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Evolution of Deep Belief Neural Network Parameters for Robot Object Recognition and Grasping

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Abstract

Robot object recognition and grasping is an important research area in robotics. Recently, deep learning is gaining popularity as a powerful mechanism for object recognition. Deep learning has very complicated configurations including network structures and several parameters, such as the number of hidden units and the number of epochs, which influence the performance and computation time. Determining such parameters require high expertise in deep learning. Thus, the development of deep learning is limiting in the skilled experts. In this work, we combine Deep Belief Neural Network (DBNN) and evolutionary algorithm in order to improve the performance and reduce the computation time. To verify the performance, robot object recognition and grasping is considered. Experimental results show that our method outperforms on object recognition and robot grasping tasks.

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Keywords: Genetic Algorithm, Deep Belief Neural Network, Object Recognition, Robot Grasping, Deep Learning;

1. Introduction

Deep learning techniques have recently achieved state-of-art performance in applications such as object detection and recognition, image segmentation, face recognition, scene classification, motion generation, depth estimation and caption generation. Human brain deep architecture is the motivation for studying deep learning architectures. Deep

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learning architectures reduce a high-dimensional problem into a number of low-dimensional problems in the hierarchical fashion for reducing complexity. It learns the features from data through multiple layers of abstraction. These features are used for object recognition purpose. Deep learning has complex configurations including network structures and several parameters, such as the number of hidden units and the number of epochs in each layer, which have much influenced on the performance and computation time.

Recently, different researchers are working on optimizing the deep learning parameters based on evolutionary algorithms. Cheung *et al.* [14] applied an evolutionary approach for searching a suitable architecture of convolutional networks. Lamos-Sweeney [15] examined the use of Genetic Algorithms for deep learning, which is trained the networks independently to increase the overall flexibility and reduce the computational complexity of the algorithms. David *et al.* [16] developed genetic algorithms to improve the training of deep autoencoders and produces a sparser network. Maul *et al.* [17] implemented standard evolutionary and cooperative evolutionary methods to evolutionary deep neural networks for guiding principles of synergizing evolutionary and error gradient. Zhining *et al.* [18] designed a hybrid genetic algorithm and Convolutional Neural Network (CNN) model. This model selects the characteristic of CNN using a genetic algorithm to form the connection weight's evolution.

In this paper, we propose an efficient structure and tuning parameter optimization algorithm for deep learning approach using an evolutionary algorithm for robot manipulator, which performs object recognition and robot grasping. We divide our methods into two parts: object recognition using our Deep Belief Neural Network (DBNN) method, which is optimized using Genetic Algorithms (GA), and robot grasping. We apply a genetic algorithm to search for the suitable parameter for DBNN method, then we show that DBNN method combined with backpropagation performed good performance on object recognition and robot grasping.

Object recognition is an important and interesting research area in robotic systems. Object recognition research was started many years ago [1]. Then, many researchers implemented in different object recognition methods [2-7]. Nowadays, many researchers are working on deep learning for object recognition to make robot useful in household services, industrial productions and so on. Recently, more and more research approaches on robot object pick-and-place problems are implemented using deep learning [8-13]. In order to enhance the performance of object recognition, it is necessary to optimize the parameters of deep learning.

This paper is organized as follows. The designed task is introduced in Section 2. Object recognition using DBNN method is described in Section 3. Evolution process is mentioned in Section 4. Experimental results for optimized object recognition and robot grasping are provided in Section 5. Finally, we give conclusions and future works.

2. Designed task

The main goal of this paper is to optimize the parameters of DBNN method for intended object recognition and robot grasping. In the experimental environment, there are several objects, which are randomly scattered. The robot needs to distinguish the intended objects from others.

The data flow of our work is shown in Fig. 1. When a user requests a specific object by clicking on its picture, then USB camera takes a snapshot of the experimental environment. The Morphological Structuring Element (STREL) operation performs on the snapshot in order to detect the objects. The detected objects are used as input of DBNN method. The parameters of DBNN method are optimized using Genetic Algorithm. After object recognition, the robot determines the object position. Then, the robot generates a motion from the initial position to the object position. After then, the robot grasps the object and generates another motion to the destination position and place the object. The robot trajectory is programmed by the control PC.

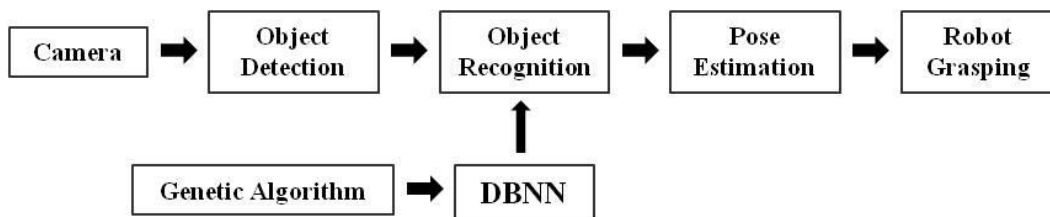


Fig. 1. Data flow of our work.

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