Attitudes to wireless audio for self-service accessibility

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ABSTRACT

Blind and partially sighted people often use headphones for listening to audio feedback, particularly in public places. This paper presents the results of a survey of blind and partially sighted people regarding their attitude towards using wireless headphones, to avoid the need to plug a physical cable into a machine. Results are presented regarding attitudes to the use of speech input and output in a self-service context.

KEYWORDS

Blind, Accessibility, Wireless, Speech, Self-Service

Introduction

Self-service terminals like automated teller machines (ATMs), kiosks or self-checkout in a retail environment (SCO) commonly include a 3.5mm headphone socket. People who wish spoken audio feedback can then plug headphones into this socket.

This approach works well but does mean that the person is then tethered to the machine (Figure 1); with a trailing cable potentially getting in the way of other activities like using the touchscreen, getting cash, or scanning shopping.

Figure 1: Person with wired headphones plugged in to the ATM

This situation therefore presented an opportunity, particularly when combined with evolving trends in technology, to make self-service more usable for people. One such trend is the use of wireless technology to transmit audio to headphones, earbuds and other listening aids, with the market for wireless earphones and headphones predicted to see a compound annual growth rate of 5% from 2017 to 2024 (Bhutani & Bhardwaj, 2017).

Wireless headphones could therefore bring some benefit in removing this physical cable but could introduce other potential problems such as pairing, perceived security risks and increased complexity, along with being more expensive than conventional 3.5mm analogue headphones. In the case of pairing with Bluetooth devices, here is one possible use case. Audio is sent directly from the self-service machine, such as an ATM, to someone's Bluetooth earbuds or headphones. This would require pairing the first time they used a specific ATM, they would have to press a button on the ATM, then put their headphones into pairing mode. They would not need to pair again the next time they used this particular ATM, but would when they used a different ATM.

Another potential problem is the lack of situational awareness in a public setting. One study that considered pedestrian injuries with trains or motor vehicles found that in some cases pedestrians using headphones were unable to hear horns or sirens from the motor vehicles. As a result, the number of serious injuries linked with pedestrians and headphones more than tripled in six years (Live Science, 2012). Another possible complexity is that blind and partially sighted people may rely more, and in some cases be more sensitive than sighted people, to binaural sound-location cues (Nilsson & Schenkman, 2016). Anything that blocks these spatial cues may also have a negative effect on safety or increase a sense of isolation from the surrounding environment. In the context of using an ATM or kiosk, these cues allow the person to know if somebody is standing next to them or looking over their shoulder. This issue of situational awareness exists for both wired and wireless headphones; any device that reduces the ability to hear sounds from the environment also reduces situational awareness.

A trend which could be helpful with this issue is the migration of technology from the military into the mainstream. A particularly relevant technology is bone conducting headsets which allow users to retain full awareness of ambient sounds thus enabling the wearer to retain situational awareness, and potentially reduce feelings of vulnerability or isolation when compared with wearing over ear headphones or earbuds (Banks, 2019). These bone conduction headsets do have poorer sound quality than conventional headphones but can also be used with hearing aids (Lamkin, 2015). Whilst the lower sound quality is an issue when listening to books or music, it is less of a concern when using a kiosk or ATM where the use time is much shorter, and the voice quality can be lower. However, if people are reluctant to use these due to lower quality audio then they will not want to carry several sets of headphones around. These can, though, be considered an option for people who are concerned about reduced situational awareness. Microsoft used this technology in a pilot navigation device that used three-dimensional, spatial audio cues to aid visually impaired people to navigate a busy city, with participants using a combination of Bluetooth, bone conduction headsets, a smartphone, and Bluetooth & Wi-Fi beacons throughout the route (Moon, 2014, Warnick, 2014). Unfortunately, although these studies do demonstrate the value of using wireless audio, they did not consider the potential disadvantages for use in a public setting; they were paired with a single smartphone that was owned and configured by the person, rather than being paired with multiple self-service machines.

Combining these two trends could alleviate some of the situational awareness issues by allowing ambient sounds, but it is still a potential concern when giving audio feedback in a busy setting where awareness of the surroundings may have an impact on personal safety.

Another growing trend is the increase in prevalence of voice recognition technology, particularly in voice-enabled digital assistants, voice-activated speakers and the like (Matthews, 2019). Some predicted that 50% of searches would be conducted by voice by 2020 (Dormehl, 2014). 13% of US households owned a smart speaker in 2017, this number is predicted to rise to 55% by 2022, with shopping via this voice channel predicted to result in $40 Billion by the same date (Siegel et al., 2018). This prevalence of voice search may alleviate some concerns that currently exist with regards to using such technology in a public environment, with adoption potentially leading to a

change in attitude. Such a change in attitude may vary with demographics. One report stated that 35.8% of millennials used voice-enabled digital assistants at least once a month, contrasting with only 10.1% of baby boomers (eMarketer, 2017). In addition, if the market moves such that more voice-enabled systems are designed for wearable headphones and microphones, this could drive further acceptance as perceived privacy with such a system is likely to be higher.

