

Physical Co-operation Between Mobile Manipulator Systems

Aim:

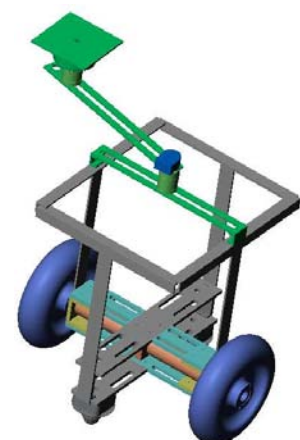
Develop a framework for integrated design, simulation and refinement of a composite system of multiple semi-autonomous mobile manipulator modules for co-operative material handling tasks.

Applications:

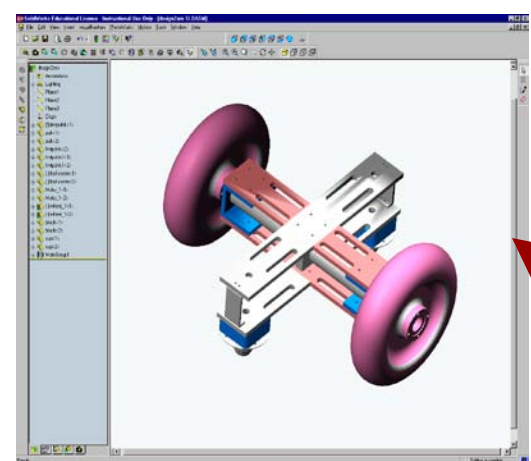
- Co-operative material handling
- Eliminate need for building GIANT monolithic robots

Each Individual Module

- Differentially driven wheeled mobile base
- Articulated arms mounted on top



Module

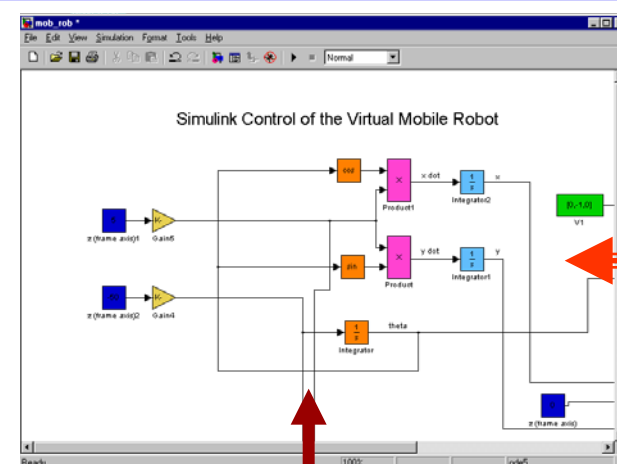


Parametric Solid Modeling (Solid Works)

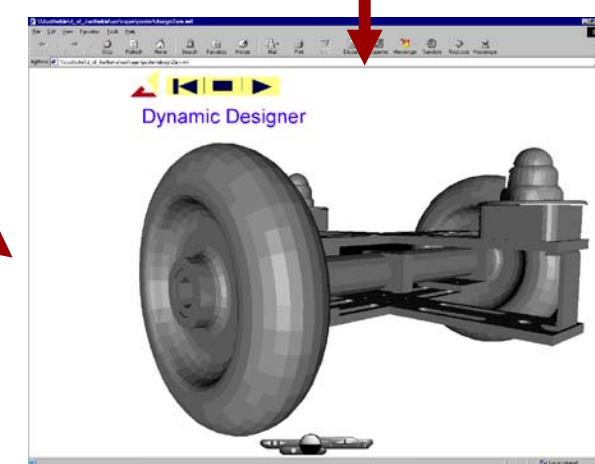
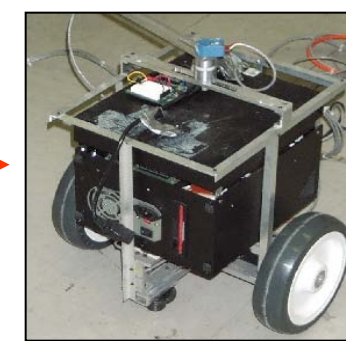
Bi-directional Data exchange

Integrated Hardware-in-the-loop Design, Simulation and Testing Framework

System Kinematics & Dynamics (Matlab/Simulink)



Mobile Robot



Visualization Interface (VRMLBrowser)

