DESIGNING A CONNECT 4 ROBOT

USING ACTOR-NETWORK THEORY TO MINIMIZE RISK IN CONSUMER ROBOTICS

An Undergraduate Thesis Portfolio
Presented to the Faculty of the
School of Engineering and Applied Science
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Engineering

By

Kellan Delaney

May 9, 2022

SOCIOTECHNICAL SYNTHESIS

The consumer robotics market is growing rapidly, especially during the COVID-19 pandemic as people spend more time inside their homes and spend more money on items that make life in their homes easier. The technical project was to build a consumer robot in the form of a semi-autonomous robot that can play Connect 4 against a human player. The STS research explores the safety and security concerns associated with the advancement of consumer robotics. The STS and technical topics are tightly coupled, as they both explore different concepts surrounding the design of consumer robots. While the goal of the technical project was primarily to build a functional robot that met the requirements as defined by the technical report, the STS explored the broader reaching implications of implementing consumer robots into society.

The Connect 4 robot is an example of one of the many applications of consumer robots. It is a primarily an entertainment robot, meant to allow children to have fun playing Connect 4 when they do not have anyone else with whom to play. It also has served as a type of educational robot, demonstrating to future engineering students the interesting applications of engineering and robots in the real world. Other applications of consumer robots lie in healthcare and household care.

The design of the Connect 4 robot was split into four main subsystems. First, a mechanical gantry was designed that was responsible for physically playing the game for the robot. A custom printed circuit board was designed that powered the robot and made the necessary electrical connections. An MSP430 microcontroller was configured and programmed to control motors and interpret physical inputs. Finally, a Java program was written to make the decisions regarding what move the robot would make. The result was a very successful robot

with multiple difficulty levels, error detection, and a robust mechanical design that requires minimal human interaction for the robot to play.

The STS research paper sought to answer the question: How can engineers design consumer robotics with minimal security and privacy risks to their users? There are several risks associated with the increasing use of consumer robots in the home, which current standards and regulations to very little to combat. Actor-Network Theory (ANT), first described by Michel Callon, Bruno Latour, and John Law in the late 1980s and 1990s, is a very helpful framework which can be used to explore relationships between both humans and non-humans and to assist in exploring how engineers can fight this problem.

By using ANT, engineers can more easily identify vulnerabilities in their consumer robots which can help them protect against these vulnerabilities. One important step in doing this is identifying their consumer robot's role in its actor-network, which can be done with the help of considering what role a human actor would have in its place. Then by understanding how this human actor could influence the system or possibly be exploited by someone with malicious intent, an engineer can understand the same thing about their consumer robot. As consumer robots become more commonplace in society, it is important that engineers strive to not only achieve perfect functionality for their robots, but also ensure that their robots are providing help to consumers while not placing additional risks on them.

TABLE OF CONTENTS