to make the car run smoothly, the shock absorption module is very important.

In terms of image recognition orbits, the image recognition algorithms in Freescale are relatively mature, and only need to be modified appropriately; in terms of vibration damping devices, various factories have been widely used and the technology is very mature. In the field of shooting: civilian entertainment has grown rapidly and has a good mass base; in the training of troops, light weapon shooting training has become an important means of military training, and intelligent mobile target systems are diverse.

4.2. Feasibility analysis
For such a project as shooting, most people are exposed to entertainment shooting, and in recent years, people's interest in shooting has been unprecedentedly strong, meeting the needs of the people for spiritual civilization in the context of increasing living standards; in the army Shooting training is essential, and mobile shooting training is receiving widespread attention, especially the design of the intelligent mobile shooting system, which directly determines the effect of mobile shooting training, which is very important. Mobile shooting training has a large audience, and the project has good feasibility.

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