Technical Paper: Developing an Automatic pH Balancer for Freshwater Aquariums

STS Paper: Impact Automation has on Labor skills

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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

Home automation is commonly referred to as the use of computers or machinery in performing repetitive tasks in the home especially in relation to home appliances, furniture, or features. As a modern day technology, the recognition gained of home automation especially in the smart home field has led to not just modification in industrial and business processes, but also in the way individuals approach technology and the way it is used. Home automation has been proven to improve many aspects of life not limited to comfort, security, energy, and even financial aspects of life [1]. Even more so, automation has an increased presence in situations used for older generations or disabled individuals.

There are many ways individuals and corporations contribute to the home automation or smart home space, and this is primarily through the use of Internet of Things (IOT) devices. In an attempt to contribute to this space, for my Engineering Capstone project, my team aims to design and implement an automatic Potential of Hydrogen (pH) balancer. The automatic pH balancer is able to periodically take pH level measurements and if deemed necessary, automatically adjust the pH level of the water in the aquarium.

The focus of my Science, Technology, and Society research paper takes a look at the societal impact these smart devices might have on our teaching and learning of these skills. Automation in general has been linked to replacement of certain kinds of employment or even loss of a specific skill in some cases especially in the labor market. In my research, I hope to explore the historical impact automation has had on skilled labor specifically in aspects of people's lives relating to items they care for or intrinsically deem as wanted

labor. The Science, Technology, and Societal research that is found would further understanding in the automation space, and help improve conversations and broaden perspectives when designing such systems.

Technical Topic

For most children, having an aquarium is usually the first kind of pet that is granted to them. Most times these individuals start out excited at the prospect of caring for something and take extreme care. Overtime, they get less excited and feel burdened by the work that needs to be done in caring for the aquarium. In this case, interest in automation increases. Most aquariums in today's market come with various options to add in automatic devices such as water heater, feeders, lights, filters, among many other items. However, there seems to be a lack of automatic pH balancers for these aquariums. A number of different ways have been devised to solve this problem such as developing easy to use pH testers, and even a single solution that can balance the pH of the aquarium regardless of its acidity or basic level.

Presently, these solutions are aimed at reducing the process of balancing the pH of the aquariums and drastically aids in the manual labor an individual has to perform. Some individuals have even found a way to combine both and provide a tester and a solution balancer in a simple package by attaching the testers to the pH balancer containers or selling a combination of both of these needed products as a pack to further ease the users manual tasks when balancing the water pH. However, these tasks still have to be scheduled

and performed manually on a regular basis which further burdens the user in an aspect they might want fully automated.

As a result, my team is working towards building a device that is capable of attaching to current aquariums that is capable of automatically performing periodic checks of the pH level of the water in the aquarium, and automatically adjust the pH back to the desired level if the aquarium water is deemed out of range for the pH level desired. After doing extensive research on the current steps needed to care for an aquarium and looking into current devices available and capable of automating most of the tasks, it showed a gap in the automation of a specific task relating to the balancing of the pH level of the water. Having gained an understanding of a gap that is addressable, my team hopes that we can design and build a device that would add to the automotive space and industry while aiding individuals in what they might need to improve their lives. Once the device is designed and built, we will test it in a physical aquarium using various metrics to compare the accuracy of the device to the desired result.

We will work by iterating hardware and software components and seeking feedback from various instructors such as Professor Harry Powell, and Professor Todd Delong among other instructors in the department. Once testing is complete, we will install our device on an aquarium that contains a live fish and test the effect it has on organic matter. If our device proves to work as intended and successfully balances the pH level of the water to a given accuracy, it could serve as a starting point for industrial interest in the field to get

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inspiration and implement a compact and more consumer friendly version for mass production.

STS Topic

Automation has become such a common item in our human lives there is practically no day where we do not encounter it. From waking up to automated alarms set on our smart devices, driving in semi automated cars with adaptive cruise control and lane detection, to offices with automated door openers, homes with smart lights, smart televisions, smart speakers, smart stoves, refrigerators, security systems and many more other devices and items that we use daily, there is no part of our lives that has not been altered in some way by automation of tasks. [2]

To better evaluate the impact of automation, this research paper explores the impact automation has had on human skill over time and the impact that has had on us socially, emotionally, and politically. Socially, we will see a change in what people prioritize as important skills to learn as human factors come into play. Emotionally, we will observe how the intrinsic connection between the user and the device is disturbed in favor of ease of use, while politically we will observe the effect it has on legislation and economic factors. At the paper's end, the reader should have a strong understanding of the effects automation has on users and its effect on future generations.

