

Creation of an Automated Foosball Table Opponent

**How Music Streaming Services Contribute to and Oppose Facebook's Impact on
Disconnecting People and Undermining Democracy**

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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

Entertainment is an essential part of humanity. Art, music, and technology are some of the many ways that people find entertainment and identify their values and culture. Due to the technological society we live in, various forms of entertainment technology have been developed and have far reaching global impact. Research has shown these positive impacts on health, education, and quality of life (Goldstein, 2017). There is also significant research into the negative effects of current entertainment technology which demand questions of how we might alter them for greater social benefit (Vaidhyathan, 2022).

For my technical topic, our team is building a robotic foosball table as a form of entertainment technology that interacts with the physical world. The system we create will play one team of a miniature foosball table so that a user can play against it. This involves five main subsystems: a camera to sense the ball, software to determine the ball's position, a microcontroller to interface with the hardware, a printed circuit board to control the motors, and a mechanical system to move the rods. By creating this system, users will be able to practice foosball skills and enjoy the game without needing others to play.

For my sociotechnical topic, I will be researching music streaming services and their impacts on society. Specifically, I will be comparing their contributions to the effects described in *Antisocial Media: How Facebook Disconnects Us and Undermines Democracy* (2022). As entertainment has been shown to help and to harm, it is important to get a deep understanding of services that millions of people use every day and how they affect our collective well-being. Though music streaming services seem to play the straightforward role of providing access to music content, there may be hidden realities that both contribute to and oppose the impacts of Facebook.

Technical Topic: Creation of an Automated Foosball Table Opponent

Foosball is a table version of soccer where typically two or four competitors spin rods in order to move miniature players towards hitting the ball. Likely invented in France, foosball has taken various forms throughout its history and has been an enjoyable pastime for many (Workman, 2013). Sources of entertainment like foosball induce positive emotions and contribute to human well-being and health (Goldstein, 2017). Our team will build a robotic foosball opponent that can play one of the teams on a miniature table. This will allow for practice that doesn't require another person. Additionally, the design of the foosball table is intended to spark users' interest in various technical domains like image processing, circuit design, software engineering, and mechatronics. These skills can be used to help society in many ways through creating medical devices, safe home electrical systems, communication technology, and more.

Robotic foosball tables have been created before, largely by members of academic institutions in similar learning contexts. Gregory Cohen, a professor of neuromorphic systems at Western Sydney University, created a foosball robot as a means of applying neuromorphic algorithms, which are algorithms based on how the brain works (2022). Graduate students Sven Bambach and Stefan Lee from Indiana University used foosball as a means for exploring computer vision techniques for tracking (2012). Rather than building a physical system that responded in real time, their work tracked a live foosball game with each players' state and the ball's position. Our work is unique from what has already been done given the scale and constraints. The other projects which created physical foosball opponent systems did so on full-sized foosball tables with expensive components. Ours is done on a small foosball table with a much lower cost constraint, which will make our design usable by many more people.

Our system will be composed of five main subsystems. A camera will be placed above the table which will capture the current state of the game in real time. This data will be processed by a Raspberry Pi¹ which will run computer vision algorithms to determine the current position and velocity of the ball. A microcontroller will use the ball's position and velocity along with the current state of the foosball player rods to determine how to move the rods. In order to design this algorithm, we will use concepts from control theory, image processing, and machine learning. The microcontroller will communicate the movement commands to a printed circuit board which will drive the motors of the mechanical system. The mechanical system will use two motors to control each rod: one motor which rotates the rods for kicking the players, and the second which drives a belt system to move the rod in and out. Through this system, the automated foosball table will be designed for an enjoyable and educational playing experience.

STS Topic: How Music Streaming Services Contribute to and Oppose Facebook's Impact on Disconnecting People and Undermining Democracy

In Siva Vaidhyathan's book *Antisocial Media: How Facebook Disconnects Us and Undermines Democracy*, he argues that Facebook has heavily contributed to negative effects on democracy and our collective social life (2022). Vaidhyathan is the Robertson Professor of Media Studies and director of the Center for Media and Citizenship at the University of Virginia and has written many related books (*Siva Vaidhyathan • Faculty Directory, University of Virginia*, n.d.). The key mechanisms he identifies are the push of radicalizing and misleading content, amplification of strongly emotional content, and creation of echo chambers which reinforce beliefs. Each of these incentivizes reactionary involvement and elevated emotion while

¹ <https://www.raspberrypi.com/>

devaluing complex dialogue with diverse perspectives. Like Facebook, music streaming services are technologies that have a dominant presence in the lives of people around the world with at least half a billion subscribers in 2021 and even more free listeners (“Music Streaming Statistics in 2022 (US & Global Data),” 2022). In my research, I plan to investigate how music streaming services both contribute to and oppose the phenomena observed from Facebook.

