Kinetic energy-powered, Mid-Range Frequency Amplifier Microphone/Speaker for Individuals with Presbycusis

Societal Perception of Age-Related Hearing Loss and Effects on Treatment 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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General Research Problem: Societal Perception Surrounding Age Related Hearing Loss and how it has Shaped Treatment

How can we develop technologies that better treat hearing loss?

Presbycusis is a condition characterized by a gradual and progressive decline in hearing ability that occurs as people age. Because the onset of symptoms generally occurs at a higher age, this condition can be one that individuals avoid bringing up or seeking treatment for because of our society's negative views on aging. Technology that has been created to aid this condition has adjusted to societal norms as hearing aids strive to become as discreet as possible. These changes have addressed the negative societal perception by making the treatment less obvious for those individuals who may be less inclined to share their affliction. For my Science, Technology, and Society (STS) research project, I intend to research the influence that our society's views on aging have had on treatment of this condition, as well as why many individuals wait to pursue medical care for their affliction. I will expand on this by discussing the effects that waiting to seek treatment has on individuals who are already facing an onset of symptoms. Lastly, I will elaborate on the mutual shaping that has occurred between societal perception and hearing aids. Complementing my STS project, for my technical project I will design a kinetic-energy powered microphone/speaker pair that will amplify the middle frequencies of a speaker's voice. Because individuals with presbycusis often struggle to hear higher frequency sounds and certain consonants, amplifying the middle frequencies of someone's voice can make it easier for some elderly people with hearing loss to hear and understand speech. My STS topic and technical project are interrelated as my STS topic seeks to address the harm that societal views on presbycusis have on those individuals with this condition, while my

technical project is intended to improve the ability of those with hearing loss to understand speech.

Technical Research Question: Kinetic energy-powered, Frequency Amplifier/Microphone for Individuals with Presbycusis

How can a microphone and speaker pairing be designed to accommodate the specific needs of an audience affected by hearing loss?

For my technical project, I intend to develop a microphone and speaker combination that amplifies certain frequency ranges that is powered by kinetic energy. The goal of this technology is to accommodate for an audience with hearing impairments, while minimizing power consumption. Many individuals with hearing loss, especially senior citizens, will lose their ability to hear higher frequencies when onset of symptoms occur. By constructing a speaker that has the ability to amplify the middle frequencies of someone's voice, it will enable people experiencing some hearing loss to understand the speaker more clearly. The speaker also has the ability to amplify other frequencies, accommodating to those affected by other types of hearing loss. This microphone/speaker pair will be self-powered in order to minimize power consumption and to allow this technology to be used in locations or contexts that may not have power available. This design project will be executed through a semester-long course that will be completed in Spring 2024. Designing the product will be separated into three major steps: designing filters and amplifiers, programming a knob that will allow for the user to choose which frequency of the speaker's voice to amplify, and making the project self-powered.

When discussing the filters and amplifiers used, it is important to note that the speaker will have the ability to amplify three different frequency ranges: low frequencies, high

frequencies, and midband frequencies. The middle frequency amplification functionality of the project is what is most relevant to accommodating to those specifically affected by presbycusis, while the other frequency amplifications can be helpful with other types of hearing loss. The first steps that will be taken to carry out this project will be analytically determining the components and the design of the schematic that will create and power the different filters, which will be achieved through analog filter design and digital signal processing. Three different filters will be designed: a low pass filter, a band pass filter, and a high pass filter. The signals that are output from these filters will be amplified, individually. This initial design will then be simulated to ensure functionality. Once the design of the three filters and respective amplifiers are verified, the next step will be to allow the user to determine which frequency of the signal will be amplified.

Allowing the user to adjust the frequency amplification setting of the speaker will be achieved by using a MSP432 microcontroller, programmed using the C programming language. This design will use a rotary encoder to allow the user to choose to amplify the low, middle, or high frequency signals that are inputted into the microphone through the speaker's voice. The user will decide which frequency will be amplified by turning a knob, and from this whichever setting is chosen will allow the electrical signal to be directed through the corresponding filter.

The last step of the design process involves adding the self-power functionality of the project. This will be done by building a hand-cranked wheel that powers the filter once it is determined how much power is required to power the microphone, speaker, microcontroller, and filters. The wheel will be rotated by hand and has a combination of inductors and coils attached to it in order to induce current flow. This current flow will be used to charge up capacitors to store the kinetic energy created. The signal will then pass through whichever filter and

amplification combination is chosen using the rotary encoder. Once the power required is determined, the microphone and speaker will be constructed, with specific rotary functions to amplify or normalize the different frequencies of the speaker's voice. After the correct decibel levels are calculated, all parts will be assembled to form and test the final product. The final product is intended to be used when a speaker or presenter has to speak to a group of people that are affected by hearing impairments. Additionally, the added self-powered functionality allows it to be used when there is little to no power available. This innovative solution will significantly benefit those affected by age-related hearing impairments, as it can be used in several contexts and improve decibel levels as well as clarify speech for the audience.

