# Toward Common Metrics for Humanoid Robot Telexistence Evaluation

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***Abstract*— This essay drafts methodologies for assessment of telexistence experiences with the humanoid robots.**

## I. INTRODUCTION

Telexistence technologies allow humans to sense that they exist in distant regardless of time or space constraints; they make the human ubiquitous with interaction capability with the remote environment [1]. Immersive real-time sensation with a humanoid robot telexistence system considers different technologies for perceiving the whole-body human motion or commands as well as providing feedback to the human from the robot. A fundamental element for such sensation leverages the intuitive and natural design of telexistence interfaces. Such a design allows higher user engagement, situation awareness, and lower user training, workload, and stress level; therefore enhancing the user experience [2], [3]. Common technologies that provide information regarding the user are motion capture systems, wearable sensors, RGB-D data, optical tracking systems, microphones, treadmill, and joypads [4]. Concerning bilateral telexistence systems, intuitive interfaces such as various haptic devices, Virtual Reality (VR) headset, and speaker have been developed to provide force or tactile feedback, vision, and sound feedback to the human [4].

In this manuscript, we aim at providing a brief overview of common methods to evaluate the telexistence systems and interfaces incorporated with humanoid robots. These methods will be used for evaluation of the humanoid robot, iCub, telexistence scenarios [4].

## II. TELEXISTENCE EVALUATION METRICS

The telexistence system is evaluated with the system and human user perspectives, in which system evaluation provides the objective measures whereas the human (user) viewpoint establishes subjective measures. These measures are applied for different scenarios, including locomotion, manipulation, mixed locomotion and manipulation, and finally social interaction scenarios. The system viewpoint defines how well the human and robot perform as a team and assesses the quality of the interaction effort. Team performance analyses the effectiveness and efficiency of the task execution quantitatively. Yet, the measurement metrics need to be identified for various scenarios. The user perspective analysis is conducted through several human factors metrics.

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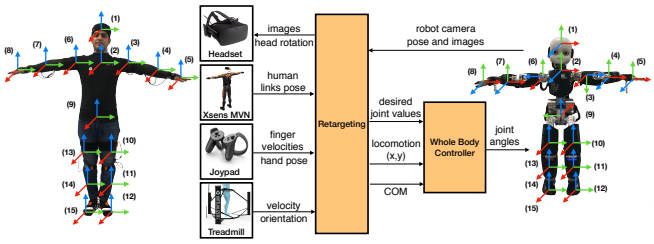


Fig. 1. The architecture of the whole-body teleoperation [4].

To assess the human successful decision-making, we evaluate the situation awareness level of the operator using assessment techniques such as Situation Awareness Global Assessment Technique as well as the team mental model of inexpert operators during avatar teleoperation. Moreover, the operator workload is estimated through the NASA-Task Load Index. Finally, the level of engagement as an index of telexistence immersion will be studied [2], [3]. Before performing the experiments, inexpert users will be trained for a limited time, and the results will be compared with the expert users.

## III. TELEXISTENCE SYSTEM ARCHITECTURE

Figure 1 shows the current architecture of the telexistence system. The user controls the robot motions via joystick, omnidirectional treadmill, and a wearable motion capture system (sensorized suit), giving the user locomotion and manipulation capabilities in remote location thorough the avatar. The user receives visual feedback from the robot through a VR headset [4]. However, the teleoperated robot owns some degree of autonomy; indeed the desired task or configuration space values are sent to a whole body controller that guarantees the feasibility of the motion [4].

## IV. CONCLUSION

This manuscript briefly proposes metrics for immersive telexistence experience with the humanoid robots.

## REFERENCES

[1] S. Tachi, *Telexistence*, 2nd ed. Danvers, MA, USA: World Scientific, 2015.

[2] A. Steinfeld, T. Fong, D. Kaber, M. Lewis, J. Scholtz, A. Schultz, and M. Goodrich, "Common metrics for human-robot interaction," in *Proceedings of the 2006 ACM SIGCHI/SIGART Conference on Human-robot Interaction (HRI)*, Salt Lake City, Utah, USA, March 2006.

[3] M. A. Goodrich and A. C. Schultz, "Human-robot interaction: a survey," *Foundations and Trends® in Human–Computer Interaction*, vol. 1, no. 3, pp. 203–275, 2007.

[4] K. Darvish, Y. Tirupachuri, G. Romualdi, L. Rapetti, D. Ferigo, F. J. A. Chavez, and D. Pucci, "Whole-body geometric retargeting for humanoid robots," in *Proceedings of the 2019 IEEE-RAS International Conference on Humanoid Robots (Humanoids)*, Toronto, Canada, October 2019.