GESTALT Robotics GmbH

Columbiadamm 31
10965 Berlin

tel +49 (0) 30 616 515 60
mail info@gestalt-robotics.com
www gestalt-robotics.com

Proposal Master's Thesis: Training data generation for Deep Learning-based Robotic Vision Systems

The goal of this thesis is to design and evaluate a pipeline for automatically creating realistic training data from simulations for real-world object classification and detection algorithms.

Visually localising and classifying objects are core tasks for autonomous and manipulating robots. They represent the basis for downstream robot capabilities, such as grasping, manipulation or navigation. In recent years, Convolutional Neural Networks [1] have become the method of choice as they have been beating competing approaches by a high margin.

However, this class of algorithms is particularly data hungry requiring thousands to millions of training data images. To make things worse, generating training data in robotics is expensive requiring manual labelling and the usage of the robot's actuators. A solution to this dilemma is using simulation environments. However, models trained on synthetic images have turned out be incapable of generalising their knowledge to the real-world environment.

In recent years, image generating approaches, such as Generative Adversarial Networks [2] (GANs) have been increasingly used to augment synthetically created data closing the realism gap. With these approaches, a high amount of automatically labelled photorealistic images can be created to train models. Exemplary applications are bee marker detection [3], hand pose estimation and eye tracking [4], face verification [5], robot grasping [6] and navigation [7].

This thesis strives to evaluate the prospects and limits of current image generation approaches for creating synthetic indoor object classification and detection training data. The image generation process will be structured into three parts: background environment image generation, foreground object image generation and final image refinement. To create indoor scenes, the Gibson Environment [7] can be employed.

Objects of interest are provided by the ShapeNet dataset [8], which contains a variety of household objects as 3D models. To enhance photorealism, the image containing background and object foreground has to be post-processed using approaches, such as Domain Adversarial Training [9] or Goggles [7]. Finally, experiments with real-world objects shall investigate the effectiveness of additionally created data on classification and localisation tasks.

Work packages

- Literature research and method selection
- Background image creation
- Foreground image creation
- Image refinement using Domain Adaptation Techniques
- Evaluation

References

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Contact

Dr.-Ing. The Duy Nguyen

nguyen@gestalt-robotics.com

+49 30 616 515 60

www.gestalt-robotics.com