

Telerobotic Rovers for Extraterrestrial Construction

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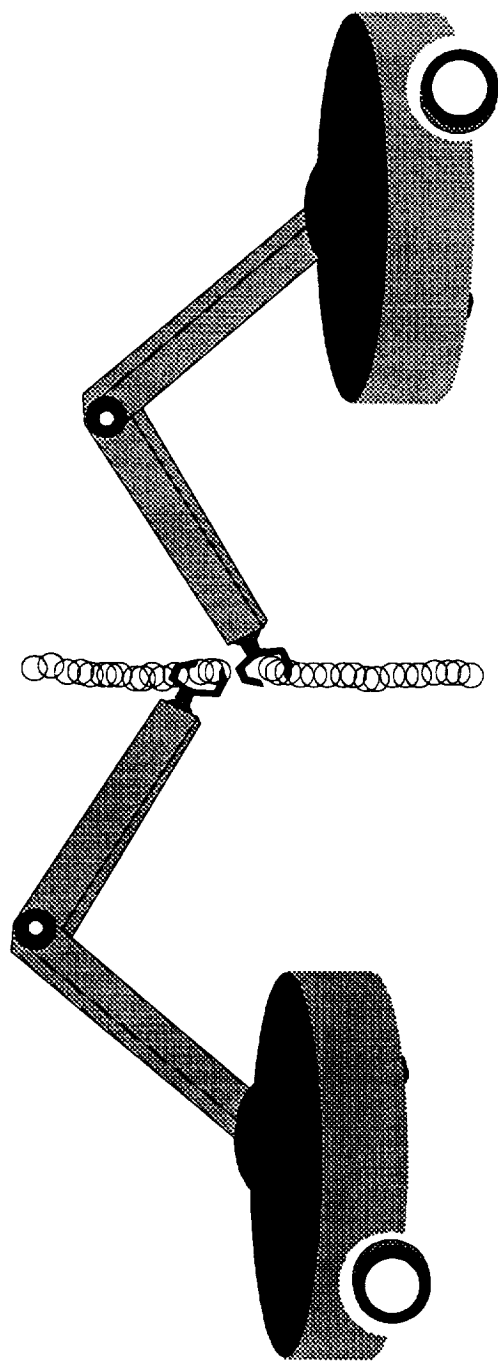
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p. 20



Objectives

- Design Small Modular Robots
- Test Robotic Cooperation and Tele-operation
- Develop Modular Control Software
- Develop Inter-module Communication Network
- Develop High Accuracy Positioning System
- Explore Distributed Algorithms for Coordination

Fundamental Concepts

Modularity implies that "robots" are temporary aggregates of independent systems

Coordination is required between these independent systems

More information passes between closely coupled modules (inside a "robot") than between robots

