Smart Shoe In-sole

The Emergence of Minimalist Phones

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Engineering

By
Kieran Humphreys

November 1, 2021

Technical Team Members: Ahmad Tamanna, Xin Yuan Zhu, Eric Csehoski, and Merron Tecleab

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.

ADVISORS

Rider Foley, Department of Engineering and Society

Harry Powell, Department of Electrical & Computer Engineering

The Problem with Walking

Walking is an integral part of the human experience. However, the intricacies of how we walk are not often discussed. When you walk, where you exert the most pressure changes constantly. The "walk cycle" is a common visualization for a normal walk (popularized as a basic type of animation) (Garcia, 2021), but this only tells part of the story. People with ailments ranging from their foot to their hip may walk incorrectly and not even realize it (Khan, 2021). Another consideration to make is older people are more likely to suffer from gait (walking) disorders (Orlin et al, 1997). Rheumatoid arthritis patients also commonly struggle with foot pain and walking disorders (Schmiegel et al, 2008). It's clear to see that walking issues are common, which is a great hindrance as walking is a necessary function for most people.

A tool to aid in the fight against walking disorders is to analyze the pressure points at different parts of your foot. By evaluating this data, conclusions can be made about whether a person has a healthy gait or not. This method has been used to accurately determine pathological (or abnormal) gait (Grenez et al, 2013). It also has been used to evaluate different methods of walking, such as shuffling (Zhu et al, 1991).

The group my capstone project aims to help is people who have issues walking. This could be evident in their posture, a malformed gait, or simply not being able to walk at all. People rehabbing from leg injuries can also benefit from this product, and applications of similar technology are already used in this setting (Pirker et al, 2016). Our effort to solve this issue is to create a shoe sole that can display a pressure distribution across the foot.

Smart Shoe In-sole

There are currently plenty of options for people to receive diagnostic feedback on their foot pressure distribution. The most well known example is probably Dr. Scholl's, which you may see at a CVS or health product store. Their product allows you to step on a foot outline, and receive feedback on the arch type, foot length, and pressure points of your feet (Dr. Scholl's, 2021). Based on this feedback, they will give you a recommendation for a custom fit orthotic insert (fancy name for shoe sole). This product is very helpful, however it overlooks one key aspect. It does not allow the user to move while receiving a pressure reading, so it only takes a static look at a person's gait. Our proposed solution would provide feedback based on how people are moving in a mobile package, which creates a more useful diagnostic tool.

The technical dimensions of this project are complex. The shoe sensors have an electronic signal flow that follows this process:

1. A reading is taken from the seven sensors on the sole, which is outputted as an analog voltage.
2. This signal is processed and passed into a microcontroller (MSP430FR5969 Launchpad on block diagram) which stores the data.
3. Then, this data is encoded (split up to transmit different pieces of information) and passed to a Bluetooth module (CC2650MODA) which relays the information to a separate computer.
4. This computer takes in the data and decodes it.
5. Finally, it creates a visualization of the pressure readings.

A detailed block diagram, showing the flow of data as well as power is shown below.

