

Smart Shoe-Insole

Analyzing The Socio-Technical Impact of New Medical Technology

A Thesis Prospectus

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By

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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 the United States, 16% of the population (Chemweno, 2016) are short of insurance coverage, which creates an issue in getting proper medical care to those who need it. This issue is proliferated by the increasing costs of bills from hospital stays, such as when average costs for some important surgeries, such as a heart bypass can cost over \$100,000 (Fay, 2021). At the source of this problem lies several issues that are compounded together, which are the cost of administration, lack of a centralized healthcare system, and the high salary of hospital personnel (Boyle, 2021). While the practice of medicine and hospital procedures have generally remained stagnant, artificial intelligence is one new technology that presents itself as a possible solution to alleviating the concerns of growing healthcare costs.

Over time, many new medical technologies emerged as a means to provide better treatment, with some aimed at lowering overall healthcare cost. An example of this is the rise of artificial intelligence systems used in hospitals. At the core of artificial intelligence, most of the costs are up-front, which come from development of such algorithms. Once implemented into hospitals, they can serve as viable replacements for humans as studies show that in trial runs, the reliability of using artificial intelligence as a diagnostic tool has met the accuracy of doctors and even exceeded some of them (Leibowitz, 2020). However, an issue with this is that most of the technologies developed do not focus on making them economically available for patients that come from low-income backgrounds, which itself creates a strain on society.

The technical topic of this thesis prospectus will cover a foot pressure distribution measurement tool that is being developed by the technical group with the issues related to new medical technology in consideration. The STS portion of this thesis will go over the flaws of medical care in the United States and highlight why the development of new medical technologies has done little in solving this issue.

Technical Topic

Foot pressure distribution (FPD) provides vital information to help with the identification and treatment of various ailments, such as helping prevent foot ulcers in diabetic patients to being able to develop better posture to prevent joint pain in the future (Razak, Zayegh, Begg, and Wahab, 2012) . However, current systems of measuring FPD are not widely used throughout hospitals and physical therapy and are mainly used in scientific studies. Additionally, the current ones that are commercially available are expensive and the setup and calibration needed dissuades both consumers because of the price and physicians because of the lack of user-friendliness. For example, Tekscan, a company that makes such systems do not have their systems easily purchasable, needing to directly contact them directly to even view pricing (Tekscan, 2021). Other issues that arise are the concern for hardware durability and the environmental impact of having to throw away an entire system because one component failed. Therefore, the technical topic of the thesis aims to make an FPD measurement device more widely available by improving on two of the biggest problems related to such devices, being cost and user-friendliness.

This project is divided into two main components, being the hardware and software side. The hardware component includes all the necessary components to make a functional device. This is the electrical circuits for the sensors, the charging and discharging of sensors, and finally the filtering of data to ensure accuracy. The software component of this project is programming the microcontroller that the sensors are connected to in order to read data from the sensors and then transmit it via bluetooth wirelessly to a java application, which will then display the data.

In order to alleviate the high costs of a FPD-measurement system, proprietary hardware such as custom-made sensors are not going to be used in this system. Rather, materials that can be bought cheaply will be used in order to keep the cost of production down. The only custom hardware that will be used is the manufacturing of a printed circuit board for the hardware interfacing, which gets much less expensive

at a high-volume of production. Therefore, in order to make such a system commercially viable, the price can be as low as \$150, less than half the price of other systems that are available.

To increase the user-friendliness of such a system, there are many additional features that are to be made in software. The first one is setting up the system, in which a calibration and connection wizard will be made. The connection wizard provides a simple way for users to connect to the system using Bluetooth communication while the calibration is as simple as one-click to tare the weight of the sensors. A visual will be constantly shown to display the data, as seen in Figure 1. This figure represents an early draft of the data-display system. The points on the sole represent the placement of sensors. When pressure is detected, it will change colors and display the new pressure reading. To make a system more useful for physicians, another feature will be the ability to store data from a session to a CSV file in order for them to receive a better diagnosis.

