Egocentric Computer Vision based Wheelchair Robot Control

Haoxiang Li and Gang Hua

Motivated by the emerging need of improving the quality of life of elder and disabled individuals who reply on wheelchairs for mobility, and who might have limited or no hand functionality at all, we propose an egocentric computer vision based wheelchair robot control system to enhance their mobility without hand operation.

As shown in Figure 1. We build the robot system upon a typical power wheelchair. The user controls the power wheelchair with an egocentric camera (e.g., a head mounted forward looking camera). The Kinect sensor and ultrasonic sensors are installed to assist the autonomous navigation. While the robot system by itself could be an autonomous mobile robot, the egocentric camera could naturally integrate human into the control loop of robot from two aspects.

First, the egocentric camera could serve as a vision sensor. In searching for a specific target, human subjects would naturally turn their focus of attention to the expected target. This is more efficient than having a pan-tilt-zoom camera (PTZ camera) exhaustively search for the target [4]. Second, the egocentric camera provides computer vision based control without hand operations. By applying the visual tracking technology with the egocentric camera, human subjects can naturally navigate the wheelchair with head motions.

Previous wheelchair control technologies without hand operation include sip-n-puff, head-control [2], chin-control, speech control [1] and tongue-operated solution [3]. Compared with them, the egocentric computer vision based control method we proposed is superior in three ways.

First, the egocentric computer vision based control is physically more comfortable. It would not affect the user's natural breathing rhythms and neither does it prevent the users from communicating to others verbally when operating the wheelchair. Second, the proposed technology provides a proportional drive control. It could require quite a bit of practice to get use to drive the wheelchair when the control technology only supports limited moving commands (e.g., forward, backward, left and right movement). The egocentric computer vision control can perfectly mimic a proportional joystick without hand operations to provide 360 degrees of controls as well as the full range of drive speed.

Third, the proposed technology is more than a navigation control. It could be a very convenient human-robot interface. With the vision tag, we can reliably capture the 2D movement of the egocentric camera. As shown in Figure 2, we leverage the movement to control the cursor in a Graphical User Interface (GUI). In a preliminary setting, we trigger the click event by hovering the cursor on the button for 3 seconds.

In summary, we propose an egocentric computer vision based control with a wheelchair robot system. The proposed control method can serve as a more comfortable, reliable and easy to use human-robot interface to support a more natural human-robot interaction.

Authors are with Department of Computer Science, Stevens Institute of Technology, Hoboken NJ, US {hli18,ghua}@stevens.edu

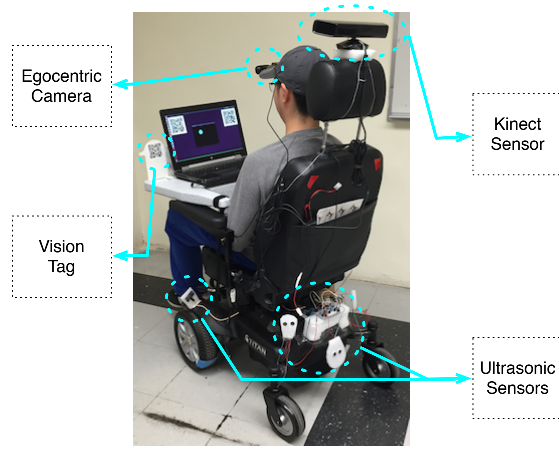

Fig. 1. Our assistive co-robot system.

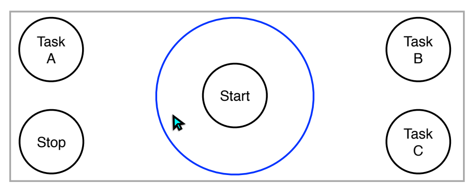

Fig. 2. The screen shot of egocentric computer vision based control system.

Acknowledgment

Research reported in this publication was supported by the National Institute Of Nursing Research of the National Institutes of Health under Award Number R01NR015371. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

[1] K. Arshak, D. Buckley, and K. Kaneswaran. Review of assistive devices for electric powered wheelchairs navigation. *ITB Journal*, 13:13–23, 2006.

[2] S.-H. Chen, Y.-L. Chen, Y.-H. Chiou, J.-C. Tsai, and T.-S. Kuo. Head-controlled device with m3s-based for people with disabilities. In *Engineering in Medicine and Biology Society, 2003. Proceedings of the 25th Annual International Conference of the IEEE*, 2003.

[3] X. Huo, J. Wang, and M. Ghovanloo. Introduction and preliminary evaluation of the tongue drive system: wireless tongue-operated assistive technology for people with little or no upper-limb function. *Journal of rehabilitation research and development*, 45(6):921–930, 2007.

[4] J. Zhang, L. Zhuang, Y. Wang, Y. Zhou, Y. Meng, and G. Hua. An egocentric vision based assistive co-robot. In *Rehabilitation Robotics (ICORR), 2013 IEEE International Conference on*, 2013.