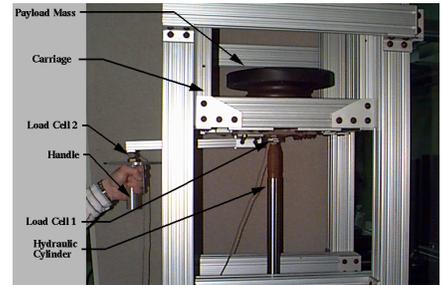




Human Strength Amplification Technology

Human-strength amplification refers to a novel methodology for human-machine synergy, in which the machine amplifies (or de-amplifies) by a selectable ratio the forces and torques applied by a human, while also providing feedback to the human of the force phenomena acting on the payload. The concept differs significantly from conventional teleoperated or telerobotic systems in the sense that the human and the machine form one integral unit, and are in constant contact with each other and with the payload, while also sensing each other's displacement, forces, and torques. This implicit sensing feedback is a critical feature of the concept and is essential for the safe and successful accomplishment of tasks in which contact takes place, such as during assembly, disassembly, insertion, or other part-mating activities. The concept can be applied in a lifting mode or in a push/pull mode (in which the human can effortlessly pull a large-payload mobile platform). It is also applicable to both amplification or de-amplification applications (e.g., for micro-assembly or surgery-assist). When applied to amplification for handling very large payloads, the approach is integrated with our unique Dexterous Manipulation of Heavy Payload (DMHP). DMHP is an integrated structure-sensing-controls design methodology, which includes some of the advanced virtual prototyping tools, and which allows systems to achieve exceptional performances in both payload capacity and precision (two requirements typically working against each other). An example is the multi-ton capacity with sub-millimeter positioning resolution achieved with some of the test beds shown in the pictures. Some of the other unique accomplishments achieved include amplification ratios of up to 500:1, multi-ton payloads, controls stability during intentional contact (e.g., for insertion or assembly) or accidental impact, and high resolution, high impact-rated force sensing and controls.



Some of the major areas of applications include:

- Materials handling
- Cargo loading, unloading, or transfer
- Assembly line operations
- Construction industries
- Field repairs
- Rescue operations (rubble removal, etc.)
- Micro-assembly and micro-manipulation
- Medical and surgical operations

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