In order to get a more complete picture of the sociotechnical landscape surrounding music streaming services, I will use actor-network theory to interpret the actors involved and the relationships between them (Latour, 1996). This is a helpful framework because the technology itself is treated as an actor which will allow for thoughtful analysis of the design of these systems along with their social impacts and relevant social groups. The main research method I will use to understand these factors is literature review of related primary and secondary sources.

One of the key actors within music streaming services is the playlist, which Eriksson, who was the primary author of a book dissecting the workings of Spotify and has published in peer reviewed journals, observed as a logistical “container” (2020). This view comes from the dichotomy of seeming controlled on the outside with other less obvious things happening on the inside. An example of this is many “fake artists” on some of Spotify’s playlists like “Piano & Chill” which were exposed in 2017 by Music Business Worldwide (and which Spotify denied) (Ingham). Possible hidden realities like this demand a deeper level of analysis to see the more subtle effects that streaming services may have compared to clearer realities seen from Facebook.

Since the inception of music streaming services in the twenty first century, their goals and means of competition have shifted. After the free file sharing approach that companies like Napster used in the early 2000s, music streaming services addressed the societal desire for legal

unlimited access to music content. With similar content among services and the difficulty of navigating endless content for users, streaming services started to focus on social functionality where music discovery could happen in community. Today, following the trend of other platforms like Facebook, music streaming services have a high emphasis on algorithmic recommendations and personalization (Maasø & Spilker, 2022). Morris & Powers argue that the focus of streaming services has become creating “branded musical experiences” in a frequently cited article (2015, p. 106). Because of the intentional curation of content, Morris & Powers (2015) seem to imply that this takes the choice away from the user. This is an interesting possibility to consider but seems to embrace technological determinism.

These hidden factors and subtle design decisions are a part of the lives of millions of people in a culture where the realities seen in Facebook are widespread. As I research the actor-network in and around music streaming services, I seek to understand ways that they contribute to and oppose undermining democracy and disconnecting people. Underneath this research are many questions. Are the recommendations based on “relevance” an extension of the listener or are they external forces with unexpected consequences? Despite seeming to broaden music taste, do music streaming services tend to narrow listening habits? If they don’t, in what ways do they resist the echo chambers of Facebook? If they do, do they contribute to them? how? Do music streaming services’ designs for profit match up with the best interests of the users or do the designs chase profit at the users’ expense? In seeking to answer these questions and understand the parallels with Facebook, I hope to envision changes that would help make music streaming services a greater individual and collective benefit.

Conclusion

With entertainment technology playing a key role in our lives today, the design and evaluation of these technologies are essential. My team's robotic foosball opponent will serve to create an enjoyable experience that also aids the education of the users. Because of the smaller size compared to similar efforts, the design will be less restricted to the wealthy and bring benefits to more people. My STS research will help to understand the unseen roles that music streaming services play in our collective social lives and how they compare and differ to the effects seen from Facebook. This will allow for thoughtful reflection on how to design these and similar services to be a greater benefit to society's ability to engage with diverse cultures and have constructive dialogue.