Societal Perception of Age-Related Hearing Loss and Effects on Treatment Technology

What societal perceptions are associated with presbycusis and how has technology been shaped in order to adjust to this view?

The general issue my research seeks to address is the societal perception of age-related hearing loss and its impact on the development and utilization of treatment technology. From diving into the history of hearing aid technology and how societal factors have shaped what it has become today, we can predict the future of treatment options and understand the different social groups at play. The knowledge gap surrounding the social shaping of presbycusis treatment is significant for several reasons. The negative connotation associated with this condition leads to ineffective treatment, stigma, misconceptions that can affect research funding and industry innovation, and healthcare access and policy. Addressing the knowledge gap regarding societal perception and social shaping on treatment technology is essential for

improving quality of life, access to healthcare, and technological advancements in the field of audiology.

Age related hearing loss affecting individuals has stretched back over centuries. Several devices were created in order to accommodate an onset of symptoms, ranging from funnel-shaped contraptions to handheld ear trumpets. In the late 19th century, a movement toward concealing individual disability began to gain movement which led to creating more discreet hearing technology. This was facilitated by Thomas Edison's creation of the carbon transmitter that amplified electrical signals and decibels levels (Valentinuzzi, 2020). From this, further inventions such as circuit boards, button-size batteries, and the invention of the transistor allowed for more discreetness in hearing aid technology. Fast forwarding to the 21st century, the ability to program hearing aids forever changed the way these devices would be improved. By 2005, digital hearing aids accounted for approximately 80% of the market (Valentinuzzi, 2020).

Today hearing aid technology strives to be as discreet as possible as a result of social perceptions surrounding age-related hearing loss and the perception of aging. Age-related hearing loss represents a prominent contributor to disability among elderly individuals and is associated with feelings of social and emotional isolation, as well as psychological discomfort (Jayakody et al., 2022). There are several studies that demonstrate how hearing loss leads to depression, cognitive decline, and even dementia (Cominetti et al., 2023). Because of all these issues that arise from untreated cases of hearing loss in adults, it seems evident how important it is to have corrective action. However, many adults refuse to seek treatment because of social stigmas that are associated with loss of hearing and aging. In a 2023 study on disclosing hearing loss, 8 out of 11 participants initially kept their condition hidden due to factors like embarrassment, pride, and fear of being seen as weak or disabled (Katsuya & Sano, 2023). These

social norms, driven by a desire not to appear "old" or vulnerable, discourage seeking help for hearing issues. Consequently, hearing aid technologies are becoming increasingly costly as they strive for discretion.

Although age related hearing loss has been a prevalent issue, technology is still being perfected in order to best alleviate the symptoms. The “best” technology that is being created is the type that appeals to most social groups. The societal web that stems from this issue is very complex. The people that are affected by this disease may have the most influence on the direction of the aesthetic changes on this technology. Additionally, the engineers and individuals who design these products have a stake in how technology dictates social perception. Furthermore, lawmakers that decide legislation surrounding counter products, affordability, and the technologies that alleviate symptoms are involved in the social shaping of hearing aids. Lastly, the hearing health care professionals that diagnose patients also must understand societal perception in order to be able to best approach the discussion with patients. These relationships build off the concept of actor network theory, where the “best” treatment of this condition is subject to the opinions and needs of the social groups at play at the time. How societal needs and perceptions have influenced the direction of hearing aids also draws upon social constructionism.

I will be addressing the question of how treatment of age-related hearing loss is affected by societal perception by collecting information on how societal perception has shaped past hearing aid technology and how social factors will continue to dictate the direction of treatment options from published accounts and other research papers. To expand upon this, I will gather data from groups who are affected by this disease, and how social views impact their preference of hearing treatment.

Conclusion

This research encompasses two intertwined projects aimed at addressing the overarching issue of societal perception surrounding age-related hearing loss and its influence on the development and use of treatment technology. The STS research project seeks to delve into societal views on presbycusis, examining why many individuals delay seeking medical care and the consequences of such delays. Furthermore, it explores the mutual shaping that has occurred between societal perception and the evolution of hearing aid technology. The technical research project is designed to create a kinetic energy-powered microphone and speaker combination, tailored to amplify midband frequencies, thus aiding individuals affected by presbycusis. By improving their ability to understand speech, this project directly aligns with the goal of enhancing the quality of life for those facing age-related hearing impairments. Looking ahead, the knowledge generated from these projects can inform future work in this field and can shape accessible solutions that align with societal needs and preferences.

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