Autonomous Checkers Robot

(Technical Paper)

Autonomous Robot Safety

(STS Paper)

A Thesis Prospectus Submitted to the

Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

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Fall, 2022

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

According to Locus Robotics, an autonomous robot is “an intelligent machine that can perform tasks and operate in an environment independently, without human control or intervention. [1]”. This idea of self-sufficiency requires the entity to be able to perceive its surroundings, make decisions based on that information and proceed to engage in a movement in accordance with that decision. The primary purpose of autonomous machines is to assist humans in completing a mundane, time-consuming, or even dangerous tasks. Having a supply of autonomous or semi-autonomous robots has been a key factor in the growing efficiency of factories and tech companies today.

Some common uses of robots are Automated Guided Vehicles (AGVs) which move materials around in warehouses, flying drones that are integral in disaster response or a vacuum capable of cleaning an entire room without assistance. Most of these applications oversimplify the meaning of robot and can be hardly considered autonomous. The misuse of the term “robot” likely stems from companies’ desire to represent their products as a highly sophisticated artificial intelligence when it’s not entirely true. Differentiating between a pre-programmed machine capable of performing a specified task when a button is pressed and a robot that can sense and respond to real-time stimuli is crucial to address the concerns that arise when they operate without user input.

For my Major design Experience Course at the University of Virginia, my team and I are creating a robot gantry system capable of playing checkers against a human opponent. I am primarily responsible for the circuit board design as well as assisting with the gantry that will control the robot’s movement. The robot will be able to operate autonomously and use a Checkers playing algorithm along with a camera to select its next move. In light of societal

concerns that could present themselves if our project were to become public, I intend to research and potentially resolve ethical issues that could arise from having a machine that moves on its own around regular people. This distinction forms the basis of my STS topic and how it correlates with my technical project.

Autonomous Checkers Robot

There's no major problem that my capstone team expects to address, but rather a desire for elevated entertainment that we hope to accomplish. Creating a Checkers playing robot may not alter the technological world as we know it, but it could be very beneficial to anyone who wants to sharpen their skills and doesn't have an opponent always available to play. In industry now, there are several robust designs of robots capable of what we're trying to accomplish, but none of which have been commercially made available. With a budget of $500, we hope to create a lower cost alternative to our industrial competitors.

To tackle the problems present in our project, my team and I have laid out a detailed plan to thoroughly test and adjust the technical expectations of our product. The Checkers robot involves intensive coding in Python and C, in which we adapted an open-source program for the game playing A.I. and implemented software on a microcontroller to drive the motors and magnets we're using to operate the gantry. For image recognition, we used a Raspberry Pi and a small digital camera. To pick up, move and place the pieces during the game, we are using a solenoid and an electromagnet to connect to the metal washers attached to the bottom. There will also be a user interface that alerts the player when it is safe to move and signal that the power is on.

We were given three and a half months to complete this project so that it will be ready for demonstration by the end of the semester in December of 2022. The design work of the circuit board and gantry had to be almost completed before the software or testing phases could begin. We used Solid works for the computer aided design and KiCad for the circuits. To select components for our project we visited and read through countless data sheets so that the devices we chose suited our purposes well. Thankfully, many of our tasks could be completed in parallel, keeping every member of the team busy with furthering our goals as we approached deadlines.

Our technical advisor is Harry Powell from the Department of Electrical and Computer Engineering at UVA.

Autonomous Robot Safety

I hope to cover the potential ethical issues that could manifest from an automated system that requires human interaction. This is important to anyone who could be a potential user or investor in my team's project if it were ever to become commercialized. I will research what the standards and procedures it would take to ensure that my Checkers playing robot is not a danger to anyone using it. There have been cases in the past where safety concerns have become a prominent issue in autonomous machines using Machine Learning or artificial intelligence. This is tightly coupled with my capstone project because we plan to let our classmates and professor play against our robot on the day of our demonstration.

Research Question and Methods

My primary research question focuses on what potential software or hardware standards can be instituted to eliminate or at least limit the risk of human endangerment with the increasing capabilities of Machine Learning and the growing popularity of commercially deployable robots. If these machines aren't pre-programmed, and have to be trusted to sense and respond to external stimuli, it's very important for there to be well define safety measures in place. My goal is to find the current standards that autonomous robots that interact with humans have to adhere to and determine whether or not they are sufficient.

To achieve this, I will search for edges cases. These will range from the most simple abnormalities in operation to more dangerous life threatening experiences people have had with autonomous machines. Once I've found similarities and commonalities when these robots fail, I'll have a better grasp of the scope of the problem at hand. Using this information, I can better inform manufacturers and consumers of these technological issues so that the risk of autonomous robots harming people can be eventually eliminated.

Conclusion

In order to promote robot safety, my team and I will design, build and test a semi-autonomous checkers playing gantry system. Creating this project will also provide an avenue to implement safety requirements and procedures to minimize the risk of dangerous events occurring and be an example of the benefits that can come from additional autonomous robot regulations. Researching the current state of machine safety standards and exploring how they can be further improved will help us prepare for the rise of autonomous systems.

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