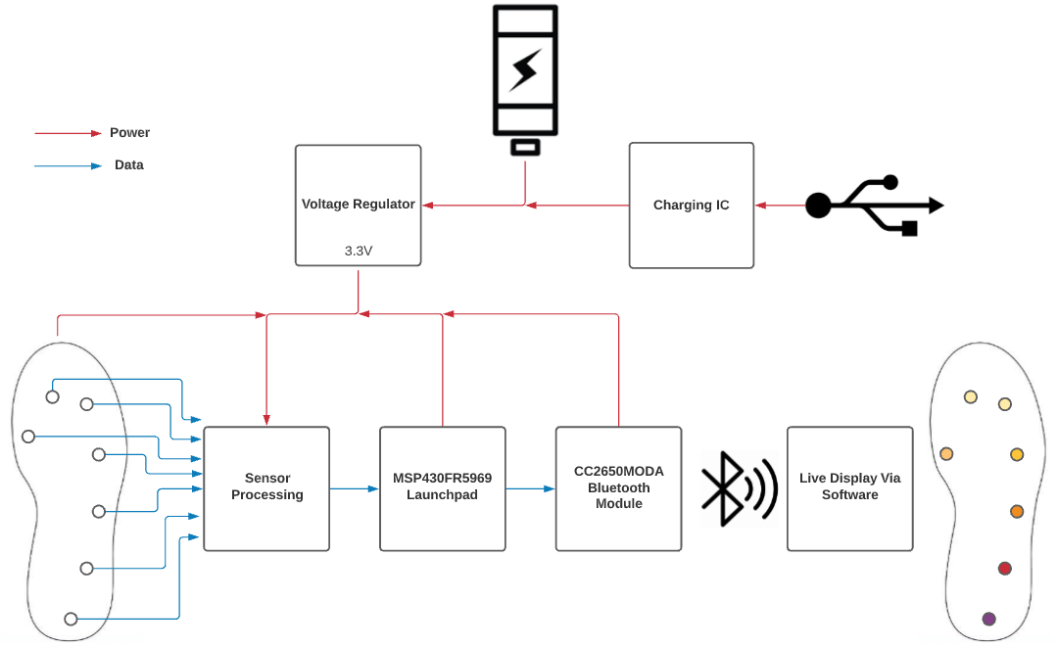

Figure 1: Block Diagram of Shoe Sole (Humphreys, 2021)

Multiple components in this circuit require power (in varying voltage ranges), and other electrical engineering is required to process the data before it is passed into the microcontroller. All of this will be housed on a printed circuit board that a user can attach to their ankle. We believe our design is a good solution to the problem by providing a cheap and mobile shoe sole that can be used to diagnose gait patterns.

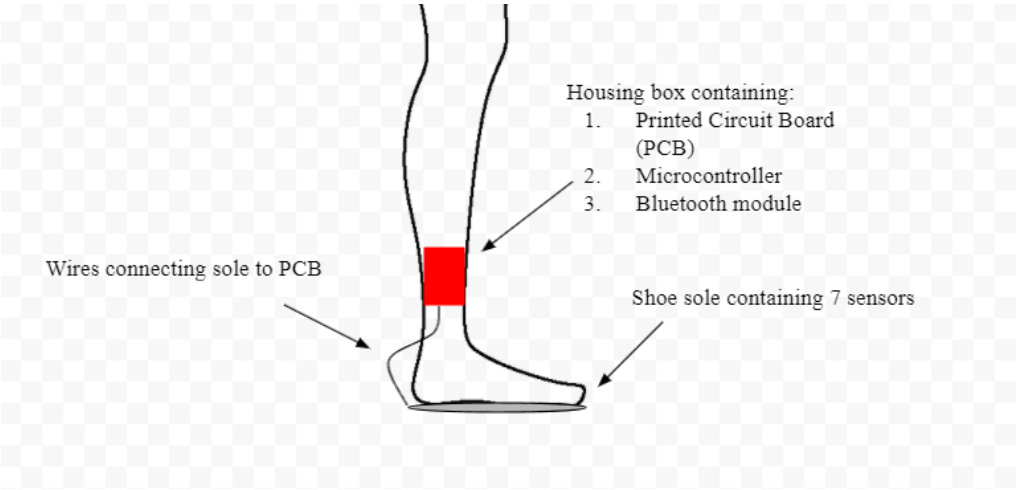

Figure 2: Physical Layout of Shoe Sole (Humphreys, 2021)

This device is designed to be used as a medical tool, but it also has other applications. For example, it could be used for athletes to design better footwear based on their pressure distribution. Although we are engineering this product, the information that can be obtained from it would be most effective in the hands of a doctor or medical professional. With a pressure distribution a doctor could prescribe better walking and posture habits, or even distribute medical equipment if a patient needed it (Hessert et al, 2005). In this way, the human interpretation of our project is quite important. The data alone cannot aid many people, but in the hands of professionals, it could do a world of good. Unfortunately, because this is only a capstone project, our sole is being designed for one size (10.5 men). In this way the project discriminates against people with a different shoe size (Latour, 1992). but it also is not useful for people with foot deformities or abnormally shaped feet.

Not So "Smart" Phones

Next, I will be examining the implications of the emergence of minimalist phones as an alternative to smart phones. Around the turn of the 21st century, the invention of the smartphone revolutionized how people communicate with each other. This started in 1992 when IBM released the Simon Personal Communicator, which would later be regarded as the first *smartphone* (Staff, 2021). A touch screen, access to emails and cellular pages, and other features such as a calendar and calculator signified that this phone was indeed *smart* compared to its cellular predecessors. Only about a decade later, in 2007, the iPhone was released. With ability to store music, browse the web, and use GPS, Apple had created an even smarter phone, one that would see hundreds of millions of users in only a couple years after its release (Statista, 2021).

According to Pew Research (Pew Research Center, 2021), 35% of Americans said they used a smartphone in 2011. By 2021, that number has risen to 85%. In a world dominated by remote communication, the need for a smartphone has never been greater.

