MUTUALLY ASSISTIVE ROBOTICS

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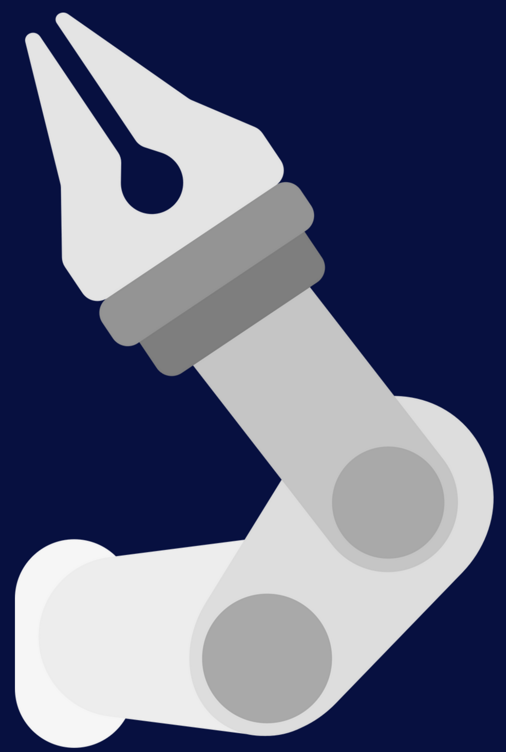

How can augmented reality (AR) facilitate better interaction between disabled users and their assistive robots?

Background

The project I worked on was Mutually Assistive Robotics, which involves using augmented reality specifically for disabled users. I did this work under Jivko Sinapov in the Multimodal Learning Interaction and Perception Lab at Tufts University. Over 25% of Americans suffer from some form of disability. Assistive robotic technologies can help improve the quality of life for disabled people by enabling them to participate more actively in work and leisure activities and to feel more independent. In this project, we used a strengths-based approach to assistive robotics, where the user and the robot assist each other. The user will be able to understand and control not just the high-level tasks, but low-level aspects of the robot's movement and behavior as well. to achieve this we used AR which uelps users understand the information robots are using to make decisions. AR can help users understand the mental models of the robot, which are used to explain the robot's behavior. Robotic arm wheelchair attachments are designed to be mounted on wheelchairs, providing enhanced reach and manipulation capabilities to wheelchair users. These arms allow their users to interact with their environment, from grabbing objects on shelves to opening doors

Existing Technology

Robotic arms can be controlled in many different ways, including manually or using artificial intelligence (AI). I focused on manual ways to control a robotic arm. Some common control systems are devices like joysticks, remote controllers, and touch-screen interfaces. A novel way to control robotic arms is Brain-Computer Interface technology which establishes a direct link between the human mind and machine movements. There are also many existing AR devices that are currently being used to control robotic arms, for example, wearable AR smart glasses or simply a a tablet or computer screen.

Robotic Arm AR Model

The robotic arm we use is a Kinova Jaco arm, which is designed to be mounted on a wheelchair. I worked on displaying important information about the state of the arm using AR. Using Unity, a game development engine, and an existing 3D model of the arm, I was able to display the joint temperatures and joint positions relative to their maximum and minimum position.Around each joint are green rings representing how far each joint can turn in either direction. I also included a pointer at each joint that indicates the joint's current orientation. The pointer travels around the ring as the joints move. The rings and pointer are used to see how much farther each joint can turn in either direction. The arm is also a heat map. Each motor's temperature can be seen by the color of each joint, which allows the user to see if part of the arm is overheating, which could cause problems.

Robotic Pouring Study

I also assisted Andre Cleaver, PhD student and research coordinator, in his robot pouring study. Pouring liquids showcases the contrast between humans and robots. Humans, with our advanced sensory perception, possess the ability to discern various properties of liquids to adjust their pouring technique accordingly. In contrast, robots, while capable of precise and consistent pouring, lack the nuanced sensory perception and adaptive learning that humans exhibit.

In this study, the robotic arm would pour from source container with a set amount of water into a target container which remained in the same location throughout the study. First, participants would look at physical and AR visuals and predict if there would be a spill. The second part was when we allowed human participants to adjust the parameters on the robotic arm to prevent a spill. The parameters included: rotation angle limit, rotational velocity, vertical position, and horizontal position. The human participants would be able to visualize the pour using AR and then would be able to use the visual feedback to adjust the arm accordingly. Before the trials, the research coordinator carefully selected 10 pouring configurations using 10 different pouring containers, including a soda can, a water bottle, and a mug. These arrangements led to either a verified spillage, meaning there is visible water reaching the surface of the table, or a successful pour, where all water is transferred from one container to the other.

The goal of this study is to determine uow much a visualization tool helps users see the changes they apply to the robot. We ask: by visualizing the results of parameter changes, such as the robot's wrist height, can humans better identify optimal parameters to minimize spills? We hypothesized that participants using AR visual feedback will be more confident in their parameter changes and result in less spills compared to a not using AR.