COVID-19 Prevention, an Automated Solution
(Technical Paper)

Privacy and Public Health
(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 for the Degree
Bachelor of Science, School of Engineering

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Fall, 2020

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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 late 2019, inter-special transmission of a novel coronavirus sparked an epidemic in Wuhan, China (Taylor, 2020). This disease, like the 2002 strain of coronavirus commonly referred to as SARS, is easily transmitted and difficult to contain. As of October 2020, there is no cure and no vaccine for this disease furthermore referred to as COVID-19. Symptoms of COVID-19 include fever, cough, muscle aches, loss of taste and smell, sore throat, congestion, nausea, and vomiting. In severe cases, it can cause respiratory failure, pneumonia, and death. The virus is airborne, can spread asymptomatically, and has spread to every inhabited continent (Centers for Disease Control and Prevention, 2020a). COVID-19 is projected to kill 240,000 Americans by 2021 (Centers for Disease Control and Prevention, 2020b). Every day, experts are trying to minimize the harm of this disease and its resulting complications.

Therefore, as an engineering student, I want to use my knowledge and skillset to help combat this disease that has affected millions. The technical project focuses on a novel prevention mechanism that automatically rejects access to a space if a person is demonstrating symptoms of communicable disease. The STS research will analyze how privacy laws and social perception of privacy influenced COVID-19 containment measures through the lens of the Social Construction of Technology (SCOT) framework. It will analyze a case study by looking how the European Union chose to contain, monitor, and track COVID-19 once it reached their member countries. The STS research is tightly coupled with the technical project since both address facets of the COVID-19 pandemic response.

TECHNICAL PROJECT

COVID-19's impact on everyday life cannot be overstated. The goal of the technical project is to help combat the spread of the novel coronavirus in a low cost and effective way. Concern for public health has given rise to the demand for technology to track cases of the coronavirus and protect the public. The technical project collates engineering knowledge from low power electronics, embedded systems design, and software design techniques to facilitate a system that improves the safety of indoor spaces.

Background Information

Development and construction of the technical project will be spearheaded by a team of five members. The team consists of Andy Hui, Amanda Rein, Jack Schefer, Greg Vavoso, and Matthew Bain. The team is advised by Harry Powell and Adam Barnes, and construction of the project will be held in the National Instruments Laboratory on UVA's Grounds. To help prevent the spread of COVID-19 and protect essential workers, the team proposes the development of an automated temperature measuring system that can control access to various spaces. A web dashboard will keep track of temperature-over-time and admittance ratios to help the owner of the system keep an adequate cleaning schedule and assist in documenting the spread of COVID-19. This system will act as an attachment to the current door infrastructure to simplify adoption and usage. It must be intuitive to use, quick to operate, and accurate in its readings to best help achieve its goal of preventing the spread of COVID-19.

This technical project combines inspiration from inadequate COVID-19 prevention measures and common interactions with technology in everyday life. Public safety is of primary importance. Restaurants, bars, gyms, and other private businesses have employees screening customers with a contactless infrared temperature scanner (Brumback & Bynum, 2020). Our device eliminates the need for an employee to put themselves in harm's way and come near patrons that may carry COVID-19. The influence for construction of the device comes from motion activated appliances such as soap dispensers (Mease & Burridge, 1993). This project leverages electronic locks as an accessible tool to modify since they are commonly implemented around the country. We will combine these inspirations to create a novel system for the technical thesis project.

Breakdown of the System

The first subsystem of the technical project is the peripheral subsystem. The peripheral subsystem consists of the temperature sensor, motion detector, and electronic lock. Temperature accuracy is of highest importance, so a medical grade temperature sensor is ideal. The temperature sensor must take a quick, accurate temperature reading, and it must operate at lower power when not in use. To adhere to the low power requirement, a motion sensor will detect motion and wake up the temperature sensor. This motion sensor must also be low power and have a small ratio of false positives to further conserve power. The electronic lock must achieve two goals. Firstly, it needs to adhere to the Virginia Uniform Statewide Building Code. The Virginia Uniform Statewide Building Code always requires exit be possible whether powered or unpowered. It also states that in the event of a power failure, it must be possible to enter to allow emergency personnel to save lives (Virginia Department of Housing and Community Development Division of Building and Fire Regulation, 2018; International Building Code Council, 2017). Secondly, the door must respond quickly to a lock or unlock signal when operating under nominal conditions.

The next subsystem is communication and coordination. This includes the microcontroller used to coordinate the peripheral subsystem as well as the Bluetooth module used to communicate with the server that hosts the historical data dashboard. The microcontroller must be low power and be able to perform tasks akin to a real time operating system (RTOS). Since it must make quick decisions to lock or unlock the door, the timing of the tasks necessitates the use of an RTOS. The strict timing is to ensure accurate data transmission and intuitive use when deployed. Communicating the data with the server will be done over Bluetooth using a module.

The server and web dashboard are the final subsystems of the technical project. The Bluetooth module from the coordination subsystem communicates with the server which, in our project, is implemented on a Raspberry Pi, a low budget computer architecture. Temperature recordings and admittance decisions are sent from the microcontroller over Bluetooth to the server to update its database periodically. Persistent storage, a reliable method of storing data, in the form of a solid-state hard drive or secure digital card are a part of the system in the event of a power failure. Writing to the persistent storage may introduce latency in the dashboard, but this data may save lives and must be recorded. The web dashboard must take the database information and provide a user-friendly interface that displays data recorded from the peripherals in a readable fashion.

