Thesis Project Portfolio

Leveraging User Preferences for Adaptive Decision-Making in Human-Agent Interaction

(Technical Report)

An Actor-Network Theory Examination of Pepper's Healthcare Integration

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Jinhong Zhao

Spring, 2025

Department of Electrical & Computer Engineering

Table of Contents

Sociotechnical Synthesis

Both my technical capstone project and STS research paper share the same main objective which is to determine how robots can effectively coexist with humans in their environments. The two research projects study human-robot collaboration through separate yet connected perspectives. My team developed a robot that uses machine learning to adjust its behavior according to user preferences in the technical project. My STS research analyzed the sociotechnical misalignments responsible for the failure of SoftBank's Pepper robot when applied to healthcare settings. The Actor-Network Theory (ANT) provided the analytical framework for both research to study how human and technological components generate final results.

The technical project aims to establish a decision framework which enables robots to sense human preferences and modify their responses accordingly in real-time situations. A robot equipped with large language models (LLMs) and Markov Decision Processes (MDPs) can predict human collaborators' preferred words during joint storytelling tasks. These predictions make the robot's contributions appear more coherent and responsive. The system demonstrated its capabilities during a collaborative story creation test involving two humans and one robot that used acquired preferences to direct the narrative flow. The research aimed to enhance user satisfaction alongside narrative flow and team alignment in human-robot collaborations.

The STS research evaluates the reasons behind Pepper robot's unsuccessful deployment into healthcare environments although it was created for social interactions. Through the ANT analysis, I demonstrate that Pepper's breakdown resulted from network breakdown rather than purely technological defects. The paper demonstrates major translation process failures including interessement and enrollment, misaligned roles of human and non-human actor, inadequate network builder support from SoftBank and healthcare administrators. The analysis demonstrates

that effective robot deployment needs harmonious alignment among social structures and institutions together with technical requirements.

The combined work on these projects deepened my understanding of engineering as a sociotechnical practice. The STS research revealed that technical accuracy must be matched with user trust, emotional connection, and institutional fit. The technical project design emphasized accuracy as its main priority while keeping adaptability and mutual understanding intact. Through the technical system testing process, I gained direct experience of sociotechnical challenges. The research findings support ANT's explanation that technologies need to establish their roles within human actor networks. These projects demonstrate that effective innovation needs a complete understanding of how human and non-human actors interact to produce technological results. They taught me the breakdowns in communication or expectations can destabilize collaboration. Furthermore, I have a better understanding about the responsibility of network builders to align the interests of all actors and provide the support necessary for a stable and successful integration.