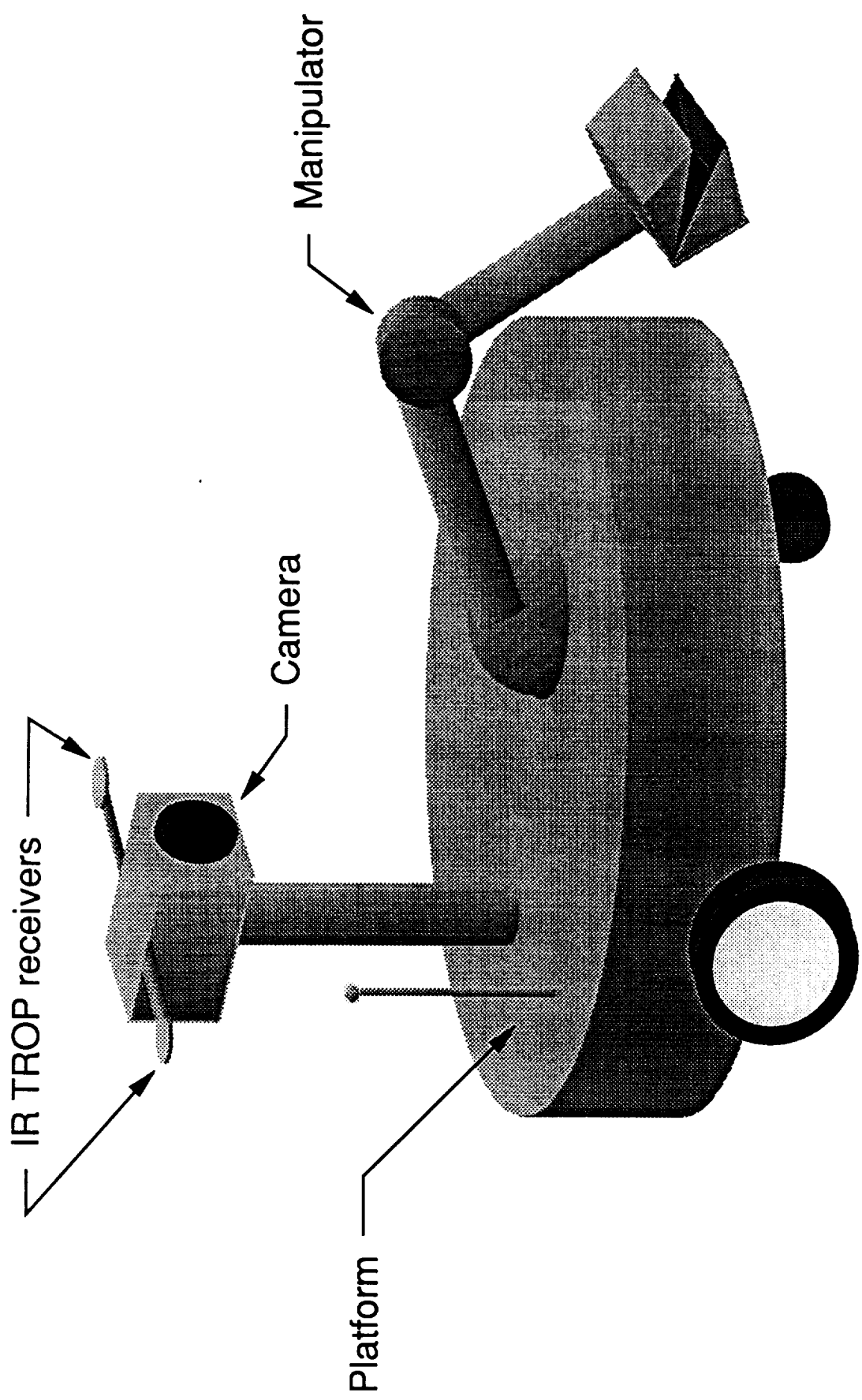
Goal is "plug and play" modularity

Advantages of Modularity

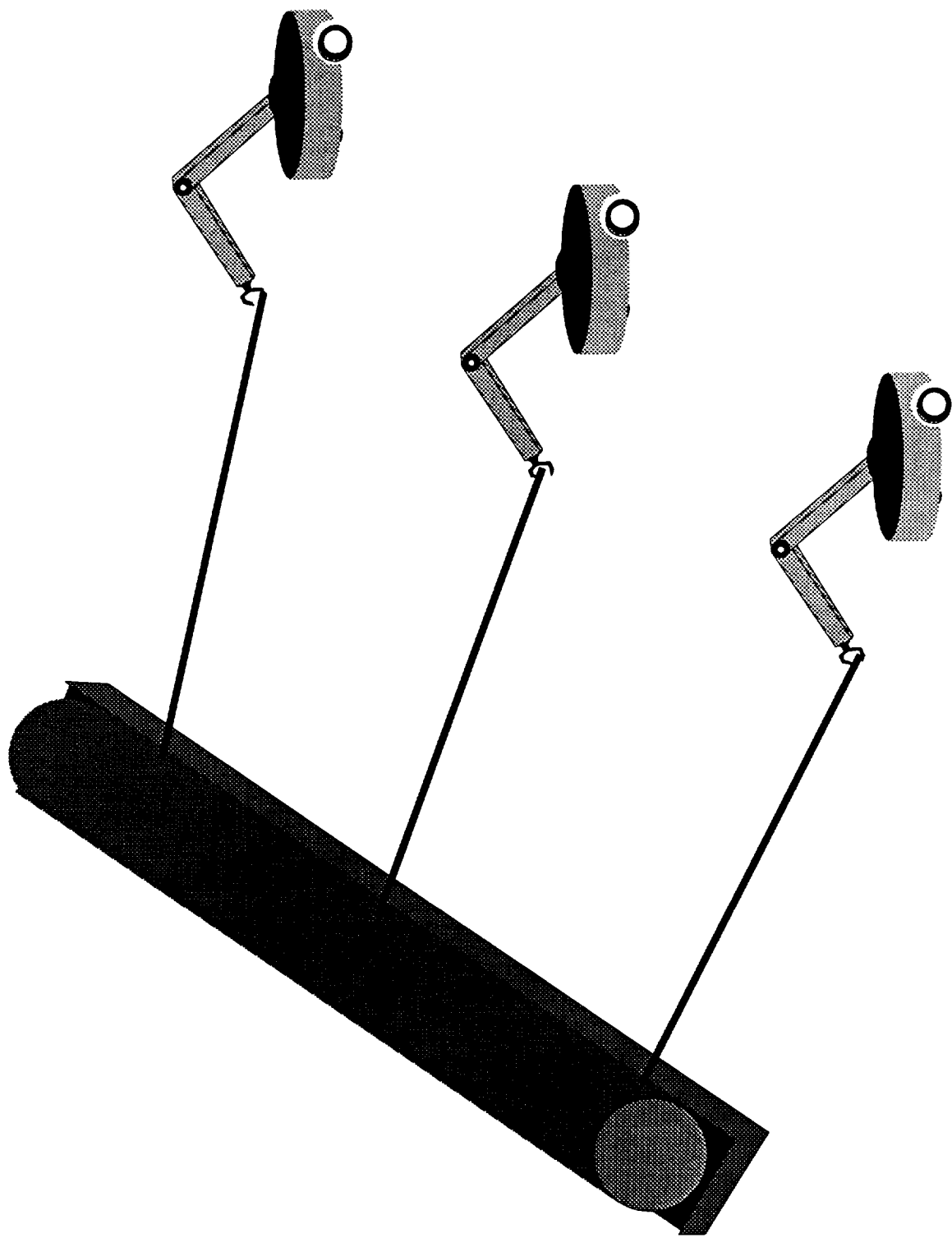
Small, multi-purpose devices are easier to transport, maintain, and configure.

