Design and Implementation of a Real-Time Target Detection and Automatic Tracking System

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1 Project Overview

This project aims to design and implement a real-time target detection and automatic tracking system based on deep learning models and automatic control. The system uses computer vision technology to detect and automatically track targets in a gaming environment, and combines control theory to achieve precise mouse operations. The project involves the deployment of deep learning inference models and explores the application and optimization of a Proportional-Integral (PI) controller in target tracking. The implementation of the entire system will demonstrate how to effectively combine deep learning, computer vision, and control systems to solve practical dynamic target tracking problems.

2 Technical Summary and Project Content

2.1 Deep Learning Target Detection Model

ONNX Model Inference: The project uses an ONNX format target detection model for inference. ONNX models have cross-platform compatibility and support GPU-accelerated inference to improve real-time detection performance.
Model Deployment and Optimization: The onnxruntime library combined with CUDA is used to provide GPU acceleration, ensuring that detection remains real-time at high frame rates.

2.2 Computer Vision and Image Processing

Image Capture and Preprocessing: The mss library is used for real-time screen capture, and OpenCV is used to resize and convert the color format of the images to meet the input requirements of the target detection model.
Detection Area Limitation: By dynamically adjusting the detection area, the target detection is limited to the vicinity of the game crosshair, thereby

reducing computational load and improving detection accuracy and system responsiveness.

2.3 Automatic Control System: Proportional-Integral (PI) Controller

PI Controller Design: Two PI controllers are implemented in the project to control mouse movement in the horizontal and vertical directions. The proportional gain (Kp) and integral gain (Ki) are used to adjust the speed and stability of the mouse response.
PI Controller Tuning: Through experiments, Kp and Ki are adjusted to find the optimal control parameters, enabling the system to smoothly and quickly track the target once detected, while avoiding oscillations due to overadjustment.

2.4 Real-Time Interaction and System Integration

Mouse Event Simulation: The win32api and win32con libraries are used to simulate mouse movement, enabling automatic aiming and following of the target.
Multi-Module Integration: The target detection, image processing, and mouse control modules are integrated to form a complete real-time automatic tracking system.

3 Project Objectives

Target Detection and Recognition: Achieve accurate detection and classification of dynamic targets and optimize the detection model to meet real-time performance requirements.
Automatic Control and Tracking: Design appropriate control strategies (PI controller) to enable the system to automatically adjust aiming and accurately lock onto the target until it disappears.
Performance Evaluation: Evaluate the system's response speed, stability, and tracking accuracy in different scenarios, and improve overall performance by tuning parameters such as Kp and Ki.

4 Project Outcomes

Develop an automatic target detection and tracking system that can operate in the Overwatch practice range, demonstrating real-time detection and response to dynamic targets.

After collecting the data and training with YOLO, the accuracy we get on the test data set is around 95%, and it function well in the game.

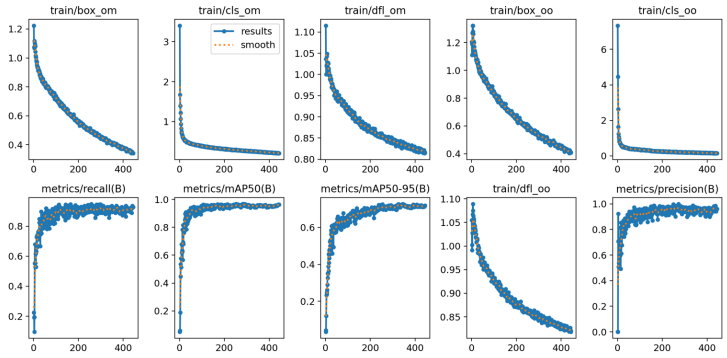

Figure 1: predict graphs

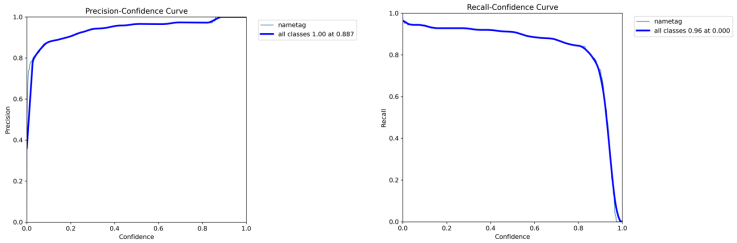

Figure 2: precision and lose graphs

5 Conclusion

This project provides a new solution for dynamic target tracking by combining target detection models with automatic control systems. By optimizing the deep learning model and adjusting control parameters, the system achieves a good balance between real-time performance and accuracy. These research results can be applied not only to gaming scenarios but also have reference value for automation and intelligent control fields.