Autonomous Navigation by a Mobile Robot

ROAMAN is a computer program for autonomous navigation of a mobile robot on a long (as much as hundreds of meters) traversal of terrain. Developed for use aboard a robotic vehicle (rover) exploring the surface of a remote planet, ROAMAN could also be adapted to similar use on terrestrial mobile robots. ROAMAN implements a combination of algorithms for (1) long-range path planning based on images acquired by mast-mounted, wide-baseline stereoscopic cameras, and (2) local path planning based on images acquired by body-mounted, narrow-baseline stereoscopic cameras. The long-range path-planning algorithm autonomously generates a series of waypoints that are passed to the local path-planning algorithm, which plans obstacle-avoiding legs between the waypoints. Both the long- and short-range algorithms use an occupancy-grid representation in computations to detect obstacles and plan paths. Maps that are maintained by the long- and short-range portions of the software are not shared because substantial localization errors can accumulate during any long traverse. ROAMAN is not guaranteed to generate an optimal shortest path, but does maintain the safety of the rover.

This program was written by Terrance Huntsberger and Hrand Aghazarian of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

Software Would Largely Automate Design of Kalman Filter

Embedded Navigation Filter Automatic Designer (ENFAD) is a computer program being developed to automate the most difficult tasks in designing embedded software to implement a Kalman filter in a navigation system. The most difficult tasks are selection of error states of the filter and tuning of filter parameters, which are time-consuming trial-and-error tasks that require expertise and rarely yield optimum results. An optimum selection of error states and filter parameters depends on navigation-sensor and vehicle characteristics, and on filter processing time. ENFAD would include a simulation module that would incorporate all possible error states with respect to a given set of vehicle and sensor characteristics. The first of two iterative optimization loops would vary the selection of error states until the best filter performance was achieved in Monte Carlo simulations. For a fixed selection of error states, the second loop would vary the filter parameter values until an optimal performance value was obtained. Design constraints would be satisfied in the optimization loops. Users would supply vehicle and sensor test data that would be used to refine digital models in ENFAD. Filter processing time and filter accuracy would be computed by ENFAD.

This program was written by Jason C. H. Chuang of Marshall Space Flight Center and William J. Negast, formerly of Gray Research, Inc. Further information is contained in a TSP (see page 1). MFS-31967-1

Centralized Planning for Multiple Exploratory Robots

A computer program automatically generates plans for a group of robotic vehicles (rovers) engaged in geological exploration of a terrain. The program rapidly generates multiple command sequences that can be executed simultaneously by the rovers. Starting from a set of high-level goals, the program creates a sequence of commands for each rover while respecting hardware constraints and limitations on resources of each rover and of hardware (e.g., a radio communication terminal) shared by all the rovers. First, a separate model of each rover is loaded into a centralized planning subprogram. The centralized planning software uses the models of the rovers plus an iterative repair algorithm to resolve conflicts posed by demands for resources and by constraints associated with the all the rovers and the shared hardware. During repair, heuristics are used to make planning decisions that will result in solutions that will be better and will be found faster than would otherwise be possible. In particular, techniques from prior solutions of the multiple-traveling-salesmen problem are used as heuristics to generate plans in which the paths taken by the rovers to assigned scientific targets are shorter than they would otherwise be.

This program was written by Tara Estlin, Gregg Rabideau, Steve Chien, and Anthony Barrett of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

Electronic Router

Electronic Router (E-Router) is an application program for routing documents among the cognizant individuals in a government agency or other organization. E-Router supplants a prior