User Input

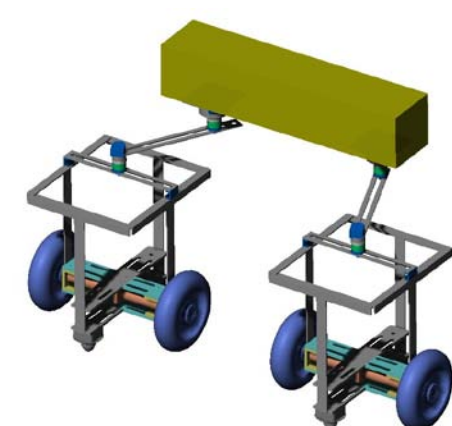
Virtual World

Real World

Cooperative Framework

- Autonomous individual modules
- Flexible and scalable
- Remotely Controlled

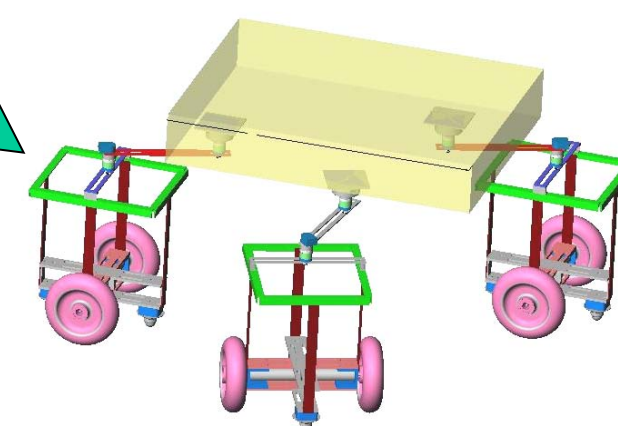
Team



Two

or

Three



Research Issues

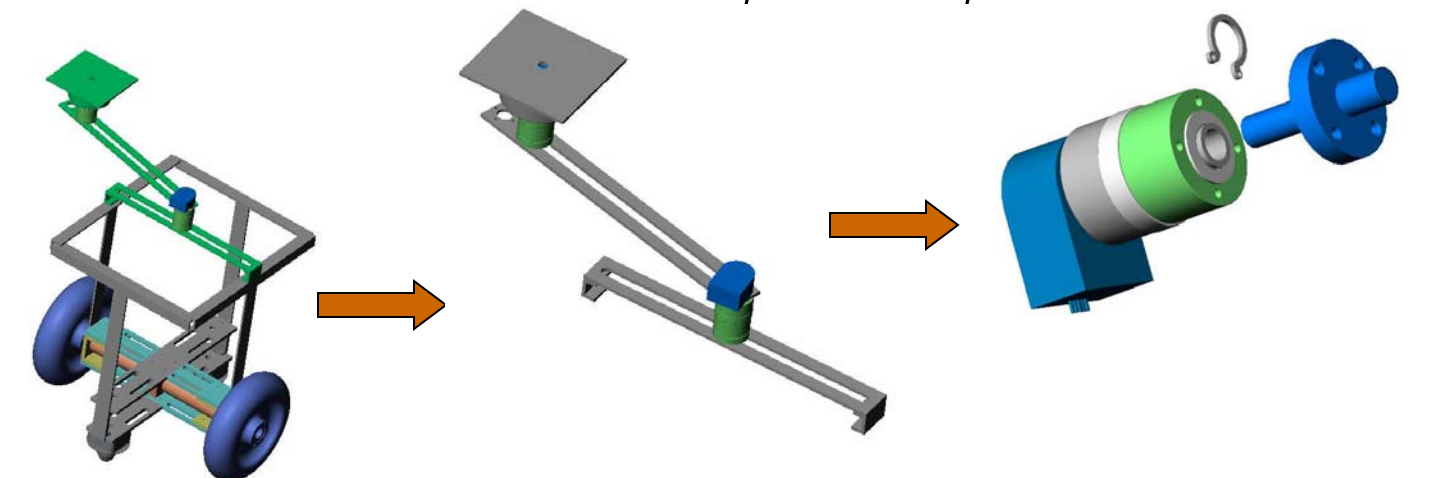
- Modular design of system – ability to add and remove modules based on the task

Research Issues (cont'd)

- Task Performance Metrics – System mobility/manipulation used for quantification of abstract concepts such as co-operation.

System Mobility/Manipulability depends upon:

- Selection of the link lengths
- Selection of the initial configuration
- Relative motions of the mobile bases
- Selection of individual module parameters– type and number of articulations/Joints, wheels, etc.



- Optimization of individual modules and system parameters for enhanced system mobility

$$f(\chi) = \frac{\sigma_{\max} - 1}{\sigma_{\min}} \quad \chi = [L_1, L_2, L_3, L_4, \phi_1, \phi_2, \phi_3, \phi_4, \gamma, x, y, \delta]^T$$

$$\text{Min}_{\chi} f(\chi)$$

s.t.

$$\begin{bmatrix} L_1 \cos \phi_1 + L_2 \cos \phi_{12} + L_3 \cos \phi_{123} - x \\ L_1 \sin \phi_1 + L_2 \sin \phi_{12} + L_3 \sin \phi_{123} - y \\ \phi_1 + \phi_2 + \phi_3 + \phi_4 - \delta \end{bmatrix} = 0$$

- Hardware-in-the-loop testing framework

