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The “Key” to Robot Vision: Learned Keypoints for 6DoF Pose Estimation

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Classification of an object’s identity in a visual scene, combined with an estimation of the object’s rigid transformation, is a fundamental and longstanding problem in Computer Vision. This is known as the Six Degree-of-Freedom Pose Estimation (6DoF PE) problem. 6DoF PE is considered to be the enabling visual component to a number of important robotic functions, such as robotic grasping and bin picking. Accurate visual pose estimation is essentially a necessary pre-condition to provide robots with the ability to effectively interact with non-structured environments.

Advances in the application of Machine Learning to Computer Vision have given rise to 6DoF PE solutions which are extremely effective, both accurate and efficient. This presentation will describe a recent solution approach based on learned keypoints. Keypoints are 3D locations defined in an object-centric reference frame. During learning, a regression network is optimized on a labelled dataset of images of keypoints. During inference, the keypoint locations are then estimated using a voting approach. It is shown that the particular learned quantity regressed and voted upon impacts accuracy, and that the choice of keypoint locations themselves can be effectively learned using graph convolutional network methods. A novel self-supervised method is presented that allows the training data to be automatically generated, producing pseudo-keypoints, relieving the need to manually annotate the data.

Learned keypoint methods has been shown to achieve state of the art performance, on standard benchmark datasets. A number of industrial robotic grasping applications are presented that recently make use of these learned keypoint techniques.