MERIT Domestic Internship Report

2nd year doctoral student, Ogata Laboratory, Department of Physics

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1. Internship Outline

Period: October 22, 2021 (Fri.) - December 6, 2021 (Mon.)

Place of internship (contact person): Image Processing Research Section, Computer Vision Laboratory, Advanced Technology Research Institute, Research and Development Division, Kyocera Corporation (Eijiro Shibusawa)

Subject: Learning by Random Forest of Aggregation Direction in Semi-Global Matching

2. Training Outline

Kyocera Corporation provides research-based internship opportunities for graduate students. I was accepted at the Kyocera Minatomirai Research Center and did a 6-week internship. From the viewpoint of infection prevention, about 90% of the internship was conducted in an online format. In the first two weeks (10/22-11/5), I conducted a survey of the research surrounding the theme of the host institution, and I proposed to conduct research on the above theme. In the remaining 4 weeks (11/8~12/6), I followed the proposed theme and worked on improving the accuracy of semi-global matching by incorporating machine learning.

3. Research Contents

【Background】

Stereo matching is a method of estimating disparity by matching each part of two images. If the disparity of each part in the image can be estimated, the distance can be calculated based on the principle of triangulation, and this method can be applied to image sensors. One of the methods of stereo matching is semi-global matching (SGM) [1]. This is a method of matching by optimizing on a path of eight directions, horizontally, vertically, and diagonally, in each pixel of the image. However, it is not always better to optimize in eight directions, and in some cases it is better to optimize only in the vertical or horizontal directions [2]. It has been pointed out that the accuracy of SGM can be improved by using machine learning to determine which direction to optimize [2]. I was interested in the previous study [2] and implemented learning by random forest in the SGM based on it. However, the results were lower than the accuracy of the original SGM.

【Research Objective】

Based on the above background, I set the research objective of this internship as "to improve the performance of the original SGM by incorporating learning by Random Forest into the SGM.

【Research Method, Research Contents】

(1) Analyze pixels that are not learning well, and study the cause of the failure to improve the performance.

I analyzed the pixels that are not learning well, and study the cause of the learning failure. Then,

I was able to extract pixels with such a tendency by using a function. By using conventional SGM for the extracted unsuccessful pixels and learning for the other pixels, I was able to improve the accuracy by about 10%.

(2) Examine the performance improvement by changing the way the training data is given.

I tried various methods such as increasing the number of images used for training, prioritizing training on pixels where the SGM is clearly wrong, and changing the cost calculation method. As a result, I was able to improve the learning accuracy by a few percent.

Through the research described in (1) and (2) above, the SGM with learning was able to outperform the original SGM.

4. Feeling

In this project, we used the method of removing pixels that were not learning well, but I feel that it is necessary to improve the quality of learning. I am a little disappointed that I could not go that far, due to the short time frame of 6 weeks and my lack of familiarity with machine learning. Although there was not enough time, I am very satisfied with the internship because I was able to experience a series of research activities in a company, such as surveying peripheral research, planning a theme, implementing algorithms, evaluation, and analysis. I hope to do research in a corporate research institute in the future, so it was a great opportunity for me to experience firsthand how they work and how it differs from university research.

It was also refreshing and fun to be able to conduct research using familiar objects such as images, whereas most of my university research involved building models on a desk and performing calculations on them. I would like to do more applied research in the future, and I think this was a good experience in that sense. As a physics major, this was the first time I was exposed to this field, and there were times when I stumbled, but I think I was able to absorb a lot from the careful guidance and discussions by the people in charge of the internship.

In addition, the fact that I was able to interact with a variety of researchers was also very good. Kyocera Corporation has a wide variety of people from different backgrounds, including researchers from the same theoretical physics field as me, researchers from academic posts at universities, and researchers from national research institutes, etc. It was very meaningful to have the opportunity to talk with a variety of people. In the meetings with chit-chat at my section, I was able to hear more frankly about life as a company employee, which I felt would be helpful for my future. I also had the opportunity to introduce my university research to researchers from different fields, and I was able to ask questions from the perspective of a company employee, which I think was a very good experience.

5. Acknowledgements

I would like to express my sincere gratitude to Mr. Eijiro Shibusawa of Kyocera Corporation and the members of the Image Processing Research Section for accepting me for this internship and providing me with guidance. I would also like to thank the Kyocera Minato Mirai Research Center, the Department of Physics, my supervisor Professor Masao Ogata, and my associate supervisor Professor Kaoru Kimura for

allowing me to participate in this program despite the difficult circumstances. Finally, I would like to thank the MERIT staff for this opportunity, and Ms. Konda of the GMSI program office for mediating the internship.

References [1] H. Hirschmüller. CVPR (2), 807, IEEE Computer Society, (2005). [2] J. Schönberger *et al*., ECCV (13), volume 11217 of Lecture Notes in Computer Science, 758-775. Springer, (2018).