Technical Project: Autonomous Plant Nursery

STS Project: The Ethics of Brain-Computer Interfacing

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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 this essay, I will explore the social impact of Brain-Computer Interfaces on a user's right to privacy. The driving question of this exploration is how to adapt our current beliefs of privacy to this newly invasive technology. This question is important because the human right to privacy is essential to the form and function of not just a society, but also to the very essence of personhood. As best said by S.J. Michael McFarland, “To lose control of one’s personal information is in some measure to lose control of one’s life and one’s dignity. Therefore, even if privacy is not in itself a fundamental right, it is necessary to protect other fundamental rights.” (Michael McFarland, 2012).

Introduction: Technical Project

In addition to the completion of an STS analysis on the topic above, I will also be performing a Technical Project. This Technical Project is focused on automation and sustainability. The project is an autonomous, self-contained growing environment for small house plants, capable of monitoring soil nutrients, light intake, and soil moisture. There is no inherent connection between the Technical Project and the STS Project, as I had decided upon an STS Project before my group had come to a consensus on what we would be doing for the Technical Project.

Introduction: Roadmap

This essay will begin by explaining in greater detail the design of the Technical Project before transitioning into the STS project, where I will be explaining in greater detail, the Research Question, the impacted social groups, my methods, and the timeline. Lastly, I will identify 4 key texts that assisted my understanding of this topic.

Technical Project: Autonomous Plant Nursery

The proposed project is an autonomous farming environment that will provide plants with moisture, light, and nutrients in accordance with the needs the user will specify for any given plot contained within our system. The system will be made up of multiple components that will all be interconnected using a Printed Circuit Board (PCB) that will handle power conversion and allow communication to and from external sensors and devices. The PCB will be designed to receive power from a wall outlet, and convert it to a supply that will be used to power the entire system

At a high level, the subsystems of the Plant Nursery can be defined as follows: Moisture Monitoring, Nutrient Monitoring, Light Monitoring, and Client Interface. To accomplish the task of Moisture Monitoring and Nutrient Monitoring at the same time, a device known as an Impedance Converter will be used to monitor the conductivity of the soil. An impedance converter is a device used that will send a small electrical signal into a substance of unknown impedance, or electrical resistance, and then measure the strength of the signal captured by a receptive probe. Using this contrast in the strength of the signal injected, compared to the one received, it will determine a concrete value of impedance. This impedance value is important because it is what will allow us to correlate the actual moisture content and nutrient density of the soil, to the overall impedance of the soil. Healthy soil will feature an abundance of nitrates, phosphates, and salts (High Plains Gardening, 2013), and these all have measurable impacts on the overall soil impedance. The more saturated soil is of these nutrients, the less impedance it has (Alexander Erler, 2020). The same applies to moisture content. So if the soil is measured, and is found to be overly conductive, this is an indication of too much water or nutrients.

The remaining aspects of the design, featuring Light Monitoring and Client Interface will be addressed all at once, as each is too short alone to justify its own subsection. Because this system is entirely contained within a controlled environment, this also means we are controlling the plant's access to direct sunlight by having it stored within an opaque housing. The lighting it needs will be provided through the use of grow lights, which will allow the user to dictate how many hours of light per day each plot should receive. The Client Interface is simply a Liquid Crystal Display (LCD), that will display information and prompts to the user, which they will interact with using a set of designated buttons to scroll through options and make choice selections.

The expected outcome of this device is to construct a growing environment that is completely self-sufficient and allows users to grow different plants with determined levels of water, nutrients, and sunlight, and then control the environment to make sure that the plants are able to grow healthily with no oversight from the end user, even if they need completely different growing environments.

This project should not require much more than the standard lab equipment and tools to put together the chassis. The anticipated software requirements are Code Composer Studio, Visual Studio Code, Multisim, and KiCad.

