Undergraduate Thesis Prospectus

Wearable Assistive Technology: A Hat for the Visually Impaired

Consumerism and Privacy: How Consumer Data Collection Impacts Privacy

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

How can digital systems more optimally balance their practical value against their social costs?

In serving us, digital systems also induce dependence. The IEEE Society on Social Implications of Technology (SSIT) is one of many groups founded to examine the philosophical nature of the terms "good" and "useful" that engineers aim to achieve when developing new technology. SSIT has specifically identified that the question of technological development is not "whether A or B is better technologically" but rather "whether and why the entire technological project is going to benefit anyone, and who it may benefit, and who it may harm" (Stephan et al., 2012). This shift to question the inherent optimism behind new technology and focusing on the full spectrum of its impacts on society is crucial to creating digital systems that provide optimal practical use with minimal negative social costs.

Wearable Technology That Assists Visually Impaired Individuals

How can embedded systems assist the disabled in navigating their environment independently?

In 2015, the Centers for Disease Control and Prevention (CDC) estimated that a total of 1.02 million people were blind in the United States and approximately 3.22 million people have vision impairment. The CDC also projects that by 2050 the numbers of these conditions will double, making blindness and visual impairment a major problem for Americans (CDC, 2020). This project seeks to provide aid to those who are blind or impaired by incorporating mounted LiDAR and Ultrasonic sensors on a wearable to give

tactile and auditory feedback to the user about their surroundings. The capstone project is under the Electrical and Computer Engineering department and the project advisor is Harry Powell. The capstone student collaborators are Mary DeSimone, LaDawna McEnhimer, and Hafsah Shamsie.

Currently, there are several devices that provide visual aid to blind individuals. The University of Michigan has developed an enhanced blind cane called GuideCane which incorporates ultrasonic sensors and servo motors to steer the cane and the user to avoid upcoming obstacles (Ulrich & Borenstein, 2001). Other wearable devices are also available on the market, like iGlasses Ultrasonic Mobility Aid by Ambutech, that provide a compact and affordable method to aid those who are visually impaired (Ambutech, n.d.). However, our team observed that many of these devices restricted the use of the user's hands and also did not provide feedback about approaching objects from the side or behind.

The goal of our project is to provide a hands-free wearable for the visually impaired with feedback for all surrounding and approaching objects through vibrations and tones. Our system will consist of LiDAR and Ultrasonic sensors that will be embedded into a hat, which will not restrict the use of the user's hands while also providing a stylish alternative to a cane. A MSP430FR2433 microcontroller will be used to communicate with the sensors, collect data, compute the distances of objects, and then notify the user of the object's location by tones and motors corresponding to the direction of the object. A prototype will be built with a custom designed PCB and testing will be done to calibrate the sensors such that accurate feedback is given so the user can navigate their environment unassisted.

At the end of this project, our team will have a fully functional hat with embedded sensors that will respond to surroundings and notify the user of any obstructions. This working prototype will be another advancement in visual assistance technology that will be more discrete and user friendly. Following this project, other optimizations can be made to the design to lower the cost and make mass production easier so that the visually impaired can have access to an affordable and effective method of environment navigation.

Consumerism and Privacy: How Consumer Data Collection Impacts Privacy

In the U.S. since 2010, how have privacy advocates, civil libertarians, tech companies and advertisers competed to draw the line between proper and illegitimate data collection for targeted marketing?

Companies have always gathered data to make business decisions that optimize profits. However, the rise of the internet has allowed corporations to use externally sourced data to develop databases that contain what is now called Big Data (VU, 2020). Many of the practices used by tech companies to acquire this consumer information is either unavoidable or undetectable by users (Ashworth & Free, 2006, p108). In response, several privacy advocates have called into question the ethical nature of these practices and their impact on the freedoms of consumers.

