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High Performance Techniques For Multi-Class 3D Object Categorization

Dissertation

**Submitted as a partial fulfillment of the requirements for the degree of
Master of Science in Computer and Information Sciences.**

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Dedication

This thesis is dedicated to the memory of my parents. I really miss you, but I know you are happy and proud of this progress in my life. I always pray for your happiness.

Many thanks To

My brother Mohamed, my sister Aisha and my lovely wife Omnia.

Mohamed keeps pushing me, his words of encouragement ring in my ears. He was my first teacher, without his experience I could not find the right path.

Aisha supports from my early childhood till today. I will never forget your long hours of careing us.

My beautiful and lovely wife, without your support and patience, I could not complete such work.

Also I dedicate this work to the best Prof. I met; Dr. Hossam whom gives me his support and never gives up. He treats me as a son.

Acknowledgements

Many people helped in this work, but special thanks for Dr. Doaa Hegazy. She guides me to the correct way. Her wide knowledge and experience in the field of computer vision enriches my research. I would like to thank Dr. Wail Elkelani for his encouragement and guideness. Also, I would never forget the unlimited support of my Faculty; Computer and Information Sciences (FCIS). It facilitates my research and supports me with the needed equipment. Finally, I would like to appreciates Dr. Mohamed Hamdy; The manager of Information Network for Ain Shams University. He gave me his support and allowed me to access some of the network servers for my experiments.

Abstract

This thesis is an example of how high performance computing techniques can be used to speedup the processing of computationally intensive problems. The problem of machine ability to catgeorize different objects is our selected problem. Object categorization is the task of classifing objects into generic classes. Although such task is effort-less for humans, it is a complex and computationally intensive for computers. Object categorization is an important task for its different applications such as image annotation, image retrieval, video annotation,surveillance, driver assistance, autonomous robots, interactive games. It is also used as apreparation step for object recognition.

The performance metric for the categorization task consists of two key measurements, success categorization rate and system run-time. Different trials to solve the categorization problem are currently in place. However, few trials consider both of them. In fact, the heavy processing tasks needed for accurate categorization system lead to increase system run-time. Recently, the high performance techniques are used to solve the problem of increasing system run-time

In this thesis, we provide a study of 3D object categorization algorithms based on complex feature and a study of different high performance computing techniques that could be used to enhance such

algorithms performance. We introduce a system that categorizes 3D objects based on their depth information. It matches the real time constraint with high success categorization rate compared to other existing systems.

In the proposed categorization system, spin-images are selected as features also Support Vector Machine is selected as a classifier. Spin-image is a complex feature to be extracted. We investigated the task dependancy in such feature extraction. Moreover, we modified the original spin-image algorithm to eliminate the unnecessary blocking tasks based on our task dependancy analysis.

Different strategies enhancing spin-point selection in order to enhance sucess categorization rate are evaluated. Also, we evaluated the benift of using bag of features technique for the success categorization rate. During our initial experiments, the success categorization rate was approached 65%. After futher improvements, this rate has been significantly increased such that we have achieved almost 81% in 0.85033 second for each single object.

Eventually, an evaluation to our implemented categorization system is carried out in comparison to two different types of publicly available 3D objects datasets. The first one was the Princeton shape benchmark. The second one was the RGB-D dataset. Results have proved that our categorization system provides much more accurate and faster categorization.

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