Vehicle Detection for RCTA/ANS (Autonomous Navigation System)

This algorithm can be applied to semi-autonomous vehicles for driver assistance, and to military robots.

NASA’s Jet Propulsion Laboratory, Pasadena, California

Using a stereo camera pair, imagery is acquired and processed through the “JPLV” stereo processing pipeline. From this stereo data, large 3D blobs are found. These blobs are then described and classified by their shape to determine which are vehicles and which are not. Prior vehicle detection algorithms are either targeted to specific domains, such as following lead cars, or are intended for general large-scale vehicle detection. Since these vehicles were observed at varying ranges, one is able to find the probability that a vehicle is present in the scene.

In order to detect vehicles, the JPL Vehicle Detection (JVD) algorithm goes through the following steps:

1. Take as input a left disparity image and left rectified image from JPLV stereo.
2. Project the disparity data onto a two-dimensional Cartesian map.
3. Perform some post-processing of the map built in the previous step in order to clean it up.
4. Take the processed map and find peaks. For each peak, grow it out into a map blob. These map blobs represent large, roughly vehicle-sized objects in the scene.
5. Take these map blobs and reject those that do not meet certain criteria. Build descriptors for the ones that remain. Pass these descriptors onto a classifier, which determines if the blob is a vehicle or not.

The probability of detection is the probability that if a vehicle is present in the image, is visible, and un-occluded, then it will be detected by the JVD algorithm. In order to estimate this probability, eight sequences were ground-truthed from the RCTA (Robotics Collaborative Technology Alliances) program, totaling over 4,000 frames with 15 unique vehicles. Since these vehicles were observed at varying ranges, one is able to find the probability of detection as a function of range. At the time of this reporting, the JVD algorithm was tuned to perform best at cars seen from the front, rear, or side, and perform poorly on vehicles seen from oblique angles.

This work was done by Edward T. Chou, Simon S. Wu, Mark James, and George K. Paloulian of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-48224.

Image Mapping and Visual Attention on the Sensory Ego-Sphere

This technology can be used to map a robot’s environment and direct its attention.

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The Sensory Ego-Sphere (SES) is a short-term memory for a robot in the form of an egocentric, tessellated, spherical, sensory-motor map of the robot’s locale. Visual attention enables fast alignment of overlapping images without warping or position optimization, since an attentional point (AP) on the composite typically corresponds to one of the co-located regions in the images. Such alignment speeds analysis of the multiple images of the area.

Compositing and attention were performed two ways and compared: (1) APs were computed directly on the composite and not on the full-resolution images until the time of retrieval; and (2) the attentional operator was applied to all incoming imagery. It was found that although the second method was slower, it produced consistent and, thereby, more useful APs.

The SES is an integral part of a control system that will enable a robot to learn new behaviors based on its previ-