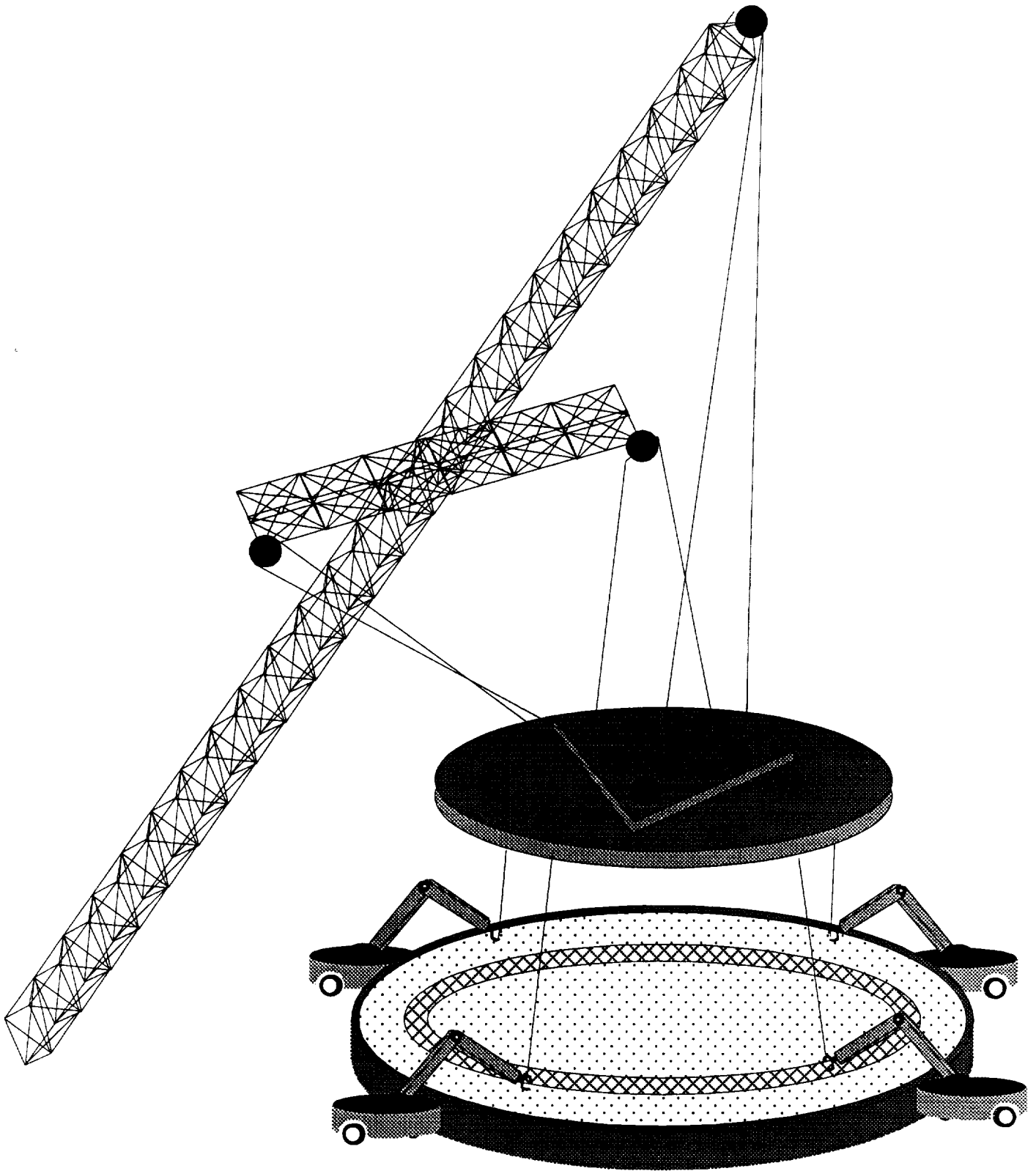
No large single-point failure mechanisms as with special purpose systems.