References

- Arditi, D. (2021). *Streaming Culture: Subscription Platforms and the Unending Consumption of Culture*. Emerald Publishing Limited.
<http://ebookcentral.proquest.com/lib/uva/detail.action?docID=6534200>
- Bambach, S., & Lee, S. (2012). *Real-Time Foosball Game State Tracking*.
- Barata, M. L., & Coelho, P. S. (2021). Music Streaming Services: Understanding the Drivers of Customer Purchase and Intention to Recommend. *Heliyon*, 7(8), e07783.
<https://doi.org/10.1016/j.heliyon.2021.e07783>
- Bolduc, H., & Kinnally, W. (2018). Examining the Impact of Social Identification with Music on Music Streaming Behavior. *Journal of Radio & Audio Media*, 25(1), 42–61.
<https://doi.org/10.1080/19376529.2017.1362893>
- Chung, J., Lee, J., & Yoon, J. (2022). Understanding Music Streaming Services Via Text Mining of Online Customer Reviews. *Electronic Commerce Research and Applications*, 53, 101145. <https://doi.org/10.1016/j.elerap.2022.101145>
- Cohen, G. (2022). Gooaall!!!: Why we Built a Neuromorphic Robot to Play Foosball. *IEEE Spectrum*, 59(3), 44–50. <https://doi.org/10.1109/MSPEC.2022.9729948>
- Eriksson, M. (2020). The Editorial Playlist as Container Technology: On Spotify and the Logistical Role of Digital Music Packages. *Journal of Cultural Economy*, 13(4), 415–427. <https://doi.org/10.1080/17530350.2019.1708780>
- Eriksson, M., Fleischer, R., Johansson, A., Snickars, P., & Vonderau, P. (2019). Spotify Teardown: Inside the Black Box of Streaming Music. In *Spotify Teardown: Inside the Black Box of Streaming Music* (pp. 1–276). Mit Press.
<https://doi.org/10.7551/mitpress/10932.001.0001>
- Fuentes, C., Hagberg, J., & Kjellberg, H. (2019). Soundtracking: Music Listening Practices in the Digital Age. *European Journal of Marketing*, 53(3), 483–503.
<https://doi.org/10.1108/EJM-10-2017-0753>
- Goldstein, J. H. (2017). Applied Entertainment: Positive Uses of Entertainment Media. In R. Nakatsu, M. Rauterberg, & P. Ciancarini (Eds.), *Handbook of Digital Games and Entertainment Technologies* (pp. 1247–1269). Springer. https://doi.org/10.1007/978-981-4560-50-4_9
- Hagen, A. N., & Lüders, M. (2017). Social Streaming? Navigating Music as Personal and Social. *Convergence: The International Journal of Research into New Media Technologies*, 23(6), 643–659. <https://doi.org/10.1177/1354856516673298>
- Hamilton, J. (2021, October 6). *Spotify Has Made All Music Into Background Music*. The Atlantic. <https://www.theatlantic.com/magazine/archive/2021/11/kelefa-sanneh-major-labels-music/620178/>
- Hracs, B. J., & Webster, J. (2021). From Selling Songs to Engineering Experiences: Exploring the Competitive Strategies of Music Streaming Platforms. *Journal of Cultural Economy*, 14(2), 240–257. <https://doi.org/10.1080/17530350.2020.1819374>
- Ingham, T. (2017, July 10). *So... Who's Actually Behind Spotify's Fake Artists?* Music Business Worldwide. <https://www.musicbusinessworldwide.com/so-whos-actually-behind-spotifys-fake-artists/>
- Latour, B. (1996). On Actor-Network Theory: A Few Clarifications. *Soziale Welt*, 47(4), 369–381.

- Maasø, A., & Spilker, H. S. (2022). The Streaming Paradox: Untangling the Hybrid Gatekeeping Mechanisms of Music Streaming. *Popular Music and Society*, 45(3), 300–316. <https://doi.org/10.1080/03007766.2022.2026923>
- Morris, J. W., & Powers, D. (2015). Control, Curation and Musical Experience in Streaming Music Services. *Creative Industries Journal*, 8(2), 106–122. <https://doi.org/10.1080/17510694.2015.1090222>
- Music Streaming Statistics in 2022 (US & Global Data). (2022, March 3). *Musical Pursuits*. <https://musicalpursuits.com/music-streaming/>
- Prey, R. (2018). Nothing Personal: Algorithmic Individuation on Music Streaming Platforms. *Media, Culture & Society*, 40(7), 1086–1100. <https://doi.org/10.1177/0163443717745147>
- Siva Vaidhyanathan • Faculty Directory, University of Virginia. (n.d.). Retrieved October 26, 2022, from <https://facultydirectory.virginia.edu/faculty/sv2r>
- Vaidhyanathan, S. (2022). *Antisocial Media: How Facebook Disconnects Us and Undermines Democracy* (S. Vaidhyanathan, Ed.). Oxford University Press. <https://doi.org/10.1093/oso/9780190056544.001.0001>
- Webster, J. (2020). Taste in the Platform Age: Music Streaming Services and New Forms of Class Distinction. *Information, Communication & Society*, 23(13), 1909–1924. <https://doi.org/10.1080/1369118X.2019.1622763>
- Workman, D. (2013, January 4). *The Murky History of Foosball*. Smithsonian Magazine. <https://www.smithsonianmag.com/history/the-murky-history-of-foosball-314668/>