Timeline and Future Work

Our timeline is accelerated, and we hope to finish by the beginning of December. In August, we prepared proposals and gathered data on what we would need to make this project a reality. In September, we created schematics and models that describe our system. We determined the specific parts and tools we would need to order and download, and we began putting our plan into action. In early October, we designed a printed circuit board and began working on the coding needed to power the microcontroller, the server, and the logic controlling the different sensors. Late October will encompass full system testing, with integration and finalization happening in November.

Future work includes slimming down the board design, using an embedded microcontroller instead of a development board, increasing the accuracy of the temperature readings by updating the sensor, and eliminating as much latency as possible.

STS RESEARCH

COVID-19 has had an unprecedented effect on the world that extends to the prevention, surveillance, and monitoring methods designed to combat it (Ting et al, 2020). The global scale of the impact of this disease causes countless scientists, engineers, and medical professionals to develop new technologies to complement traditional public health strategies to combat infectious disease (Ienc & Vayena, 2020). Examples of emerging technologies are large scale data collection from mobile smartphones, thermal imaging, facial recognition, contact tracing applications utilizing blockchains, and new efficient forms of communication like the Internet of Things (Ting et al, 2020). As these technologies become more critical for containment, concerns for user privacy have soared and caused governments around the world to prohibit irresponsible data collection and produce statements defining responsible data collection (Ienc & Vayena, 2020). While it is of utmost importance to combat this disease with the most effective measures at disposal, Nature claims it is important to preserve the balance of public trust when implementing public health toolkits (Ienca, 2020). Undermining public trust is antithetical to a cohesive pandemic response. Therefore, the STS research will utilize the Social Construction of Technology (SCOT) framework to determine how data privacy influences the design, implementation, and public reception of COVID-19 response measures.

Privacy Laws in a COVID World

For example, the European Union codified their General Data Protection Regulation (GDPR) in May of 2018. This set of laws arose from the modern need for regulation over the digital landscape and defines the extent that digital providers can collect, manage, and distribute a user's personal data. The GDPR employs a "Privacy by Design" approach that effectively keeps the data subject in focus while defining actors that influence a person's data (Das, 2018). This is to protect the misuse of sensitive data and to ensure that banking, communication, and businesses can operate efficiently with consent of the customer (Das, 2018). Earlier this year, over 5 million Marriott guests' account details were leaked internationally (Valinsky, 2020). Data breaches like these are more frequent than ever before, and laws like the GDPR are designed to limit the effectiveness and impact of them while transferring control of data back to the user (Das, 2018). In the context of COVID-19, these protections may have influenced the implementations of contact tracing, facial recognition, and other monitoring and containment technologies. Member countries of the European Union will serve as a case study to determine the measures deemed necessary and the efforts to protect data privacy when implementing COVID-19 measures. The European Center for Disease Prevention and Control's (ECDPC) website has continually updated information pertinent to the pandemic as well as other historical COVID-19 data sources to help contextualize their COVID-19 response (European Centre for Disease Prevention and Control, 2020). Public responses to the prevention measures are recorded in news posts, nation-wide surveys, and press briefings as the pandemic progresses.

Research Methodology

Measuring privacy concern is difficult to scientifically contextualize within the traditional "hallmarks of empirical research:" repeatability, reproducibility, and validity (Preibusch, 2013, p.1133). However, Preibusch (2013) defines methodologies and metrics used when researching privacy concern within a population (p. 1133). He details survey methods and observational procedures to illicit a person's requirements of technology with regards to information privacy. The STS research will extend these methods to analyze public perceptions of data privacy between members of the European Union and compare the COVID-19 containment methods employed in those regions. Additionally, the European union tracks statistics on the societal impacts of digital technologies within the Union (Eurostat, n.d). These statistics in addition to the COVID-19 specific data collected by the ECDPC, will help illuminate the relationship between public perception of data privacy and the implementation of data-oriented responses to the pandemic.

Social Construction of Technology lends itself nicely to analyzing the wider context of COVID-19 containment measures and the roles of various social groups within that context. SCOT argues that societal influences drive the way technology is created and improved upon. Utilizing SCOT will consist of identifying and defining relevant social groups within the countries of study such as development companies, engineers, medical professionals, policy makers, and the populace. Another tenant of SCOT is one of interpretive flexibility: analyzing how the various containment measures affect each social group and what that measure means to their lives. Lastly, analyzing design flexibility between containment measures' implementations in different areas helps define the societal influences that dictate coronavirus containment technologies. Utilizing these approaches allows this framework to reveal how data privacy is weighted in a greater social context and how it influences which technologies are chosen more frequently in different societies.

Looking to the Future

At the time of writing, the status of the COVID-19 pandemic is constantly changing. Every day brings new developments, new procedures, and new information to help governments of the world handle the virus. For example, in mid-October 2020, Johnson and Johnson announced they are putting COVID-19 vaccine trials on hold to ensure the vaccine is safe and effective (Weintraub & Weise, 2020). Decisions like this are happening daily with regards to other prevention measures, so the research conducted for the STS paper at one stage of the pandemic may be different from information available at other stages. This is intentional and expected, for the socio-technical perceptions of various prevention methods will almost certainly change as time moves on. The STS research paper will aim to document changes in COVID-19 research in a way that illuminates the decisions of the time.

CONCLUSION

The technical section of the thesis aims to document the production of an affordable, low power, temperature-based access control device for sensitive spaces to help prevent the spread of the novel coronavirus. This process will take place over the course of six months with the development ceasing in December of 2020. The STS research section of the thesis will document how COVID-19 prevention methods are developed, what factors are considered in their development, and how personal privacy is maintained throughout the methods' lifetimes. It will analyze these factors through the Social Construction of Technology framework to capture the wider context of the prevention methods' impacts to various social groups. In the future, this research can be expanded upon to consider other case studies, prevention measures, and social groups to paint a clearer picture of COVID-19's impact in everyday life.

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