Individual systems are less complex; each can be dedicated to a separate sub-task.



Modular Robot





Robot Design

Three (nearly) identical robots under construction:

- 80 lb payload
- Attachment point for manipulator
- Battery powered
- Speed 1 ft/s
- Card cage for electronics

Motor Control System

- DC motors driven by HP motor control chip
- Control chip programmed by 8088-based microcomputer
- System being tuned to match motor characteristics
- Capable of path following
- Processor knows possible performance envelope

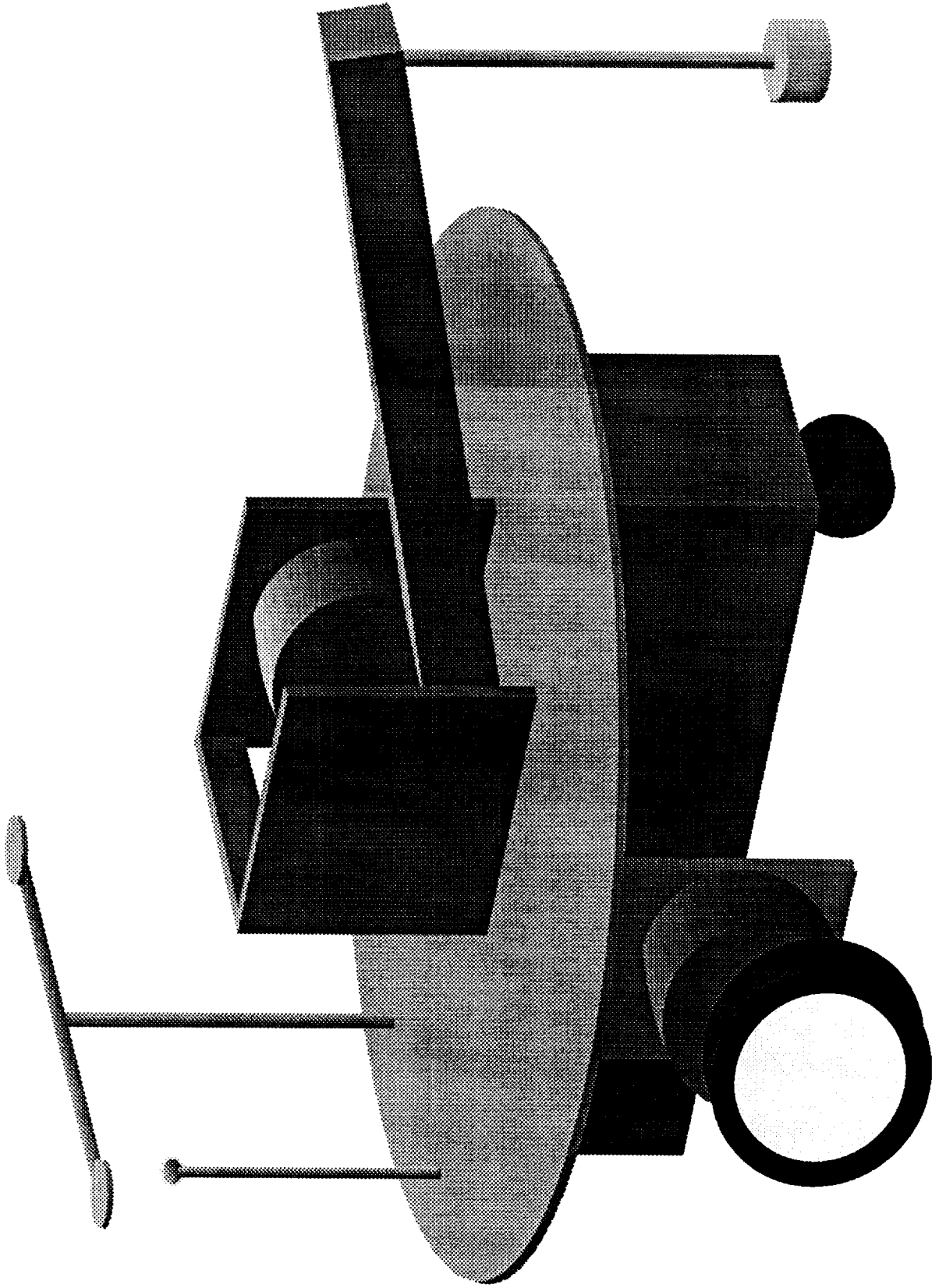
Simple Manipulator

First manipulator designed to test coordinated movement of robot

One degree of freedom

Simple to build, shares most components with rover base

More complex units under consideration



4 Degree of Freedom Manipulator

New design utilizing ball joint

Plug and play replacement for simple
manipulator

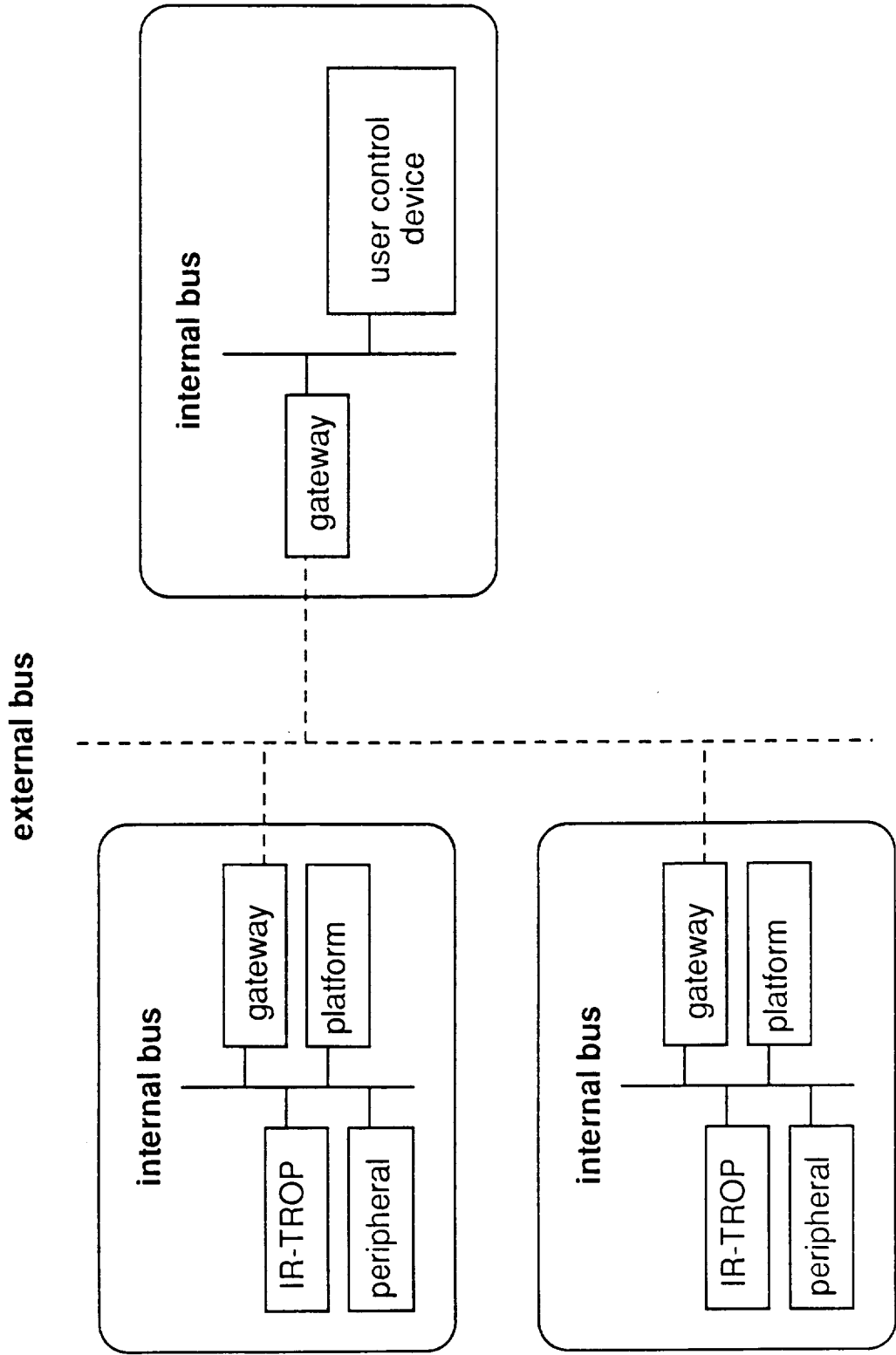
Kinematics and control theory under
investigation