STS Project: The Ethics of Brain-Computer Interfacing

To understand the social impacts of Brain-Computer Interfacing, it is important to understand what exactly is meant by this term. “Brain-computer interfaces (BCIs) acquire brain signals, analyze them, and translate them into commands that are relayed to output devices that carry out desired actions.” (Jerry J. Shih, 2012). What this means is this device strictly measures signals from your brain, and analyzes them to produce a command. This could be muscular controls, neural feedback, or even a person’s thoughts, where the desired action, is to produce an image. As recently as 2021, a prototype BCI has been designed to read a person's thoughts and convert them into text (Robin Marks, 2021). Knowing this, it is only a matter of time before this technology is applied to produce images and videos of ongoing thoughts. But to reach that point, significantly much more research must be conducted, and even more data collected, to get promising results, which leads me to my question of this topic. Both pre and post-production of these devices, users will still be subject to the espionage of data collection, and synthesis. Just as your phone tracks your browsing history, stores them as cookies, and saves copies in large corporate databases, now too, your thoughts can be monitored. So what ought to be done, if anything, to protect your thoughts?

To answer this question, still, more information is to be collected. We know that there is this invasion of privacy, but who exactly is affected by this? The answer is simply everyone. Just as mobile devices such as phones and laptop computers have made taken a stronghold in the day-to-day lives of just about everyone, it is speculated by reviewers such as The Harvard Business Review that BCIs will also enter this space, and become a dominant mode of communication, and social engagement (Alexandre Gonfalonieri, 2020). With this technology speculated to

become one of the most popular and invasive forms of technology, everyone is considered at risk of the potential misuse and abuse of this technology in how it handles data acquisition.

STS Project: Framework

The framework that this STS project will utilize is the Social Construction of Technology (SCOT) framework. The fundamental idea of this framework is that rather than technology determining human action, it is human action that determines technology. For example, it is through the pursuit of greed, and maximum business efficiency that something like a factory would be created, as opposed to the idea that in pursuing maximum business efficiency, a factory is created which enables a higher degree of human greed. It is in this case that the pursuit of a technology that can provide academic and social contributions to society, ought not to be designed with the prospect of being a highly invasive device that can collect data to be sold for profit. The design ought to be cautious and aware of this potential for misuse, and incorporate a reasonable degree of protection for the users to prevent this abuse from occurring. Just as factories now must be designed to meet certain standards of safety for the workers, so too ought this technology be designed to meet standards of privacy for its customers. The next question one would ask, is what are these standards of privacy?

The current state of privacy laws, at least in the US, "…privacy laws are a cluttered mess…"(Thorin Klosowski, 2021). Under the context that this device is used say, in a medical scenario, assisting a patient who is unable to verbally communicate and synthesize text from thoughts. One could assume that whatever data collected through this usage would be encapsulated under HIPAA. But instead, if this same device is used to conduct virtual meetings

for example, then its privacy regulation falls under the ECPA. Unfortunately, this question quickly becomes opening up a can of worms, and as I will describe in the timeline for this project, it is simply something that is too time-consuming to be considered for the depth that this project intends to dive into.

STS Project: Timeline

Conducting this research will be broken down into 3 parts, which will be completed over the course of 15 weeks. The first part is to analyze the technology in greater detail, and understand what measures are being taken now, or what should be taken in order to provide privacy for the users of these devices. The next part is to instead of analyzing the legal aspects of our right to privacy, take on this approach from a philosophical perspective, and understand just why our thoughts need so much protection, and how to avoid mishandling or misuse of these devices. The last stage of research will be how to mingle the two previous approaches together, to form a cohesive, and logical decision regarding the best manner to handle this technology.

Key Texts

This section is dedicated to a few of the primary sources I have used to develop my current understanding of the relationship between BCIs and our right to privacy.

First is an article written by Jo Best (Jo Best, 2019), where the primary focus of the piece was analyzing a variety of social consequences that could come about should BCIs not respect the human right to privacy. From a military perspective to economics and even governmental affairs, it explained many caveats at a high level that ought to be important considerations during the design of BCIs.

Next was an article by Michael Matterson and Chris Metivier (Michael Matterson, 2022), which focused on why we desire to have privacy to begin with. The article discusses how privacy is fundamentally important in a democratic society. The idea that there must exist a balance between what is kept to you, and society, is essential to the idea of personhood. And while this threshold of balance may differ from person to person, everyone has to draw the line somewhere.

There was also an article by DLA Piper (DLA Piper, 2022) discussing the matter of US privacy laws. Explaining how broad they were, and the lack of comprehensiveness and varied they are from one locality to another.

The final article was from an STS Infrastructure organization, which aided in understanding the SCOT framework in greater detail, as well as how it would be applied in this situation (Joseph Klett, 2018).

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