Self-Organized Navigation Control for Manned and Unmanned Vehicles in Space Colonies

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The construction and operation of space colonies will be a complex enterprise that requires a large number of devices, such as manned and unmanned vehicles and robots. A great deal of planning and scheduling is required to navigate those vehicles in an efficient manner. The coordination of the many different types of vehicles operating at a major airport illustrates some of the challenges facing the management of a space colony.

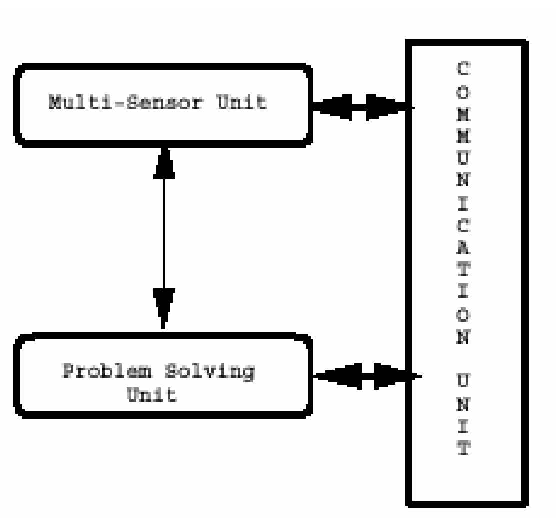
We propose to develop a self-organized control system based on the principles of coupled selection equations and behavioral force models that match the logistic needs of the colony.

At today's airports, all airplanes and ground vehicles must receive permission from the tower before they can travel to their destination. In contrast to this entirely centralized controller, self-organized planners make localized navigation decisions via communication between the network of mobile devices. Thereby, the controlling is distributed among the various units, and can be restricted within certain areas.

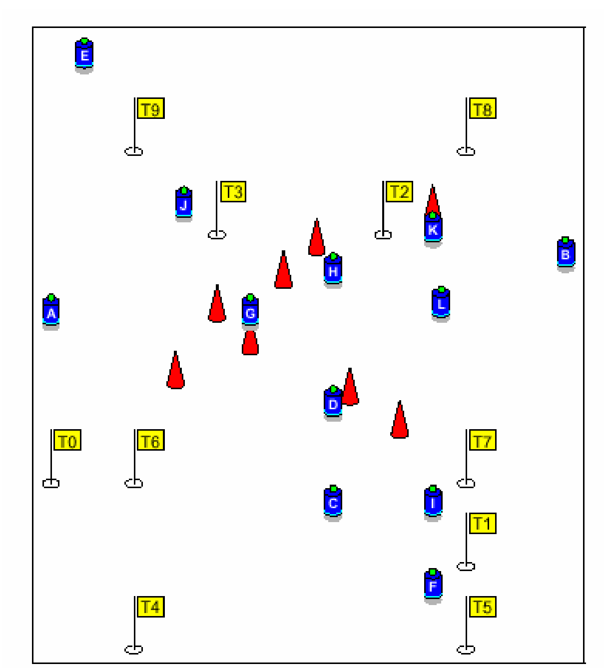
The proposed control system will include manned and unmanned vehicles, e.g robots. These vehicles can deliver fuel, construction material or other supplies. The self-organized control system will be able to handle both manned and unmanned vehicles to optimize resources. The entire systems will include a multitude of unmanned vehicle, or robots. However, the system can also assign space ships and shuttles to landing docks based on the availability of supporting devices and supplies at those locations.

Our dynamical systems approach of planning and scheduling addresses two important aspects in particular:

1. Redundancy: In hostile environments, like space stations and colonies on distant planets, system failures and the loss of particular devices can affect the entire mission. In case of the break down of one device, other available units should fill in, or some device should change their previous assignment to fill the gap.
2. Modular Components: The use of smaller, more versatile units has the advantage of easy replacement and transportability to the space station. In recent years promising concepts of versatile robots, such as cellular robots, have been developed. These units can form teams in order to perform tasks such as moving large pieces of material, or hold them in place for assembly.



The three components of a robotic unit.



Example of a typical situation. Twelve robots (depicted as cylinders) need to be assigned to ten locations (flags). The cones represent obstacles in the scene.