Designing an Unmanned, Semi-Autonomous, Electrically Propelled Maritime Vehicle for Promoting Electric Propulsion

Exploring the Effects of Science Fiction Media on the Development and Use of Robotics

A Thesis Prospectus

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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

In a society that is increasingly concerned with the effects of climate change, many industries are exploring ways to transition away from fossil fuels and towards other cleaner energy sources. A notable example of this is the automotive industry, where the proportion of electric vehicles is rapidly increasing every year and now account for 8.6% of new car sales in 2023 (*America Grows Increasingly Divided on EV Adoption*, 2023). A natural assumption might be that electric vehicle adoption is occurring at a similar rate in other industries as well, but in the case of maritime vehicles the adoption rate is significantly lagging behind the automotive industry and is currently only roughly 2% (*Global Electric Boat Market 2023-2030 | October 2023 Updated*, 2023). The electrification of watercraft is not receiving the same level of investment by boat manufacturers as compared to car manufacturers, and research into effective electric propulsion watercraft is not as well studied and understood. To combat this discrepancy and promote research and adoption of electric watercraft, the American Society of Naval Engineers (ASNE) has begun to host the Promoting Electric Propulsion (PEP), a five-mile boat race that is competed in by many universities. ASNE even provides funding for teams to help them compete and purchase materials.

In addition to the engineering challenge of designing a fully electric maritime vehicle, the technical project introduced in this paper additionally aims to implement low level autonomy in the developed unmanned boat. Autonomous marine vehicles have many potential applications from search and rescue missions to managing aquaculture farms. The adoption of autonomous watercraft can lead to much more efficient and effective production in industries that rely on

navigating open water as there will be less need for skilled operators and there may not be as much downtime at nighttime.

The adoption of autonomous vehicles and robots in general comes with discomfort from the general population, however. In many news articles on robots and AI, it is exceedingly common to find comparisons to Skynet from *The Terminator* films or HAL 9000 from *2001: A Space Odyssey*. Science fiction references are certainly very prevalent in the context of robotics discourse, but it is unclear whether science fiction is influencing how robots are being implemented. Science fiction has no shortage of both protagonist and antagonist robots, and it will be interesting to investigate whether these depictions alter societal opinions on real world robot uses and if the effect exists, is it more positive or negative.

Technical Prospectus

The Promoting Electric Propulsion (PEP) competition hosted by the American Society of Naval Engineers (ASNE) is a competition focusing on promoting the development of fully electric watercraft. The competition is formatted as a five one-mile lap boat race, so speed is an important factor. The unmanned category of the competition focuses on developing autonomous or remote-controlled boats that do not require an onboard passenger to operate.

In the automotive industry, the market is very rapidly shifting toward the adoption of electric and semi-electric vehicles. The benefits of electric vehicles are abundant: less pollution from burning gasoline/diesel fuel, higher efficiency, quieter operation, etc. The electrification of watercraft is the logical next step, but the market is lagging behind the more rapidly moving car market. The PEP competition is intended to prove the feasibility and introduce new ideas to

manufacturers who seem hesitant about the idea of investing a lot of money into the research and development of electric boats and other watercraft.

Although not part of the competition, an added focus on autonomous operation has wide potential benefits. Autonomous watercraft can be used for aquaculture farms, search and rescue missions, offshore windmill maintenance and construction, and many other applications. The ongoing process of automating vehicles, though not as widespread as electrification, is likely a more significant and more disruptive change and will have larger impacts on society.

To complete the goal of completing the five-mile course in less than one hour, the system diagram shown in Figure 1 was developed. It is expected that operational range will be the biggest design challenge, so extra care is being taken to select high efficiency electronics and ensure that the battery rack has an appropriate battery capacity. The propulsion subsystem consists of a rudderless differential steering system that uses two motors, and steering can be achieved by applying different thrust levels to each motor. Based on initial calculations, the boat is expected to be able to complete the course in a 25-minute run with two 9000W 44.4V motors with a 120 Ah lithium polymer battery system, which will be achieved with twelve 10 Ah batteries wired together. This motor configuration will generate a large amount of heat due to the high current being carried in the wires, and different active and passive cooling methods are being researched to figure out the optimal method of keeping the boat cool for the duration of the race.

The autonomy and teleoperation will be handled by an onboard Intel computer, which will be interfacing with a Raspberry Pi microcontroller that will communicate with the rest of the electronics such as the motors and cooling pump. The computer and microcontroller will be

powered by a different battery bank than the motors to limit the current drawn in the wires and limit the heat being dissipated throughout the hull. The onboard computer will be connected to a GPS receiver for autonomy and will be also receiving radio signals from the base station for teleoperation. The boat hull structure is an off the shelf carbon fiber hull that will be 3D scanned with a handheld laser scanner and imported into SolidWorks as a CAD file for the design of the other subsystems.

The base station is going to be the computer that will be used for teleoperating the boat from a distance via a radio transmitter and will also contain its own power supply.

