Design and development of 3D reconstruction system for the embedded system

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Abstract— With the development of computer vision, 3D reconstruction, image processing and image recognition are becoming more and more frequent in daily life. This project aims to implement the design and development of 3D reconstruction system on the NVIDIA Jetson Nano platform, using the binocular cameras to detect the object and estimate the object distance.

Introduction

The goal of this subject is to establish a 3D reconstruction system based on a deep neural network model, using binocular cameras on the NVIDIA Jetson Nano platform to identify, measure and estimate the distance of the objects through the graphical interface. At the same time, four main requirements including image capture, target detection and calibration, target range output and interactive operation need to be meet. On this basis, it is necessary to improve the accuracy of object recognition and distance detection, and a more complete system needs to have a smooth interactive function and a user-friendly visual interface.

Methodology

Figure 1 is the flow chart of the algorithm in this paper. The algorithm is divided into the following three parts:

1. Binocular cameras are used to collect environmental information simultaneously with the left and right lenses. After that, image processing technology is used to reconstruct the obtained image data in 3D to process the distance information of each point [1].
2. An accurate 3D point cloud fusion algorithm is used to optimize the reconstruction results of multiple stereo pairs [2]. Then, use Jetson Nano to perform image segmentation on the previous image data.
3. Build a deep neural network model to improve the precision of the 3D reconstruction project. In this step, different classification models will have completely different accuracy and results.
4. The mathematical principle of binocular imaging is used to improve the imaging effect and enhance the accuracy and accuracy of 3D reconstruction. Using this method, the accuracy of binocular imaging is improved. The relevent model is shown in Figure 2.

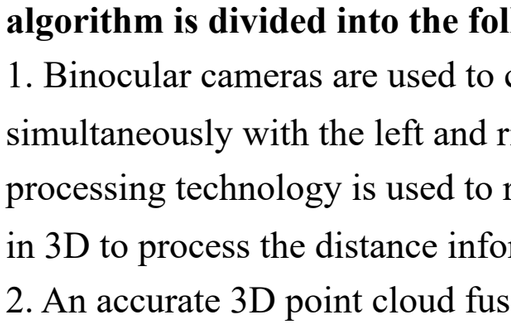

Fig.1 Algorithm flow chart

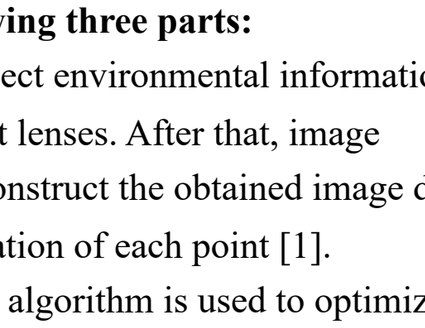

Fig.2 Binocular vision system [3]

Results and Discussion

1. I achieved the preparatory work for many objectives, including learning some deep learning algorithms and learning the usage of NVIDIA Jetson Nano. To be specific, I am learning the deep learning algorithms along with Python pyQt, especially for the CNN. Meanwhile, I understood the purpose of using Jetson Nano, and watched several videos related to the device, including tutorial and creative development videos.

2. I learned about the previous academic research results in this field and the current lack of scientific research content. As I mentioned in literature review, most research is related to this project, but lacks certain functions or accuracy. Therefore, after reading many papers, not only did I have a better comprehension of the field of deep learning and image recognition, but I also began to clarify the implementation method of this project. However, the actual effects of these methods need to be practiced in the next semester, and they are still in the theoretical stage.

3. I preprocessed the image data set. Because this project involves the training of enormous deep neural network models, and training requires the support of an extensive number of image data sets. Processing images is a very time-consuming and basic task. Hence, I have completed the image preprocessing of a public data set ahead of time, so that the subsequent work can proceed more smoothly.

Conclusion and Future Work

In conclusion, this project has completed three parts of the listed objectives, including learning CNN/other deep learning algorithms along with Python pyQt, reading relevant paper and trying to familiar with Jetson Nano. In terms of data processing, it has been completed preprocessing of some image data sets. The current main result is the design of the project method. After learning a lot of papers, I began to understand the specific areas of this project and devised the methods mentioned in methodology.

There are still some limitations that are difficult to solve in the current project, including that a suitable model has not been found, a platform has not been built with Jetson Nano, and specific testing and verification work has not been started. However, all of this will be tackled in Semester 2. Therefore, in the long run, the progress of this project is optimistic.

Selected References

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[3] D.-y. Ge, X.-f. Yao, and Z.-t. Lian, "Binocular vision calibration and 3D re-construction with an orthogonal learning neural network," MULTIMEDIA TOOLS AND APPLICATIONS, vol. 75, no. 23, pp. 15635-15650, 12/01/ 2016, doi: 10.1007/s11042-015-2845-5.