Cooperation and amplification of human ability using a robotic arm on a moving platform

A popular science summary of the Master Thesis [1]

Johan Furuhjelm and Oliver Larsson

December 2025

Something curious happens when a robot arm is given the ability to move around a room: Suddenly the range of the robotic system is extended to an entire warehouse, or just as far in one direction as the batteries will last. Many challenges face this kind of system: How do one make sure the robot does not hurt people, objects or itself? How do you find a simple and intuitive way of communicating what you want the robot to do? One approach for communication has been studied in our thesis, with many beneficial results.

Examples of the use of robots to amplify human ability can be found all over society: A computer can have a better memory, means of communication and can be stronger than the human operating it. Never is the connection between human and machine more prominent than during the technique we have studied, called "physical human–robot interaction". Using this approach, it is the physical force from the contact with the human that governs the robotic behavior, rather than a remote controller or some lines of code.

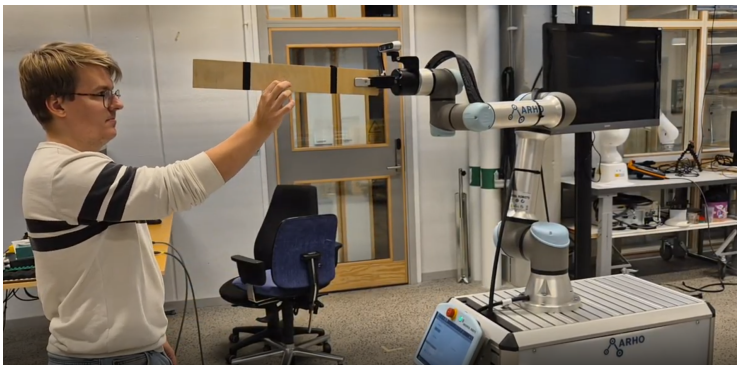

Figure 1: The robot and an operator moving a wooden board together.

We have developed a robotic system, consisting of a robot arm mounted on a

moving platform. The robot can be seen in Figure 1. The robot is programmed to behave as a spring: Touch it and it moves in your desired direction while pushing back on your hand. The human is asked to hold on to a small wooden board together with the robot, as to simulate holding a larger and heavier object. This object can then be transported across the room.

A central question of our investigation was the tradeoff between creating a stronger and more reactive robot, or a heavier and confident one. The first option requires less effort to use, but has the unfortunate consequence of a jittery and unpredictable behavior. The latter is heavier to use, but has a very predictable and smooth movement pattern. There are also multiple ways for the robot to solve the same problem: A forward motion might be accommodated by either the robot base moving forward, or by the arm extending. Many interesting questions appear when dealing with these kinds of possibilities. The robot is able to get in to a better position all by itself, while the wooden board floats still in the air. This allows the robot to at any time put itself in positions in which it is operational in any direction.

Additionally, we attempted to create a control system to avoid obstacle the robot encounters while transporting the object together with the human operator. The interesting conclusion from this experiment was that more robot autonomy is not always better. The robot could be easier to operate if the navigation was left to the operator, while the obstacle avoidance was used as a fail-safe. Avoiding obstacle is of great importance for robots like this one. The robot is very heavy, and if no protection is implemented, the robot might as well run over people, fragile wares or the very person trying to operate it.

Our thesis lays the foundation for a cooperating strategy of moving objects around a warehouse, elderly home or any situation where a human could benefit from help with transporting an object. This, while not needing to tell the robot the path or any instruction beforehand.

References

[1] Johan Furuhjelm and Oliver Larsson. “Physical Human–Robot Interaction Using a Mobile Manipulator”. MA thesis. Lund University, 2025.