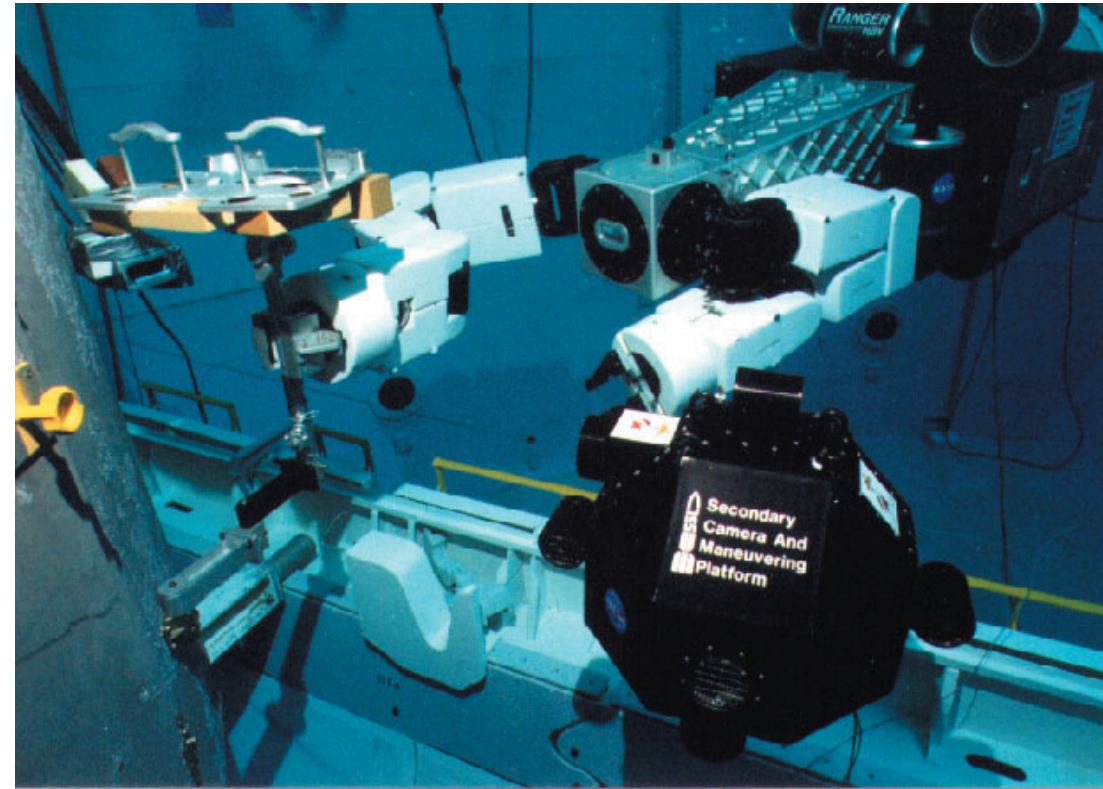
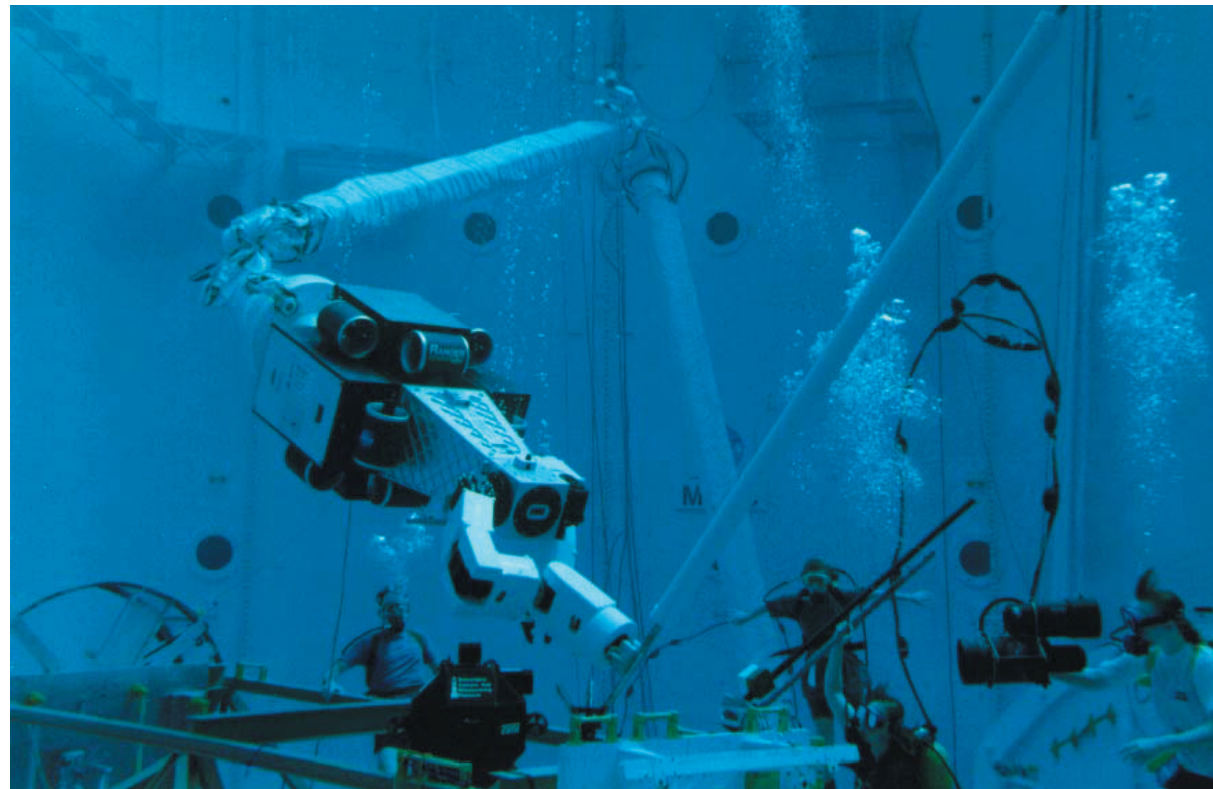
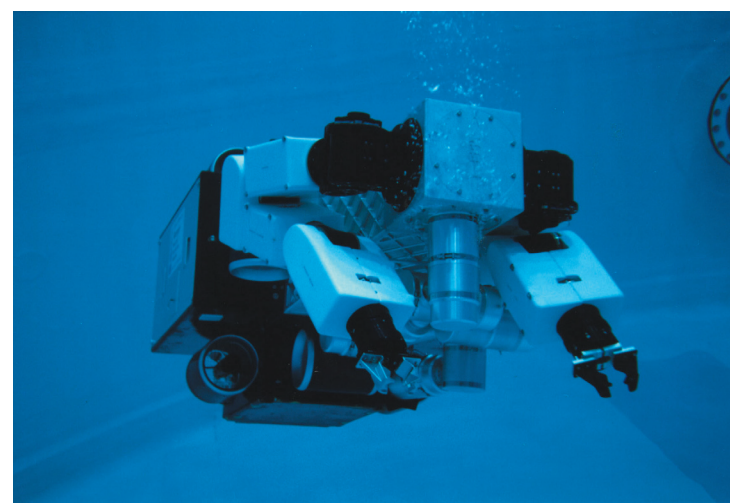
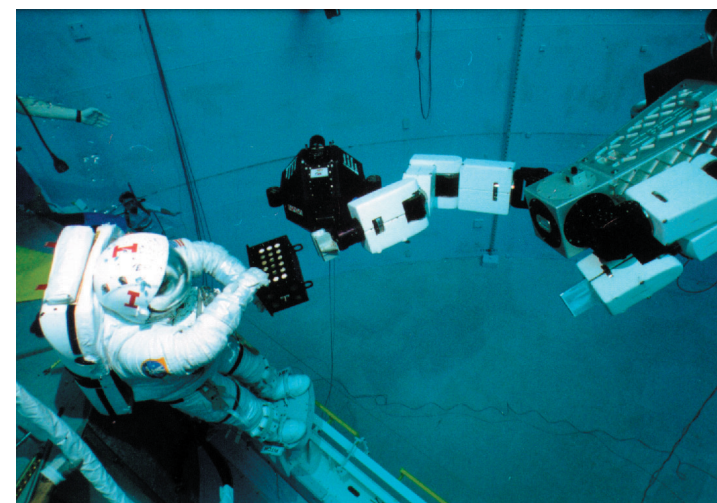
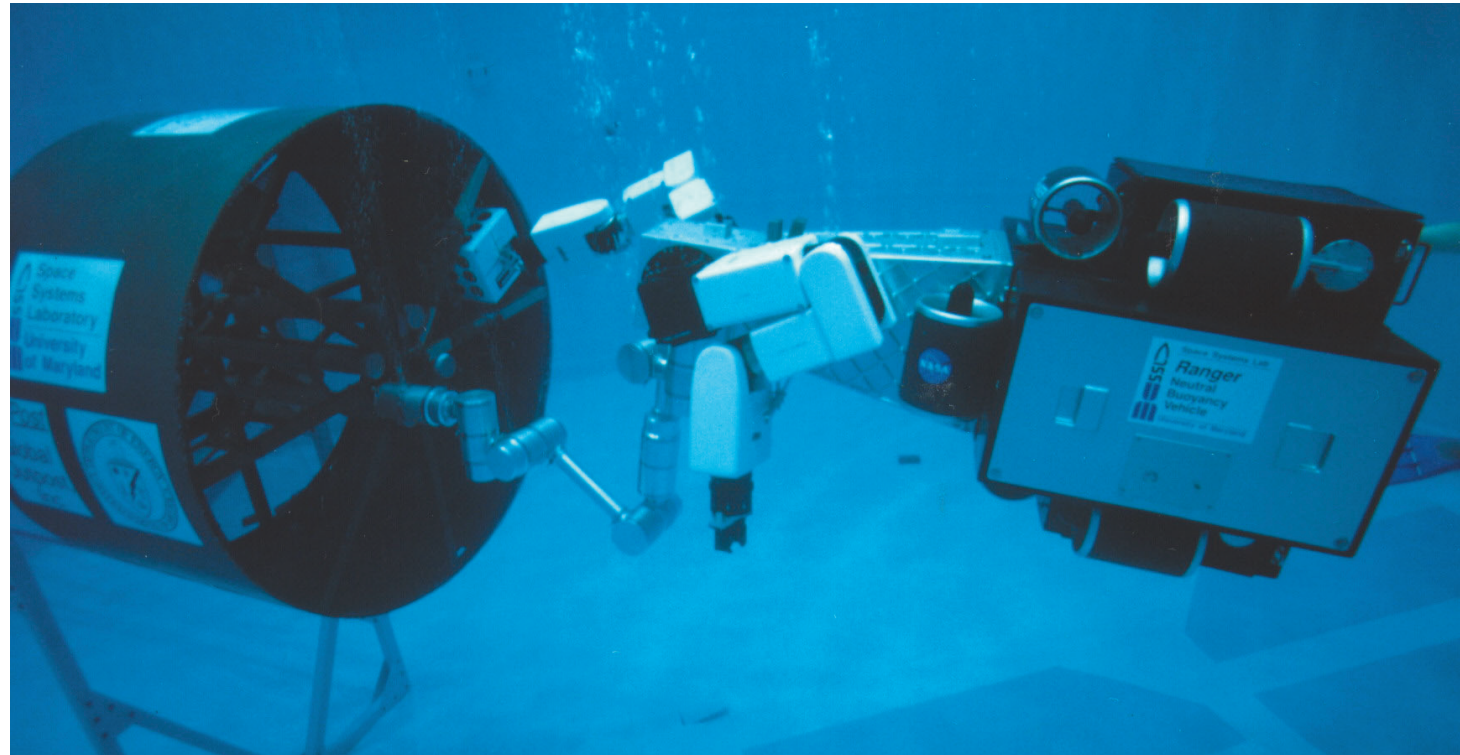
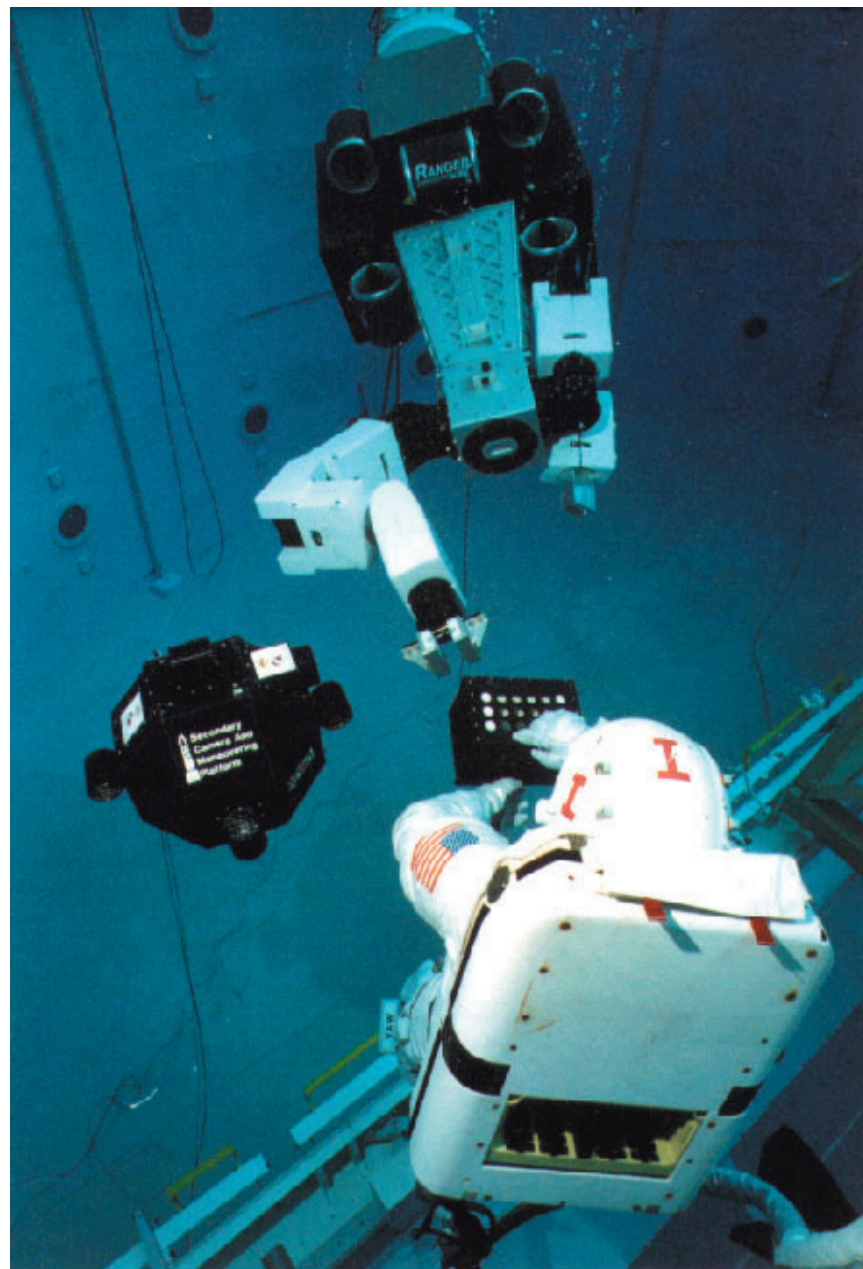


Ranger Neutral Buoyancy Vehicle I



The first Ranger neutral buoyancy vehicle (NBV I) was developed as the prototype and ground data collection vehicle for the Ranger Telerobotic Flight Experiment. As a high-fidelity analogue of the flight vehicle, NBV I was designed with a full 6 degree-of-freedom motion base, two 7 DOF dexterous manipulators, a 7 DOF grappling arm, and a 6 DOF camera positioning manipulator. It also incorporated advances in neutral buoyancy simulation technology, such as active buoyancy compensators and automatic control of the center of gravity for fine rotational buoyancy adjustment.



Since its rollout in 1994, Ranger NBV I has been extensively used for neutral buoyancy simulations of dexterous telerobotic operations. This has included direct telerobotic servicing of a high fidelity Hubble Space Telescope mockup, as well as cooperative EVA/robotic servicing operations. It has demonstrated free-flight to grapple, and hand-over-hand translation along EVA handrails at a work site. NBV I has performed structural assembly tasks, and has been operated at the end of a Remote Manipulator System simulator as a dexterous end effector system. In perhaps the most ambitious test to date, Ranger prepared a work site for EVA servicing of Hubble Space Telescope, including attaching and positioning a portable foot restraint. It then supported the EVA operations and closed out the work site.