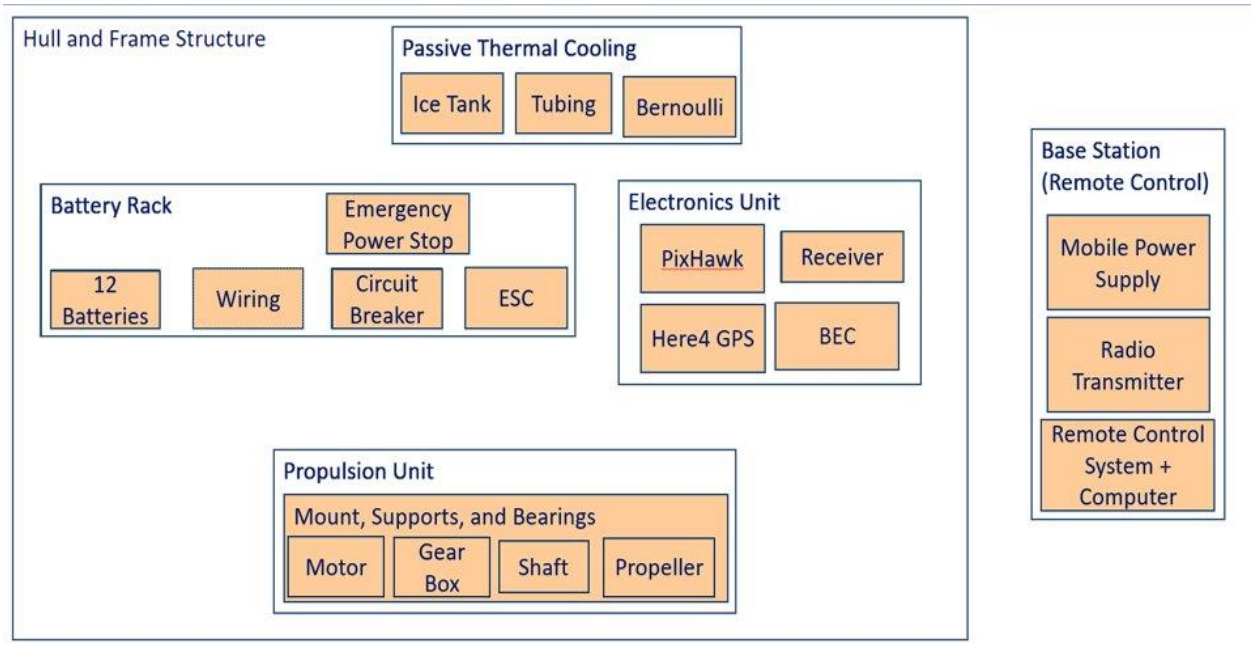

Figure 1. System Diagram of Proposed Boat and Base Station

STS Prospectus

From the cotton gin to the assembly line to the rise of personal computers, the history of societal responses to automation are frequently marked by fear, fear that these automation trends

will lead to mass unemployment, or that society will change and destroy traditional life and values. Of course, in most cases these fears did not come true and in many cases, automation led to economic booms and net job creation (*Understanding the Impact of Automation on Workers, Jobs, and Wages*, n.d.). But is the modern rise of robotics different, or is it the same story in a different setting?

To many people, robots feel more threatening and scarier than past automation trends. Many argue that robots will not lead to the same level of job creation as past technological inventions because robots are not meant to improve human efficiency like inventions such as the assembly line, but rather robots can theoretically entirely replace humans. And in addition to the fears surround job displacement, as much as 47% of Americans are somewhat or very concerned about the possibility that AI will cause the end of the human race on Earth (Orth & Bialik, 2023). Whether this

Another difference between robots and past automation movements is the rate of development around robotics. The first "modern" robots were created in the 1950s, but widespread adoption has not occurred yet, partially due to the limitations of computers until recent years. As a result of this slow development and rise of science fiction as a serious literary genre in the second half of the 20th century (*About the Nebulas*, n.d.), the science fiction community has gotten a head start on predicting the catastrophic futures we face with robots. A brief survey of popular science fiction will make it clear that overall science fiction has been predominantly negative towards robots as a technology of the future, based on notable examples such as The Matrix or The Terminator series. Despite the numerous dystopian depictions of

robotics, there have been many notable examples of expressing robots in a more positive or neutral light, such as WALL-E and Star Wars.

The question to be investigated in the STS paper is whether the depiction of robotics within science fiction is having a measurable effect on the development and/or adoption of robot technologies. Has science fiction led to an overall positive or negative view of the field of robotics, or are most people able to separate fact from fiction and not let their opinions be biased by Hollywood fantasies?

To answer this question, two methodologies are proposed: sentiment analysis of public discourse and news articles surrounding robots and measuring the frequency that different science fiction robots are used as analogies, and interviews of both consumers and producers of robot technologies to determine what the effect of science fiction consumption is on the behavior of shareholders within the robotics industry. As with many other similar types of studies around measuring the public opinion of a broad category of technology, it is important to limit the effects of confounding variables. For the purposes of this paper, it is decided to narrow the scope of study to robots in "neutral" contexts. For example, food delivery is a very non-polarizing industry, and as a result food delivery robots are a great example to study public opinion of robot use on a "blank slate". On the other end of the spectrum, the US military is a complicated web of highly dynamic and contrasting opinions, and therefore it would be nearly impossible to study opinions on robot use in the US military without including the effects of the opinions on whatever military conflict they would be used in. This does limit the meaningful associations that could be made, as in most dystopian science fiction media the antagonist robots are

commonly military or police robots, but it will nonetheless be interesting to investigate how often these associations occur in completely different contexts.

Conclusion

Modern society is adapting new technologies at a startling rate. The development of new automation trends such as AI and self-driving vehicles and other robots is going to transform the economy in ways that are difficult to predict. These technologies have the potential to revolutionize many industries. An autonomous watercraft can be used for anything from search and rescue missions, tourism, or even aquaculture farms. But as with all technologies, the adoption and development of the technology is primarily dependent on how the developers and users of the technology view the technology. The large volume of science fiction media that represent robots has created a unique scenario in which stakeholders of robotic technologies may have a view of robotics that isn't based on the state of the art of the technology, but instead the state of the fiction of the technology.

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