There has been some work in the area of using wireless audio devices as accessibility aids. For example, Gilmore (2019) proposed that Apple AirPods could be used as an accessibility aid for hard-of-hearing individuals. Gharpure & Kulyukin (2008) proposed the use of robots to provide assistance for independent shopping in a grocery store. Their system included the use of wireless headphones but they made no mention of any issues with such a system. The focus was instead on the benefits that various shopping aids can offer for blind people.

There have been a number of studies that used a variety of wireless technologies to help blind and partially sighted people to navigate. An old study (Loomis et al.,1993) investigated blind people performing navigation tasks. This included an experiment that used FM wireless headphones to give audible cues but focused primarily on the spatial element of the navigation tasks. No issues were mentioned about the wireless audio. Yánez et al., (2016) proposed a system that detects and recognises nearby objects or obstacles. This system did use audible feedback but did not use wireless audio, a speaker or wired headphones were used instead.

Ramsgaard et al. (2016) compared sound quality between different hearing aids that use wireless (in this case, 2.4 GHz MFi), and found significant differences in perceived sound quality of hearing aids, despite the fact that all of them used the same wireless technology. This study was concerned with perceived speech and music quality rather than lag, but still demonstrates the variability that currently exists in the market.

There has been some work on the rise of digital voice assistants. Tulhan & Dhage (2018) conducted a survey of 100 people who used virtual (voice) assistants. Their results showed that many services could now be offered by voice assistants but improvements are still needed, particularly in the accuracy of voice recognition and in understanding and adjusting to different contexts of use. Lau & Leimer (2019) took the positive position that modern applications of artificial intelligence can build trust and empathy thus creating a stronger emotional bond with the customer. This view was somewhat countered by an evaluation with prototype banking voice applications reported by Lambertsson (2017). This study found that perception of privacy (and the desire for different levels of privacy) varied significantly between participants. An awareness of context in order to modify what is said and how it is voiced were proposed to improve perceived privacy, along with customising the solution to match individual user preferences.

However, unfortunately this work all assumes that the wireless audio device is linked to another personal device such as a smartphone or wearable. Similarly, there has been little published about acceptance of voice input in a public space by blind and partially sighted people.

We therefore created an online survey to elicit feedback from blind and partially sighted people as to their attitudes towards using wireless headphones at self-service, along with their reaction to the idea of using voice input and output in a public setting (applying an experience like a voice assistant to a self-service context). This was part of a wider engagement where different technical approaches to using wireless audio were outlined. This paper only covers the general attitude and feedback towards wireless audio and voice input as more detail on the exact technical approach to be used is commercially sensitive. This additional detail may be published at a later date.

It was important to get input prior to making any decisions about the direction that a particular development should take, rather than creating a technical solution that may not support what people actually need or want.

Method

This experiment followed a repeated measures design with all participants completing all questions. However, as this was an online survey, some participants omitted some responses. This might have been partly due to technical issues (as most were using a screen reader in addition to a web browser to complete the survey), or a deliberate omission.

Volunteers were sought through a number of mailing lists, newsletters and online sites in partnership with RNIB (the Royal National Institute of Blind People). All participants had the option of being entered into a prize draw for one of two gift vouchers by way of an incentive.

The survey was designed and delivered using the online tool from Qualtrics. The accessibility of the survey was tested using the automated checker built-in to Qualtrics. However, a number of additional issues were found when testing manually with different combinations of screen readers (VoiceOver, TalkBack, JAWS), browsers (Safari, Chrome, Firefox, Edge) and operating systems (iOS, Android, macOS, Windows 10). Changes were therefore made to the survey to alleviate these issues and make it easier to use in conjunction with a screen reader. It is, however, important to acknowledge that issues can still occur which could have made it hard to fill in the survey and thus may have led to some of the omissions mentioned above. As a result of this potential difficultly, we also had a plain text version of the survey available for those that preferred it, and in one case, the survey was conducted via the telephone (for a participant who had computer issues and therefore was unable to complete the survey online).

Results

38 people participated (27 male, 11 female), all were located within the UK. Age varied from 25 to 75+, with the majority being 45 or over, which fits with the demographic of blind and partially sighted people being older than the general population. The majority of participants (22) reported as blind without any useful residual vision, 12 reported as blind with some useful residual vision, and 4 as partially sighted. The majority were able to read some Braille (26 could, 12 could not).

People were also asked some specifics about how their vision influenced their use of ATMs. The majority (24) were unable to see enough to identify an ATM when walking past it. There were similar results for seeing someone standing close at an ATM (24), seeing where to insert the card (26), and reading the numbers on the ATM keypad (31).