However, this constant connectivity has not come without drawbacks. As more people began using smartphones, scholars (and parents) began to observe its addictive properties (Bányai et al, 2017). With the worldwide web at one's fingertips, it's hard not to want to look at your phone! The popularity of social media, powered by the quick dopamine fix one gets when looking at an Instagram post or a TikTok, has only aided this addiction. Recognizing a market for people who resent the negative aspects of smartphones, in recent years, companies such as Mudita and The Light Phone have introduced a novel concept to the world of smart phones; the *minimalist phone*. These phones promise users the same connectivity as smartphones, being able to call, text, and use some other essential functions like GPS. However, they get rid of everything else. The internet, apps, anything not essential to what a phone used to be, is what minimalist phones promise to do away with.

In many ways, minimalist phones are a return to the era when phone usage was dominated by flip phones and blackberries. However, these phones promise the same limited functionality in a much more aesthetic and modern package. For example, the Light Phone II has a sleek electronic paper screen, popular in many e-readers (Light Phone, 2021). Whether or not minimalist phones will become popular is yet to be seen. However, their emergence shows a trend that many people desire to be less connected, even after technology has advanced so much for us to be more connected.

I will be analyzing minimalist phones using the Social Construction of Technology (SCOT) framework. This framework emphasizes the importance of social groups in how technology is shaped. It describes a push and pull relationship between the users and creators of technology (Bijker, 2012). A major question that will be answered is what social groups are driving the emergence of minimalist phones. We know that millennials are seeking better strategies to use technologies with more awareness of their addictive properties (Hameline, 2020). “Millenials” are generally referred to as people born in the 80’s and 90’s, and are the first generation to grow up with smartphones. That being said, it would make sense that many of them would become disillusioned with the technology they saw grow so rapidly. I will be using the concept of “interpretive flexibility” to analyze how this social group has influenced the development of minimalist phones. This concept gives importance to how artifacts are interpreted, but also to how they’re designed (Bijker, 2012). Using this, I will answer how millennials attitude’s towards standard smartphones influenced the production of minimalist phones and their design.

In addition, I will seek out other social groups that may be interested in minimalist phones. While it would seem that this product is not being marketed to 20-something-year olds, I know there are people my age who share the same disillusionment with smartphones that millennials do. A question to research would be how older middle-aged and elderly people feel about the concept of minimalist phones. Using surveys as a research collection tool will help to answer this question, and give good breakdowns of attitudes towards smartphones based on demographic outlines. Lastly, I will make a comparison between millenials’ attitude towards smartphones and the Amish community’s reluctancy to adopt new technologies (Wetmore, 2007).

Gathering Data

The focus of my STS paper will be to explore the question, how the development of minimalist phones says about millenials' represent millenials' views on smartphones and connectedness? Given that smartphones play a dominating role in many modern lives, this question is an important one to answer and could give insight into how society's relationship with technology will develop.

The data to analyze this question will be collected with two methods. First, a handful of interviews will be conducted with experts on phone usage. Specifically, an expert from a sociology background will be sought out to provide critical knowledge on the topic. Another source of interviews will be the minimalist phone companies themselves, which I will seek to question and determine who they are marketing to. These interviews will serve to gain more concrete answers from experienced researchers and provide external sources of analysis on the problem. Additionally, a large survey on cell phone usage will be conducted, trying to draw from different demographics to get a broader view of the society's interaction with the technology. This survey will contain questions about people's use of their cell phone (with actual time values), attitude towards their cell phone, and lead into questions about the concept of minimalist phones. It will also contain some more personal questions regarding the survey taker's self esteem and if they experience depressive feelings, with sensitivity of course. There is evidence to support severe consequences resulting from phone usage such as depression (Bányai et al, 2017), and it would be interesting to see if this trend continues with new data. Some data analysis will be done on the back end to see if there is a correlation between these responses, and the respondent's cell phone usage. This will be an interesting exercise to see if phones really do

decrease well-being if they are used more. I will not be critiquing respondents' for their "smart phone addiction" as this has been demonstrated to be a misleading framework for the discussion (Panova et al, 2018).

Wrapping Up

Problems with gait and posture are common across age groups and can result from a variety of medical issues. To correct this issue, my team and I will design a shoe sole that can provide a pressure distribution visualization across the foot. This will be useful in diagnosing foot pathologies, and has applications for athletic and physical therapy purposes as well. The research paper aims to take a deep dive into the emergence of minimalist phones, a technology borne from using too much technology. The paper will answer the questions of what is motivating people to want these phones, why their attitudes towards their smartphones are the way they are, and larger conclusions that can be drawn based on data about cell phone usage.

