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OBJECT RECOGNITION ALGORITHMS IN ROBOT SIMULATION SYSTEMS

Recent years have seen significant progress in object detection, mainly due to machine learning methods that have become practical and efficient. New data representations and models have also contributed to this task. It is expected that object detection algorithms, activated for robotics, will detect and classify all instances of an object type (if they exist). They should be detected even if there are variations in position, orientation, scale, partial occlusion, and environmental variations such as intensity.

Object detection is crucial for other computer vision functions, such as 3D scene reconstruction, obtaining additional object information (e.g., facial details), and tracking its movement through consecutive video frames. As mentioned earlier, robotic applications such as navigation and object selection may require more detailed image information. In this case, additional image capture channels may be used.

Self-navigating robots use multiple cameras, each directed in a different direction. A set of additional image generation sensors (LIDAR and RADAR) is used. The computer vision system combines data during or after object detection algorithms.

For each object, the computer vision system provides the following information: location (position and orientation of the object in the "real world"), type (which object has been detected), and movement associated with each object instance.

Classical object detection methods consisted of template-matching algorithms. Some of them used a structured matching process: first, recognizing parts of an object, and later, global matching using partial matches. Statistical classifiers such as Neural Networks, Adaboost, SVM (Support Vector Machines), and Bayesian classifiers were used to improve recognition in cases with variations.

Humans are a special class of objects that robots interact with. Human faces are considered a particular part that helps robots identify "objects." Additionally,

robots need to recognize human movement, especially those parts with which they can interact, such as hands.

Efficiency in such object detection algorithms can be achieved with multi-resolution models, where initial recognition is performed at a lower resolution, while selective parts, where objects are estimated to be, use high-resolution sub-images. The location and size of such sub-images can be estimated from frame to frame in a video based on motion estimation.

The initial search for objects (within an image) can use several alternatives. These alternatives are triggered every few image frames (video frames) as frequently as the information encountered by the robot may change. Efficiency is also a key factor here. A general frame search may be conducted with a process of searching for "hints" of an object's existence. When such a "hint" is detected, a fine-detail recognition method is activated. Naturally, "hints" from previous image frames, i.e., the predicted movement of an object, can be used here along with other "hints".

Object detection methods used with robotic equipment can be classified based on computer vision performance (how well they recognize objects) and efficiency (how much time they need to "understand" an image).

As a result of this work, approaches to robot computer vision in simulation systems have been reviewed, allowing robots to recognize objects that enter the camera's field of view. Object recognition algorithms were also implemented in the Webots robot simulation system to modify the controller of the Custom Robot.