Augmented mobile telepresence with assisted control

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1 Introduction

Although the idea of a teleoperated robot for remote presence is not new [2], only recently have so called *telepresence robots* become available to the broader public [1, 3, 4]. The idea of a mobile telepresence robot stems from the inherent limitations imposed by traditional videoconferencing systems, in which interaction is restricted to the meeting room only. Such systems do not allow the user to join the - often important - informal part of meetings generally taking place in hallways and coffee corners. A teleoperated robot can provide means for a mobile teleconferencing system, allowing the user to interact more naturally in the remote office environment.

Figure 1: Interacting with MITRO.

Various authors have already investigated the use of mobile robots for telepresence. In [4] the authors compare two recently launched commercial products, Anybots' QB and VGo Communications' VGo, with respect to user experience in two scenarios: the scheduled meeting, and the informal hallway meeting. One of their findings is that adding some level of autonomy would enhance the user experience, as it would allow to focus more attention to the conversation and interaction, and less to driving. One possible solution, assisted navigation, is investigated in [3]; the authors conclude that assisted navigation decreases the number of collisions with the environment.

To provide assisted control the robot has to be outfitted with a range of sensors that allow to observe the surroundings and steer clear of obstacles. Of course these sensors can also be used to provide additional information to the remote user or allow for additional functionality. *Augmented telepresence with assisted control* goes beyond the idea of a teleoperated robot simply equipped with a screen and camera. Mapping and localization functionality are used to provide the remote user with a floor map indicating the current location; the map can be annotated (e.g. room numbers) and information overlaid on the live video feed. Furthermore, the system can autonomously drive back to its charging location after a meeting or wait ready-to-use at a preset location before the meeting commences. People detection and tracking can be used to automatically follow a person to her office; while face tracking allows to follow a conversation without constant steering corrections to keep the conversational partner centered on the screen.

Impact: Telepresence robots can be deployed in a wide range of application domains, e.g. in workplaces, the public sector or for home use. We already touched upon the workplace informal meeting scenario and outlined the benefits of assisted control. Telepresence robots are already being used in hospitals to allow doctors and specialists to give consultations from afar. Assisted living facilities outfitted with telepresence systems can provide 24/7 supervision and assistance through remote caregivers. Family members or friends can use the system to pay a virtual visit when time does not allow to be present in person. Telepresence robots can also be used to give people with restricted mobility a new way to outreach and interact beyond their usual living quarters. In all these domains, augmented presence with assisted control can greatly improve the experience for the user.

2 MITRO - Maastricht Intelligent Telepresence RObot

We present a custom-built robot system (see Figure 1) specifically designed for augmented telepresence with assisted control. MITRO is an ongoing research project at the *swarmlab*[1], the robotics laboratory at the Department of Knowledge Engineering (DKE), Maastricht University. The swarmlab is embedded within the Robots, Agents and Interactions (RAI) group.

System specifications: The MITRO platform is based on the Parallax Mobile Robot Base kit[2], which includes the base plate (⌀ 46 cm), powerful motors and 6 inch wheels with pneumatic tires, as well as 10 ultrasonic sensors providing an easy and low-cost method for distance measurements. Additionally, a Hokuyo URG-04LX-UG01 laser range finder[3] is mounted at the front of the base to provide a more detailed representation of the environment (240° range; 0.36° resolution; 10 Hz rate, 4000 mm range). A pole is fitted on the base plate and serves as the elevated attachment point for the 14" LCD screen, speakers, two cameras (one pointing forward for conversations, one fish-eye camera pointing downwards for driving), and a Microsoft Kinect sensor[4] (for people tracking and extracting features from the environment). This gives the robot an overall height of 160 cm, the size of a small person, allowing for natural conversation while standing or seated. The system is powered by an Intel 1.8GHz Dual-Core Atom D525 processor; motor speed control and low-level sensor interfacing is handled by an Atmel microprocessor.

Software: The MITRO project makes use of and contributes to ROS[5], the open source robot operating system . In order to provide assisted control and augmented telepresence, the robot is able to perform SLAM (simultaneous localization and mapping), obstacle avoidance using a range of sensors, people and face tracking. Users can take control of the robot and engage all additional features using a web-based interface. Video and audio streaming is handled using the cross-platform video conferencing software application Skype[6].

3 Demonstration

We invite people to engage in a hands-on experience of our MITRO telepresence system. A laptop computer running the web-based control interface and the video-conferencing application allows the user to steer the robot around, take part in conversations and test the assisted control. Additional information (such as an annotated map) is overlaid on the video-stream if desired. Furthermore, we will demonstrate autonomous drive to a chosen location (e.g. charging station) and people tracking.

System requirements: A reliable wireless network connection for both the robot and a laptop computer is required. The network should allow internet access and communication over non-default ports, e.g., port 9090. Alternatively, a stand-alone access point can be used. The demo can be run continuously without any strict time requirement, though we advice to plan for 5-10 minutes for a hands-on experience per participant.

References

[1] Daniel A. Lazewatsky and William D. Smart. An inexpensive robot platform for teleoperation and experimentation. In *Proceedings of the 2011 IEEE International Conference on Robotics and Automation (ICRA 2011)*, 2011.

[2] T.B. Sheridan. Telerobotics. *Automatica*, 25(4):487 – 507, 1989.

[3] Leila Takayama, Eitan Marder-Eppstein, Helen Harris, and Jenay M. Beer. Assisted driving of a mobile remote presence system: System design and controlled user evaluation. In *Proceedings of the 2011 IEEE International Conference on Robotics and Automation (ICRA 2011)*, 2011.

[4] Katherine M. Tsui, Munjal Desai, Holly A. Yanco, and Chris Uhlik. Exploring use cases for telepresence robots. In *Proceedings of the 6th ACM/IEEE International Conference on Human-Robot Interaction*, 2011.

[1] For more information visit: http://maastrichtuniversity.nl/swarmlab
[2] The base kit is available at: http://www.parallax.com
[3] For more information about the laser visit: http://www.hokuyo-aut.jp
[4] For more information about the Kinect visit: http://www.xbox.com/kinect
[5] For more information on ROS visit: http://www.ros.org
[6] Skype is available at: http://www.skype.com