Automation as a social artifact and sociotechnical system

Thomas Hughes defined a technological system as both "socially constructed and society shaping" having "messy, complex, problem-solving components". Automation devices fall under this category not just as physical devices and hardware but also as impacts in things such as our way of life and the reaping of natural resources. Together, these categories work together to create the common goal of furthering human kind both in knowledge, skill, and ability.

Technological system theory is shown throughout history by the evolution that has happened in automation. Over the past 30 to 50 years, the adoption of automation has transformed the workplace and our daily lives with people increasingly interacting with smart machines. These technologies and interactions have brought benefits in the form of increased productivity, product growth, improved performance and prosperity in people's lives. With this automation adoption we have also seen changes to the required skill of human workers. In the vast adoption of automation, we've seen the need for basic cognitive, physical, and manual labor skills decline, in favor of automation. Based on this trend, it is reasonable to infer that the adoption practices and effect of automation will be translated into the household when micro services and items are further automated.

Socially we will start to see a shift in traditional learning styles changing in favor of higher cognitive focused skills. Creative thinking, creativity, decision making, and complex problem solving will become higher in demand as opposed to basic processing and

thinking skills [3]. The effect automation has on the industry is staggering because it can replace and alter situations with or without improving productivity.

Automation and Intrinsic User-Device Relationships

Due to the rise in automation, interaction between users and their tasks has decreased. The skill of vacuuming and the "joy" it brings some people in performing the task is noticeably interrupted when automation of the task is done with the introduction of a Roomba for example. While independently, the Roomba increases productivity, as the user is now free to do other tasks or take a break, the intrinsic joy of performing a task and using a skill is lost in the process, and over time the emotional attachment to that task is broken.

However, a number of articles argue that some tasks are just far too complicated to be automated justifying it's claims by using examples to many industrial processes that could be automated but are not. Claims about time, cost, and effort in completely automating these systems are quite large, but these are hurdles that can be overcome [4] However, the emotional impact it would have on the users who hold those positions and perform those tasks are not taken into account where if put in comparison to other factors, arguably outweighs them. "It's more about using manual labor even where the people have something quicker, easier, more efficient, and overall better". The emotional impact cannot be ignored when looking at human response to attachment of tasks.

Political Implications and Regulations of Automation

Regulation of automation has been aimed at protecting and promoting human values, however, excessive control and regulation over automation has proven to provide the opposite effect. Lisanne Bainbridhe in 1983 pointed out by describing how the life of an operator was meant to be easier with an automation centered design, but it actually made the operators life worse and more difficult. Legal approaches to regulating automation are usually a product of neglecting the sociotechnical nature of automation where the relationship between man and machine are interdependent, not exclusive. Policy makers need to adjust and focus their legal treatment to recognize this interdependence and meet the goal of ethical integration. Several research has been conducted in this field where automation and its regulation are explored with several provisions provided in intertwining these topics. [5]

Next Steps

These artifacts and connections will be reviewed and analyzed by a variety of sources as well as their references to other articles of research. As detailed above the impact of automation will be compared to the actual impact it has once the technological phase has been completed and implemented. The interconnection between automation and human nature can then be explored in more detail specifically in the micro sense where the automation happens inside the home and in more individual scenarios as opposed to the historical impact it has had with bigger more disruptive systems.

Discussion of the implications of the automatic pH balancer and the impact it will have on the learning to care for pets will be included. Financial impacts and encouragements will be explored as this will bring in more perspective on the motivation behind why users like to automate certain tasks as opposed to some others. The implication being made here is that automation is done not only in response to the ease it brings to users but also because there is some other value that makes them what to automate most tasks. Some examples might be financial motivation or even societal status motivation.

Completion of the technical capstone project will occur in December 2021 where final testing on the automatic pH balancer will conclude and results can be analyzed. The STS research project will conclude in May 2022 where a full report with observations made will be presented. With this in mind, for the technical portion of the paper, my capstone team will present to our advisor a complete product that is able to automatically balance the pH of an aquarium as proof of a successfully created home automation system that is usually emotionally tied to a user. We hope we can implement this and properly rely on the system to improve the quality of life and relieve responsibility from the user.

For the STS research portion, I hope to produce a paper that provides an in depth look into the effects of automation and the impact it has on the integration between man and machine. This impact can be shown in the sociotechnical aspects that we observe, in the emotional response that is given to some types of automation, and also in how we structure our legal and regulatory systems to reflect those changes. Once this is complete, I

hope that individuals, including the engineers that develop the systems, are more informed

and choose to minimize the disruptions caused by automation.

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