Human-Robot Communication with VR/AR Technology
Michael Chung, Computer Science and Data Science
Mentor: Dr. Zhang, Assistant Professor
Arizona State University

Introduction
The current issue of the communication between humans and robots is how words are grounded, or derive their meanings from a robot’s perspective. Grounding frameworks are heavily dependent in the environment a robot is in, and as a result, the natural language process must take in multiple contextual definition for words in order to have effective communication. This project aims to create an environment where it takes in both technical and temporal aspects of the robot interactions.

Technical Approach
1. Mapping natural language phrases and the groundings in the environment
2. Transitioning inverse semantics framework into temporal spatial inverse semantics
3. Training and testing temporal spatial inverse semantic framework on the experiment domain

Results
• Setting up TeSIS (temporal spatial inverse semantics) code.
  Replicated environment to run simulation on local machine. TeSIS code used a spatial language understanding (SLU) framework that required various packages including the SLU Core and Corpora.
• Debugging Unity Engine
  Constructed an environment on Unity in order to simulate the goals of multi-modal communication.
  The limitations and boundaries of the Unity framework in regards to shadows turned out to be a product of the limitations of version 2018.4.17f1. In this version, the Unity engine does not allow for casting real-time shadows when you turn the object’s shadow off, even when there is an object in front of it. This is due to how Unity treats an object with shadow casting off as a transparent object where light can pass through it.

Anticipated Outcomes and Impact
Following the completion of this project, we expect to find new methods for human-robot communication, create an integrated platform for testing, and develop additional research papers and results. The impact of this project is that it will increase the adaptability of a robot in its environment and have improved communication in a human-robot workspace using VR/AR technology. Additionally, this code and dataset will be available on Github so that other researchers and developers may apply this study to their own.

Future Research and Work
Because mixed-reality technologies show promise for more effective ways of providing information to a human and predicting what the robot must do to execute its planning, the need for research in applying such mixed technologies to human-robot workspaces is a must. Thus, future research and work is needed to incorporate the theoretical simulations of the temporal spatial inverse semantic framework into hardware machines such as virtual and augmented reality devices. Utilizing VR/AR technology will allow us to address more complex interactions and to visualize a virtual agent’s internal decision-making processes.

References

Acknowledgments
Thank you to Yu Zhang, Zhe Gong, and Andrew Boateng for extensively helping me throughout this project.

Images and diagrams related to the project's technical approach and results.