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OPTIMIZING PERCEIVED HEAVINESS AND MOTION FOR LIFTING OBJECTS WITH A POWER ASSIST ROBOT SYSTEM CONSIDERING CHANGE IN TIME CONSTANT

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Abstract-Power assist robots are usually used for disabled and elderly people to augment their abilities and skills. This paper proposes to use these robots to handle heavy objects in industries, and thus brings a novelty in the applications of power assist robots. However, it is difficult to optimize perceived heaviness and motion either independently or simultaneously for lifting objects with power-assist. Hence, this paper investigates the techniques to optimize perceived heaviness and motion following bionic and psychophysical approaches. We developed two systems-one was used to lift objects manually, and another was a power assist system to lift objects with it. Several hypotheses and strategies related to weight perception and time constant were adopted.

Humans lifted objects manually and with power-assist independently. Analyses showed that load force rate for power-assisted lifting were lower than that for manual lifting. We hypothesized that time constant of the assist system might be responsible for this. We changed time constant and found that increase in time constant reduced perceived heaviness and load force. Then, objects were lifted with power-assist in some selected conditions pertaining to time constant. Analyses showed that perceived heaviness was related to load force rate while object motion (acceleration) was related to load force magnitude. It was then demonstrated how to independently optimize perceived heaviness and motion by optimizing load force rate and its magnitude respectively. Techniques for simultaneous optimization of motion and perceived heaviness were also presented. Finally, we proposed to use the findings to develop power assist robots for manipulating heavy objects in industries that may enhance interactions with humans in terms of maneuverability, safety etc.

Index terms- Power assist robot system, lifting objects, weight perception, psychophysics, time constant, motion, human-robot interaction, bionics/biomimetics