Accessible Robot Control in MR

Mixed Reality Project Proposal
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GROUP MEMBERS

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I. DESCRIPTION OF THE PROJECT

This project aims to help people with disability to operate the spot robot with HoloLens to help them do daily tasks easier. More specifically, we plan to design and implement a pipeline to help people with arm/hand amputation to control the robot with HoloLens by eyeball tracking technology. This way, when users want to grasp some items, the spot robot with an arm can go to the item's location and the user can use head gestures to control the robot to grasp it, which highly improves the users' living quality.

The use of mixed reality to control robots to complete tasks is a recent research direction that has emerged. Previous works [1][4][5] utilize mixed reality device to control the robotic arm. [6] applies the mixed reality to the mobile robot for path planning. However, none of these works is amputation friendly, which means hand gesture is required to control the robot. Compared to these works, [3] combines hand gestures and eye detection to select the object more precisely, [2] utilizes the head position or gesture pointing in combination with speech to control the robot arm. But none of these works is tailored for the mobile robot, and hand operation has not been completely replaced.

II. WORK PACKAGES AND TIMELINE

The work packages and timeline are described in the following table.

For the robot-related part, we plan to use ROS (Robot Operating System), and most of the code for this part will be written in C++ and Python. For the HoloLens-related part, we will mainly use C# and Unity, MRTK package is also included.

III. OUTCOMES AND DEMONSTRATION

In our plan, the expected final outcome contains mainly two stages:

1) Once the user stares at an object, the HoloLens can get the target's approximate location by eyeball tracking. Then, the HoloLens sends messages to the spot robot and drives it to go to that location automatically.
2) Allow the Hololens to detect users' head movement and view ray transition. And guide the robot's arm to reach and grasp the object based on those information.

For the above two stages, we will test them under the same physical constraints exposed on our aimed users, i.e. we will control the HoloLens only with head and eyes. The experiment will be carried out in a room where a user wearing a Hololens interacts with a Spot robot.

For the first task, we will put a cola can on the ground and let the user watch it to check whether the returned position is close to the true one. Besides, the communication between the HoloLens and the robot needs to be tested. We will send a position coordinate to the robot by HoloLens and check whether the robot can go to the right position.

For the second task, the user will use eye and head motion only to let the robot arm reach certain points. Hopefully, the robot arm can reach these targeted points smoothly. The grasping will also be tested, different items will be placed for checking whether the robot arm can grasp them successfully.

The final demo will be a recording demonstration for the full proposed pipeline. One user will complete the aforementioned two tasks by controlling Spot robot and HoloLens with only eyes and head. If it is possible, we would like to give a live demo in class.

Work Packages and Timeline			
Task	Timeline	Responsible members	Comments
Item localization (MR)	10/24-10/28	Deheng Zhang	
Robot localization (MR)	10/24-10/28	Ganlin Zhang	Achieved by tags on the floor.
Communication between HoloLens and robot (Spot Robot)	10/24-11/4	Longteng Duan, Ganlin Zhang	
HoloLens user interface (MR)	10/29-11/4	Guo Han	
Eye controlling for the mobile robot (Spot Robot)	10/29-11/4	Deheng Zhang	
Path planning (Spot Robot)	11/5-11/19	Deheng Zhang, Ganlin Zhang, Longteng Duan, Guo Han	If we can use eye detection directly to control the robot, path planning is not needed. However, if we only use eye to determine the object to be taken, the path planning from the spot robot to the item is required.
Head Motion Extraction (MR)	11/12-11/19	Longteng Duan, Guo Han	
Mapping head and eye motion to robot arm (Spot Robot)	11/20-12/2	Deheng Zhang, Ganlin Zhang, Longteng Duan, Guo Han	If this method cannot work smoothly for fetching the item, we will use YOLO as an alternative solution to find the precise location.
Framework design and testing	12/3-12/18	Ganlin Zhang, Deheng Zhang, Longteng Duan, Guo Han	Details are mentioned in Section III

REFERENCES

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