Experience with self-service

The majority of participants had used an ATM, with only 6 having never used one. However, only 9 used an ATM independently all the time, with another 14 sometimes using the ATM independently. 17 respondents reported that they used ATMs with voice guidance.

Headphone & smartphone ownership and experience

Half the respondents own wireless headphones or earbuds (18 currently own, 1 planning on a future purchase, 19 do not own).

The majority of participants:

- Carry headphones when planning to use an ATM (23 do, 3 sometimes do, 12 do not)
- Carry headphones when going out shopping (19 do, 4 sometimes do, 14 do not)

- Occasionally or regularly use wireless headphones or earbuds (17 use regularly, 6 use occasionally, 15 never used)
- Like using wireless headphones or earbuds (20 like, 4 dislike)

The majority of participants:

- Own a smartphone (35/38)
- Use mobile data occasionally or frequently (frequently:21, occasionally:8, pay when needed:1, hardly ever:2, never:6)
- Would be willing to use mobile data in order to use an ATM or kiosk (19 extremely willing, 5 moderately willing, 6 neutral, 5 moderately unwilling, 3 extremely unwilling)

Table 1: Comments on wireless headphones

Positive	**Negative**
• Convenient • No wires • Light weight • Compact • Less chance of breaking • Can use bone conduction headphones with hearing aids	• Battery runs down quickly • Need to remember to charge • Lag issues • Quality isn't as good as with wired headphones • Concerned about using over-ear headphones when using ATM • Difficult to use with a lot of surround sounds • Can't use earbuds with hearing aids • Worry about losing or dropping them

Use of speech input and output at self-service

Opinion was mixed about using voice input at self-service, with 14 wanting to use it, 17 not wanting to, and 7 neutral. The majority of participants preferred to input manually using their phone or the self-service machine instead of speaking (21 prefer manual entry, 7 prefer speaking, 8 neutral).

If speech input was to be used, there was a slight preference for using a phone or headset for speech entry instead of a microphone on the self-service machine, although the majority would prefer to not use speech input (10 using phone or headset, 3 using microphone on self-service machine, 8 neutral, 15 do not want to use either option).

Table 2: Comments about speech input

Like	**Dislike**
• Don't need apps, plugs or smartphone to use • Easier than having to locate buttons • Save time clicking through options • Useful for those with less dexterity • Can use any machine regardless of layout of keyboard • It's very easy	• Being overheard • Standing out even more • Speech not being reliably interpreted by machine

Participants were also asked if they had any concerns about the use of speech input. The most common concerns were being overheard, standing out even more and speech not being reliably interpreted.

Table 3: General comments

• Speech input can be very frustrating but great when everything is working. I doubt it would work well in a noisy environment. • Perhaps ATMs could have an option to speak out loud through their own internal speaker like they do in Canada and in the US. I think this should only be in bank branches and shouldn't be a default option. The user should have to select this rather than headphones. • I would like to see all ATMs and other self-service machines audio-enabled, not just some. • Technology is moving very quickly and it's good to be able to use all machines like everyone else so, adapted machines are a good thing. • Personally, I would still prefer machines to have built in speakers, thus doing away with the need to mess about with headsets, phones, or any such things just to use it.

Discussion

Wireless audio output

Despite the relatively small number of participants, there does appear to be interest in the ability to listen to private audio using wireless headphones and earbuds.

The participants in this study raised some valid concerns, including the privacy and security of the solution, and practical issues such as potential lag in the audio, battery life and remembering to charge wireless headphones or earbuds. There are also digital inclusion issues; not everyone owns wireless headphones, earbuds or even a smartphone. This inclusion issue would be reduced if the option was offered in addition to the current option of a headphone socket, at least for a substantial transition period. This is supported by the results of the survey where about a third of participants never use wireless headphones.

Despite these concerns, there does appear to be some merit in exploring different ways of offering wireless audio, especially as growth in the use of these devices is likely to increase. Whilst attitudes can provide an indicative direction to take when considering emerging technologies, building prototype systems which integrate these emerging technologies enables us to more thoroughly evaluate the advantages and disadvantages that they may offer for future accessible products.

We are therefore planning to investigate different technical implementations of wireless audio output to assess the feasibility of each, which should guide the high-level implementation. In addition, we intend to build a prototype system and conduct a user test with blind and partially sighted people to explore any technical issues, usability and acceptance.

Speech input

Opinion was rather more divided on whether speech input is a feature people would like. For those that liked the idea, there were a number of very positive comments. However, it is clearly a feature that may cause strong negative emotions, so further work is needed to try and understand if it is possible to address the concerns of privacy, security and drawing attention to oneself when using such a system. If speech input became more mainstream, issues of standing out when using such a system would decrease and therefore attitudes may change.

In the immediate future, participants showed a clear preference for manual entry (either via a mobile phone, or directly on the self-service machine) and we shall therefore focus more attention on this input modality.

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