Inter-Module Communication

We are designing a hierarchical communication system for the test-bed:

- Physically connected units communicate over a twisted pair ethernet
- Separated units communicate over radio frequency local area network (RF LAN)
- Bus managers act as gateways between systems
- Operators communicate with rovers over RF LAN

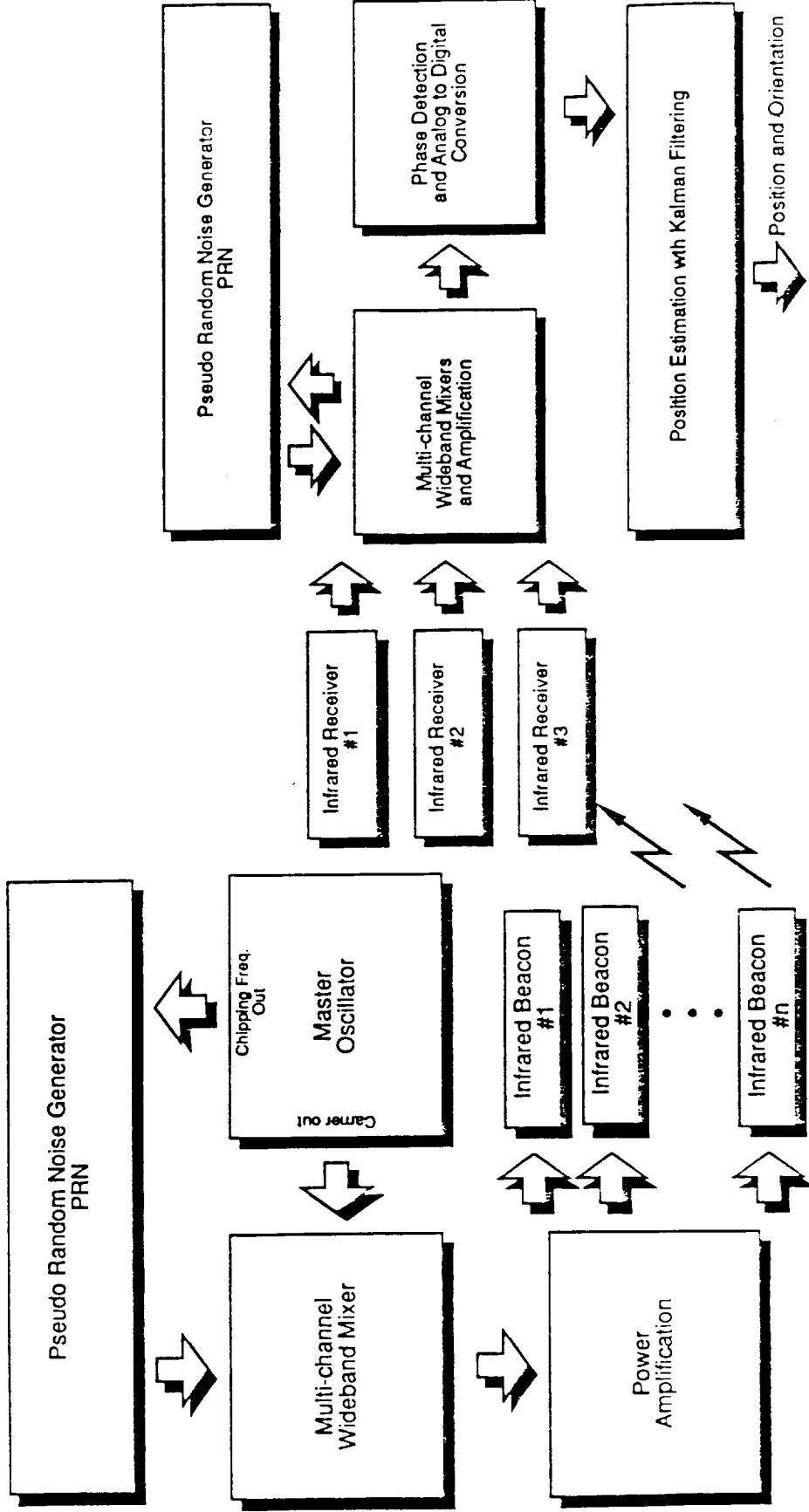
Network Layout



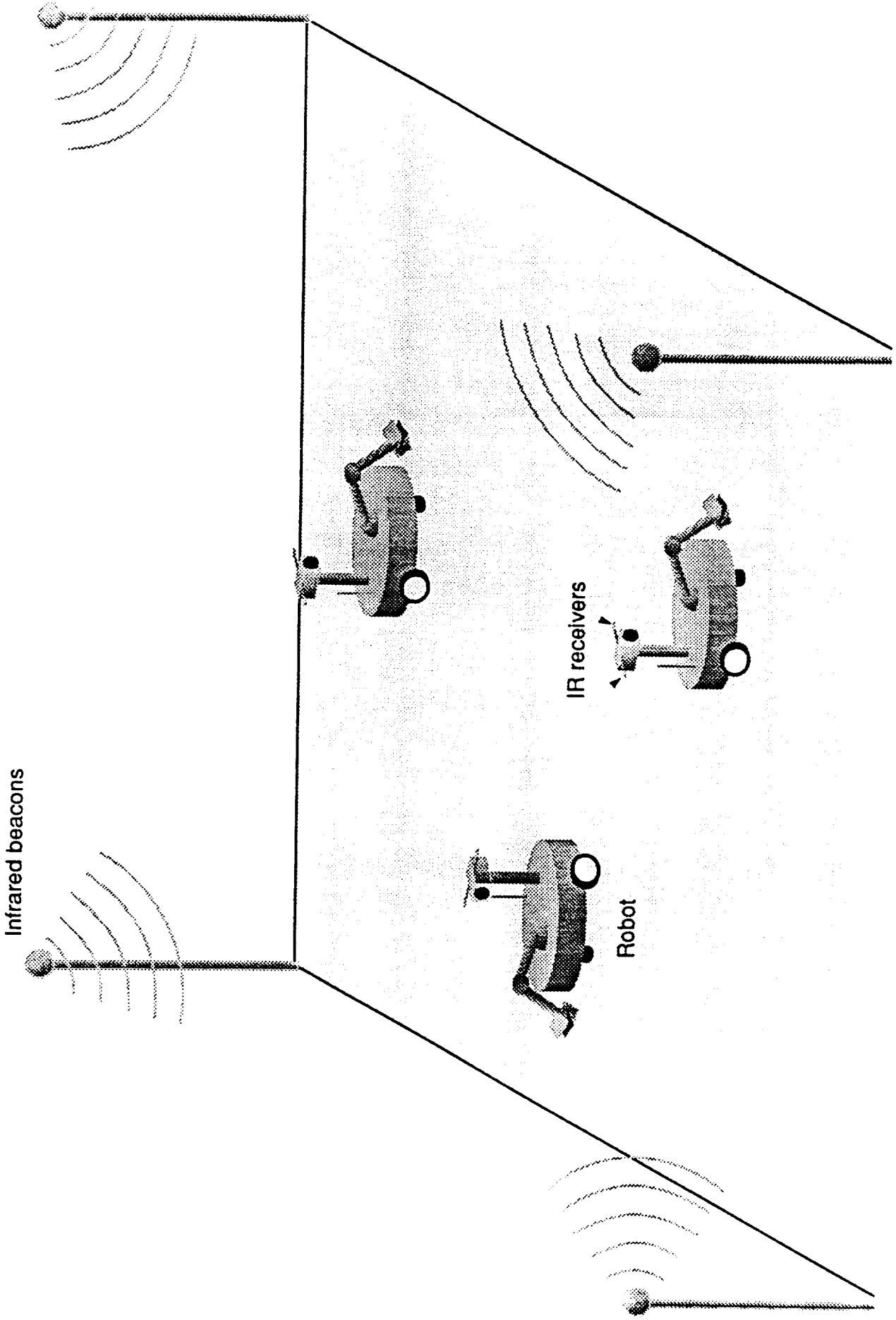
Positioning System: IR-TROP

- Goal to provide position sensing to ± 2 cm in two dimensions
- Derived from GPS technology
- Currently only ± 5 cm available

