POSITION PROFILE – M2 Internship: 6D Pose Estimation for Manipulating Heavy and Complex Geometric Objects with a Robotic Arm

Informations

Laboratory: LIRIS (UMR 5205)

Type of working contract: M2 Internship

Supervision: Emmanuel Dellandréa

Working contract duration: 5-6 months

Job starting date: Between January and March 2024

Gross monthly salary: standard M2 “gratification de stage”

Place of work: Ecole Centrale de Lyon, 36 avenue Guy de Collongue, 69130 Ecully

Research field

Context:

This mission is part of the acROBaTTH project, which involves collaboration between LIRIS, SETFORGE, and INNOVTEC companies. The project aims to propose new technologies for the robotization of the thermal treatment process for forged parts. Indeed, automating certain handling operations currently performed by human operators will help reduce the labor intensity of the work and prevent accidents and musculoskeletal disorders.

Thus, the overall objective of the mission will be to develop new vision and machine learning methods that will allow, based on camera images, the identification of the poses of objects arranged loosely in bins, so that the robotic arm can safely grasp them, and then determine the optimal placement position for depositing these objects on a tray in order to optimize their arrangement. It should be noted that this mission will focus on image analysis for predicting the grasping position, while the trajectory of the robotic arm will be handled by Innovtec.

Description of the activities

The problem of estimating the pose of objects (position and orientation in a three-dimensional space) is at the heart of this mission. There are multiple scientific challenges involved. Firstly, the scene images captured by the cameras will be highly noisy due to the significant heat conditions and the presence of calamine dust on the surface of the forged parts, which gets released into the air during their manipulation. Moreover, the objects to be grasped can be very heavy (up to 250 kg) and have complex shapes, requiring extremely precise pose estimation to avoid any drops. Lastly, based on the knowledge of the object's pose, the most appropriate gripping point for the robotic arm must be determined to enable the deposition of the object in a suitable position, optimizing the placement of the parts on the thermal treatment pallet.

The preferred approach is to consider a model-based pose estimation method (a 3D model of each part is available). The positions for possible grasping will be determined in advance by an expert human operator for each part model. The objective will be to estimate the pose of the parts in the bulk and determine, at each unpacking step, the most graspable piece (the one least covered by other parts). To achieve this, it will be considered to adapt state-of-the-art solutions for object pose estimation, such as PVNet [Peng19], DenseFusion [Wang19], G2L-Net [Chen20], FS-Net [Chen21] or GDR-Net [Wang21], to the context of bulk handling and partial occlusion [Grard20]. These methods will need to be studied and evaluated to propose an approach suitable for the noisy context and capable of achieving high precision.

References

[Grard20] Matthieu Grard, Emmanuel Dellandréa, Liming Chen, "Deep Multicameral Decoding for Localizing Unoccluded Object Instances from a Single RGB Image", International Journal of Computer Vision, vol. 128(5), pp. 1331-1359, 2020.

[Peng19] Sida Peng, Yuan Liu, Qixing Huang, Xiaowei Zhou, Hujun Bao, "PVNet: Pixel-Wise Voting Network for 6DoF Pose Estimation", Conference on Computer Vision and Pattern Recognition (CVPR), 2019.

[Wang19] Chen Wang, Danfei Xu, Yuke Zhu, Roberto Martín-Martín, Cewu Lu, Li Fei-Fei, Silvio Savarese, "DenseFusion: 6D Object Pose Estimation by Iterative Dense Fusion", Conference on Computer Vision and Pattern Recognition (CVPR), 2019.

[Chen20] Wei Chen, Xi Jia, Hyung Jin Chang, Jinming Duan, and Ales Leonardis, "G2L-Net: Global to Local Network for Real-Time 6D Pose Estimation with Embedding Vector Features", Conference on Computer Vision and Pattern Recognition (CVPR), 2020.

[Chen21] Wei Chen, Xi Jia, Hyung Jin Chang, Jinming Duan, Linlin Shen, Ales Leonardis, "FS-Net: Fast Shape-based Network for Category-Level 6D Object Pose Estimation with Decoupled Rotation Mechanism", Conference on Computer Vision and Pattern Recognition (CVPR), 2021.

[Wang21] Gu Wang, Fabian Manhardt, Federico Tombari, Xiangyang Ji, "GDR-Net: Geometry-Guided Direct Regression Network for Monocular 6D Object Pose Estimation", Conference on Computer Vision and Pattern Recognition (CVPR), 2021.

Required skills / qualifications

Knowledge required: Computer Vision, Machine Learning, Deep Learning.

Operational skills: Good proficiency in the Python language and deep learning libraries such as PyTorch.

Behavioural skills: Motivation, rigor, autonomy, proactivity.

Contact

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