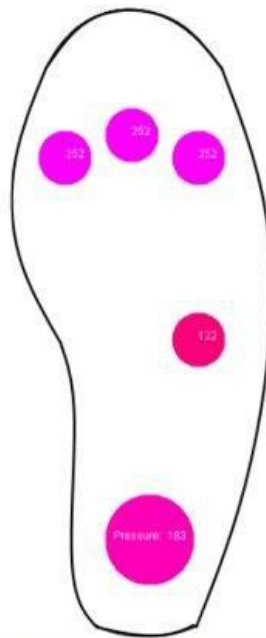


Figure 1: Data display demo

Aside from the economics and user-friendliness, another goal is to minimize the environmental impact of new electronics. Therefore, this system is designed to be modular, in which if one component fails, a replacement part can be easily installed to get the entire system working again. This drastically reduces the cost of maintenance since users will not have to purchase a new shoe in-sole every time

something fails and also promotes device longevity. Not having to discard the entire system also reduces the landfill waste that comes with throwing the entire system away.

A brief high-level overview of what will be in the technical project is in Figure 2. This figure shows how the hardware interfaces with software to provide a functional system and the specific components that will have to be used.

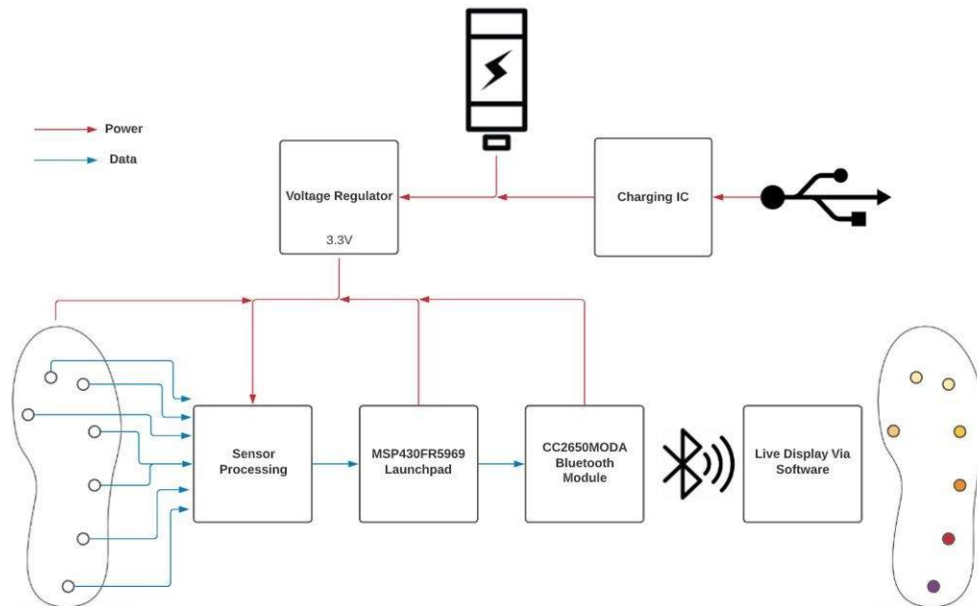


Figure 2: Block diagram of technical project

By the creation of this system, gathering the useful diagnostic information on FPD will become much more accessible to the population, ensuring that changes done sooner using the system will effectively reduce the amount of issues that will be present in the future.

STS Topic

The issue of the lack of healthcare options for everyone in the United States can be attributed to several key factors. Firstly, it would be the very high costs, which was briefly discussed in the introduction. This high cost leads to having insurance as a must if one were to be able to afford healthcare. However, the costs of keeping such insurance is getting higher and as a result, more and more people are unable to keep up with the policies (CDC, 2021). To compound this issue, not all medical procedures are covered by an insurance plan, which would further stagnate people from getting the

proper care that is needed. This obviously leads to an increase in mortality, with about 45 thousand deaths each year being caused by insufficient medical coverage (Cecere, 2021).

Another issue surrounding the poor state of medicine is a lack of information that is given to patients. The most common example of this is the sheer amount of hidden fees that pile up for a hospital bill during one's stay (Scheurer, 2013). The general result of all this is that the United States currently has a high cost of healthcare with a low return on quality. The core reason around all of these problems is that the healthcare industry is not focused on providing adequate care to all of its citizens, rather, it is good for encouraging many subsidiary companies that fall within healthcare, such as pharmaceutical companies, to prioritise profits (Case and Deaton, 2020).

