Thesis Project Portfolio

Autonomous Chess Robot

(Technical Report)

A Case for the Right to Repair Movement in the United States

(STS Research Paper)

An Undergraduate Thesis

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

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

This portfolio consists of a technical capstone project, a STS (Science Technology and Society) research paper, and a prospectus for the research paper. The technical project and research paper are only tangentially connected in their subject matter. While both involve the use of embedded computing, the technical project demonstrates how it can be used beneficially to create an educational tool and the research paper describes how it can be used to negatively impact choice in consumer electronics, this connection was not intentional and is the the central focus of either document. Both projects were selected in accordance with the author's interests. The technical project for its challenge and relation to robotics, while the research paper describes a pressing social interest facing the United States today.

For the technical capstone project, my team and I developed an autonomous chess playing robot capable of playing an intelligent game against a human opponent. The robot consisted of a stepper motor driven gantry system controlled by a custom PCB (Printed Circuit Board) and embedded microcontroller directed by the Stockfish chess engine. An array of magnetic reed switches embedded in a custom chess board allows the robot to detect where is opponent has placed their pieces and autonomously respond. The robot would continue the game until checkmate, stalemate, or a player's resignation. The system was capable of handling the common chess actions like taking and moving pieces, as well as the less common actions such as queening or capturing en passant. Once a move had been detected and the player indicated they were safely out of the way, the move would be transmitted to the Stockfish engine for review. Once a response had been calculated, the embedded code calculated the sequence of motor commands to move to the piece, grab it, move it to its desired location, and place it back down

before returning to a position off the board. These commands were executed as quickly as possible, utilizing a trapezoidal motion profile to reduce the affects of acceleration while moving at a high velocity, and was accurate over 95% of the time. The complete ensemble created an excellent autonomous framework that can be applied to any pick and place task.

The STS research paper examines the Right to Repair movement in the United States; the technical and economic landscape that spawned it, how repair has evolved, the technical and legal challenges facing repair, and finally some proposed solutions to these challenges. While companies have been designing frustratingly difficult to repair products for centuries, it was not until recently that both technological developments in embedded computing and copyright law combined to make repair both a technological and legal challenge. By adding Digital Rights Management (DRM) software to common components like batteries or screens, manufacturers have been able to prevent consumers from repairing their own devices and prevent tinkerers from finding clever solutions to repair their devices. Under current US law, it is illegal to attempt to bypass this DRM software, thus creating a monopoly around a products repair. Right to repair seeks to pass legislation allowing tinkerers, consumers, and independent repair businesses to legally repair devices and to require manufacturers to provide documentation for the repair of their products.