

Research Statement

Cui Chenglin

1 Past Research

1.1 National Intelligent Car Competition for College Students

During my undergraduate studies, I participated in the China University Students' Intelligent Car Competition, which is a Class A competition for university students in China. The main aspects of the competition included embedded programming, design of the car's hardware structure, and trajectory planning based on image processing. I was primarily responsible for parts welding and the image processing segment. Our team ultimately achieved a national second prize for our efforts.

1.2 Bachelor's Thesis

The 2020 report by the International Agency for Research on Cancer reveals breast cancer as the most common cancer globally, accounting for about 12% of all cancer cases each year. Traditional breast cancer diagnosis methods are often slow and subjective. To improve this, I'm using AI to enhance diagnosis speed and accuracy. My data comes from the Breast Cancer Wisconsin (Diagnostic) dataset on Kaggle, involving 569 patients. The dataset's goal is to identify if breast tumors are benign or malignant. After extracting features from the dataset's images, I used SVM and feedforward neural network models for classification. The accuracy of these models was 0.812 and 0.974, respectively.

1.3 Master's Thesis

During my graduate studies, I participated in a key national research project in China, focusing on multi-object detection and tracking in a multi-sensor system. I published a paper at the ITSC conference on this topic. My research involved multi-object detection and tracking based on cross-camera fusion, using images from multiple cameras mounted on a vehicle to create bird's-eye views for feature extraction and tracking. The model framework was designed using transformers, and I proposed a new tracking method that leverages classification to learn trajectory features in the training set, eliminating the need for target matching between frames during training. Currently, I am further researching 3D multi-object detection and tracking with sensor fusion, combining LiDAR and cameras to create more accurate and informative bird's-eye views. This method, which specially designs positional data to enhance detection and data association, will be the main focus of my master's thesis.

2 Future Research

2.1 Multi-object Tracking

I like researching object tracking, a field with many unresolved issues. I once attempted to create a universal tracking framework for autonomous driving, but realized that different scenarios have unique characteristics requiring tailored approaches. Additionally, target occlusion and trajectory loss are longstanding, challenging problems in object tracking. In the future, I would like to focus on a specific scenario to address these issues, whether through a streamlined end-to-end framework or manually designed modules. I hope to see my work applied industrially. Moreover, I am eager to explore data association further - what features are most suitable? For specific target characteristics, what are the best methods for similarity measurement and association?

2.2 Video Understanding & Analysis

In my research on object tracking, I've developed a deeper understanding of images and videos. Every video represents a complex scene, a segment of real-world information. Despite appearing two-dimensional, each image and video is actually derived from the 3D world and contains spatial information. This means that 3D representation is more accurate for images and videos than two-dimensional. Therefore, each tracking trajectory in a video has unique video-level features. Object tracking involves associating the same object across different frames, which includes using the video's temporal sequence and modeling trajectories. In the future, I aim to extend my research to understanding video scenes, constructing a 3D space, and extracting 3D features to understand the relationships between objects. If possible, I would also like to further extract information about actions, interpersonal relationships, and settings from videos.