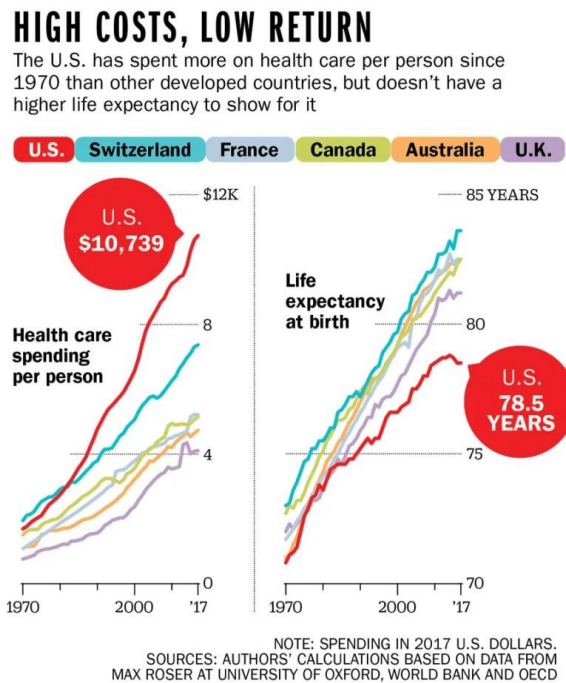


Figure 3: Comparison of healthcare among countries

The graph above from source 10 shows how when it comes to healthcare, the United States has the highest cost among other countries but yet, has the lowest life expectancy. New medical technologies have alleviated these concerns still. Often, new medical technologies are focused on being more innovative and providing better solutions to patients, which is only beneficial to those that can afford it. A

significant number of them never see wide-spread usage among the general population because the cost of treatment is not a main focus in distribution and development (Charpentier, 2020). Time also has a major impact on the lack of suitable treatments, as over time, specific tools for treatments get discarded despite there still being a demographic that needs access to such solutions. For example, Paul Alexander is a polio survivor who depends on an iron lung for his survival. However, he has struggled in the upkeep of his machine due to iron lungs fading away from society and largely becoming forgotten about in the modern world.

Another issue that arises is that newer treatments can be more expensive but more effective so hospitals and other health care facilities stop the use of older, more affordable treatments. This narrows down the group of people that are able to receive a treatment for any given disease. All of these factors come together to provide an extremely complicated network of decentralized healthcare in the United States. Left unchecked, the population may see a future where healthcare is deemed to be a privilege rather than a right.

Research Question and Methods

When framed as a question, the question would be “What is the socio-technical impact of using new technology in healthcare?” What this question details is how the development, implementation, and usage of new technology in healthcare affect the groups that are associated with it in order to properly determine the net positives and negatives. These include the technical project, the growth of artificial intelligence systems, and new pharmaceuticals. To fully understand this, there are several sources that will be needed. The first one would be articles and journals from the point of view of both patients and doctors to fully understand the different views between those that provide the care and those that receive it. Reports on previous technologies will be analyzed to see whether or not certain developments have failed due to the economic cost. Additionally, documents from several companies that specialize in using artificial intelligence will be needed, particularly the ones related to earnings in order to better understand the economic impact of new technologies.

There are several first hand sources that are present in getting data for this topic, which would be asking several doctors and also my mother about how AI use in hospitals affect them, as well as surveys that can be sent out in order to get a clearer picture of a more public opinion. Additionally, a member of the group has a family member that is a physical therapist, who can be consulted about what diagnostic tools are currently used and what technology is used for treatment.

Once data has been gathered, they will be categorized into two main categories, social and technical. The technical aspect would cover data gathered on research, medical staff feedback, and also data sheets that go over costs. The social aspect would cover media opinion, thoughts of the general public, and also comparisons between healthcare costs with and without AI. Once everything has been categorized effectively, a narrative that combines both the social aspect and technical aspect can be constructed.

Conclusion

Overall, there is a STS and a technical goal with the capstone project. The technical goal is to provide a diagnostic tool for gait discords and joint pain while the STS goal is to show what design principles should be in place in order to ensure that such a system is economically viable and can provide care to a wider audience. With these systems in place, the overall costs can be lowered significantly in order to make a commercial version of the project more widely available. These effects would be felt throughout the social and technical groups of people. It is important that this is not an end-all solution to completely rectify problems with healthcare since it is a much larger and complicated issue, but this would help in the financial sectors of such issues. By the wide scale implementation of STS focused development in healthcare, money will be less of a contributing factor towards lack of health coverage for many of those suffering from it.

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