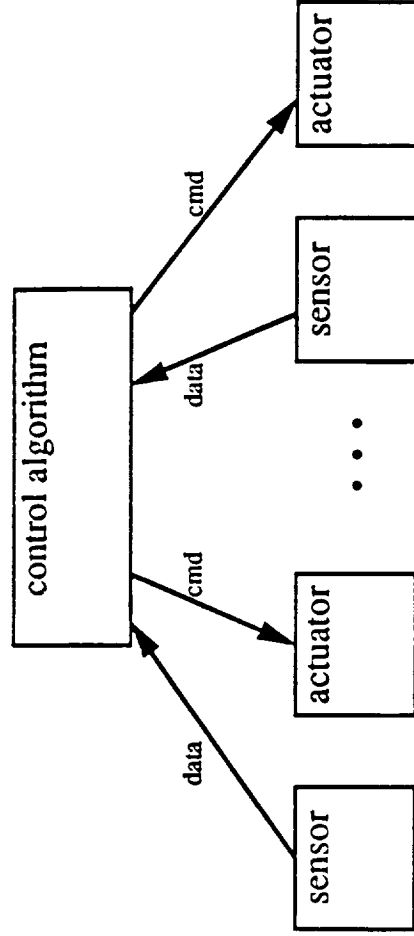
IR TROP System Design



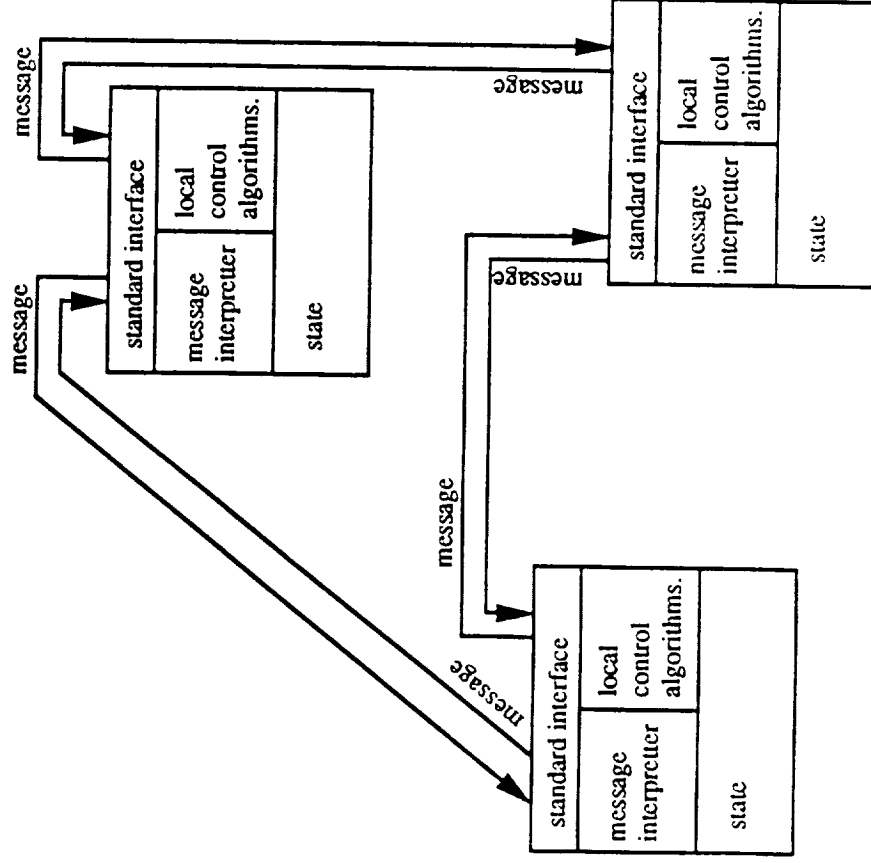
Testbed Layout



Centralized Control



Modularized Control



Messages contain requests and information

Messages passed between arbitrary number of objects

Control algorithms distributed