Works Cited

Bányai F, Zsila Á, Király O, Maraz A, Elekes Z, Griffiths MD, et al. (2017) Problematic Social Media Use: Results from a Large-Scale Nationally Representative Adolescent Sample. PLoS ONE 12(1): e0169839. https://doi.org/10.1371/journal.pone.0169839

Bijker, W. E., Thomas Parke Hughes, & Pinch, T. J. (2012). *The social construction of technological systems : new directions in the sociology and history of technology*. The Mit Press.

Dr. Scholl's. (2021). *Custom Fit Orthotics for Foot and Lower Body Pain Relief | Dr. Scholl's®*. https://www.drscholls.com/t/custom-fit-orthotics-inserts/

Garcia, D. (2021). Advanced Digital Animation. Retrieved 27 September 2021, from https://inst.eecs.berkeley.edu/~cs194-8/Fa06Sp07/lectures/12/L12-ddg-WalkCycles-AutonomousMotion-6up.pdf

Grenez, F., Villarejo, M., Zapirain, B., & Zorrilla, A. (2013). Wireless Prototype Based on Pressure and Bending Sensors for Measuring Gate Quality. *Sensors*, *13*(8), 9679–9703. MDPI AG. Retrieved from http://dx.doi.org/10.3390/s130809679

Hameline, F. (2020). *Millennials Go Minimal*. Medium. Retrieved November 1, 2021, from https://medium.com/@fabienhameline/millenials-go-minimal-594564983ccd

Hessert, M. J., Vyas, M., Leach, J., Hu, K., Lipsitz, L. A., & Novak, V. (2005). Foot pressure distribution during walking in young and old adults. BMC Geriatrics, 5(1). https://doi.org/10.1186/1471-2318-5-8

Khan, A. (2021). Walking Abnormalities: Causes, Symptoms, and Diagnosis. Retrieved 27 September 2021, from https://www.healthline.com/health/walking-abnormalities#causes

Latour, B. (1992) 'Where are the missing masses? The sociology of a few mundane artifacts', in Bijker, W. E. and Law, J. (eds) Shaping Technology/Building Society: Studies in Sociotechnical Change, Cambridge, MA, MIT Press, pp. 225-58.

Orlin, M., Stetson, K., Skowronski, J., & Pierrynowski, M. (1997). Foot pressure distribution: methodology and clinical application for children with ankle rheumatoid arthritis. *Clinical Biomechanics*, *12*(3), S17. https://doi.org/10.1016/s0268-0033(97)88331-3

Panova, T., & Carbonell, X. (2018). Is smartphone addiction really an addiction? *Journal of Behavioral Addictions*, 7(2), 252–259. https://doi.org/10.1556/2006.7.2018.49.

Pew Research Center. (2021). *Demographics of mobile device ownership and adoption in the United States*. Pew Research Center: Internet, Science & Tech. Retrieved September 23, 2021, from https://www.pewresearch.org/internet/fact-sheet/mobile/.

Pirker, W., & Katzenschlager, R. (2016). Gait disorders in adults and the elderly. *Wiener Klinische Wochenschrift*, *129*(3–4), 81–95. https://doi.org/10.1007/s00508-016-1096-4

Schmiegel, A., Rosenbaum, D., Schorat, A., Hilker, A., & Gaubitz, M. (2008). Assessment of foot impairment in rheumatoid arthritis patients by dynamic pedobarography [Review of *Assessment of foot impairment in rheumatoid arthritis patients by dynamic pedobarography*]. *Gait & Posture*, *27*(1), 110–114. ClinicalKey. https://doi.org/https://doi.org/10.1016/j.gaitpost.2007.02.008

Staff, H. C. (2021). *Simon Personal Communicator - Complete History of the Computer by IBS*. History Computer. Retrieved November 1, 2021, from https://history-computer.com/simon-personal-communicator-complete-history-of-the-computer-by-ibs/

Statista. (2021). *Apple iPhone sales worldwide 2007–2018*. https://www.statista.com/statistics/276306/global-apple-iphone-sales-since-fiscal-year-2007/

Light Phone. (2021). The Light Phone. https://www.thelightphone.com/

Wetmore, J. (2007). Amish Technology: Reinforcing values and building community. *IEEE Technology and Society Magazine*, *26*(2), 10–21. https://doi.org/10.1109/mtas.2007.371278

Zhu, H. Z., Wertsch, J. W., Harris, G. H., & Loftsgaarden, J. L. (1991). Foot Pressure Distribution During Walking and Shuffling. *Arch Phys Med Rehabil*, *72*. https://www.archives-pmr.org/action/showPdf?pii=0003-9993%2891%2990173-G