Researchers have examined the risks of having user information available over the internet, the effects of targeted advertising, and the ethics of Big Data. Kumar et al. (2010) identify the concerns of untrustworthy agencies having personally identifiable information and “quasi-identifiers” that make users susceptible to reidentification through

anonymized data. As for targeted advertising, André et al. (2017) examine the use of artificial intelligence in micro-targeting marketing practices and the misconception that lowering search, transaction and decision-making costs for the consumer empowers and increases consumer welfare. Lastly, Zwitter (2014) suggests that Big Data creates the challenge of trying to apply traditional ethics and poses new ethical problems concerning privacy, propensity modeling, and research using Big Data.

Responding to privacy threats, the American Civil Liberties Union (ACLU) warns of the "increasingly pervasive surveillance of individuals" by corporations and of the pressures to exchange privacy for services (ACLU, n.d.). Gillmor (2018) who is a part of the ACLU Speech, Privacy, and Technology Project states that "Facebook and other massive web companies represent a strong push toward unaccountable centralized social control" through their services. Gillmor adds that though he is not active on Facebook, Facebook still developed a detailed profile about him. This is done through connections of others on Facebook's platform or through his browsing habits that are linked through webpages that incorporate Facebook's like button into their content.

Privacy International (PI) is another privacy advocate that has identified tech companies that have shifted their focus to collecting large amounts of personal data, sometimes at the expense of the user, to better target their advertisements and remain competitive (PI, n.d.b). Specifically, PI explains how problematic advertisement technology is because it can be discriminatory, manipulative, and pose as a serious security risk if the data is not sufficiently protected (PI, n.d.a). Furthermore, PI has specifically called out companies like Google as "gatekeepers" who regulate how users access information on the web. They also claim that data collection is a way for large

companies to dominate in the digital economy and has caused companies to overstep the boundary of "just affecting the realm of digital advertising" (PI, n.d.b).

The Digital Advertising Alliance (DAA) "establishes and enforces responsible privacy practices across the industry for relevant digital advertising" while also striving for transparency and control on the use of multi-site data and cross-app data gathering. This alliance is led by leading advertising and marketing trade associations such as 4A's, American Advertising Federation (AAF), Association of National Advertisers (ANA), BBB National Programs (BBBNP), Interactive Advertising Bureau (IAB), and Network Advertising Initiative (NAI) (DAA, n.d.a). The DAA has designed several principles for advertising practices and uses the BBBNP and ANA to investigate and enforce any violations that consumers, business entities, or other stakeholders have observed (DAA, n.d.b).

Data collectors monetize the data by using it to target personalized advertisements at consumers. One prominent tech company that has collected user data for third-party access is Facebook, which openly states that user data is provided to advertisers and business analysts (Facebook, n.d.). Facebook even has a custom marketing service called "Lookalike Audiences", which is a feature that "allows marketers to examine their existing customers or voters for certain propensities – like big spending – and have Facebook find other users with similar tendencies" (Singer, 2018). This feature does not give advertisers personal data of the user and Facebook has policies in place to prohibit potentially predatory ad-targeting practices. However, despite these policies, many users still object to such data collection, how well they are informed about it, and the effects it has on consumer privacy.

Google also collects user's browser data for third-parties as a way to tailor advertisements and as a means to keep its services free (Google, n.d.b). The company has a specific page located in its Privacy & Terms webpage that gives an overview of how it uses various digital components on users' devices, such as cookies or IP addresses, to customize advertising such that advertisers are able to reach their desired audiences. It provides users ways to opt out of these targeted ads and give detailed information about what users can expect to see if they chose not to opt out (Google, n.d.a). Furthermore, Google even provides users access to what is called an "advertising profile," which includes a summary of "what google thinks about you" in terms of gender, age range, job industry, and interests. These again are used for targeted advertising purposes to serve users with ads that align with their personal tastes along with other personalized services (Sidell, 2020).

Overall, these participants have continued to test the current standards of consumer privacy in an effort to find the balance between providing an efficient and personalized experience while still respecting the privacy of each user. This has opened the door to a deeper exploration of the practical and social impact that these digital services have on consumers in the United States and will lay the foundation for future services that will depend on data collection.

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