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Introduction.

Since the introduction of Tesla's autopilot system in October of 2015, people have been fascinated by a future that is run by automated vehicles. However, one of societies biggest concerns is the safety of the people in and around the vehicle so this report is focused on creating efficient, effective and concise earcons. The aim is to create earcons that can communicate urgency and also keep the driver informed of the actions and decisions made by the self-driving car. Additionally, it is of the utmost importance when it comes to the creation of safety systems for them to be backed by research so that is what will be covered next.

Research.

In the purest form, an earcon is a way to communicate information through an audio signal. All earcons are important however the most important are the ones that can stop people from sustaining an injury, or worse. Generally, the most common accidents are collisions caused by the operator of the vehicle not paying attention to the road. A particularly harrowing incident would be when Elaine Herzberg was struck down and killed by an Uber self-driving car, the driver was said to be watching television on her phone (Cellan-Jones, 2020). It is to be said that if the driver was aware of the pedestrian then such an accident may never have happened. Very loud noises are often uncomfortable for people with normal hearing. Noises with frequencies ranging from 2,000 to 5,000 Hz are notoriously difficult to listen to. Studies have shown that when exposed to this particular frequency range that it can trigger the amygdala which is responsible for emotional reactions within the brain, this may explain why high-pitched noises make us feel uneasy, fearful, or even panicked (Unknown, 2020). Although using such piercing frequencies may cause discomfort with the people within in the car, it could be split second that allows the driver to swerve out of the way of an obstacle or even to give just enough time to allow the inhabitants of the car to brace for impact.

It goes to be said that self-driving technology is far from perfect, that is why the car needs to give feedback to the driver when necessary, this allows the driver to keep some focus on the road and can also prevent accidents caused by unawareness. Waymo, Google's research team who are currently developing self-driving vehicles revealed that between the dates of January

1st 2019 and December 31st 2019, there were 12 rear-end collisions (one of which was a simulation), 9 sideswipes (8 of which was a simulation) and a multitude of other collisions (Wiggers, 2020). A solution to this could be using proximity sensors on the car blind spots to aid the driver in the decision of whether they should take over to nullify any chance of there being a collision. As an earcon, a logical approach would be to utilise a sweep that would raise the frequency to increase the feeling of urgency depending on how close the vehicle was to an obstacle. However, it is important to differentiate each earcon as to not overwhelm the driver and leave them feeling confused in a moment where a quick reaction may be required. Additionally, most earcons do not need to trigger a quick reaction. Earcons such as low and abnormal battery usage notifications are very important however they can rely on attention-grabbing techniques such as repetition.

Max Patch.

As mentioned in my research, creating a sense of urgency when required is of the utmost importance, so when creating my ‘emergency brake alarm’ I made sure to use frequencies exclusively between 2kHz and 5kHz. The purpose of this earcon is to notify the driver that an emergency stop is about to be attempted. In reality, it would be as soon as possible to give passengers as much time as possible to brace themselves.

Another earcon that uses similar principles but in a less aggressive way is the ‘blind spot detector.’ It works as a proximity sensor in theory but as a patch, I have used multiple presets to show different levels of intensity depending on how close an object is to one of the blind spots. Additionally, I've also updated it so that it pans depending on which side is obscured, to better tell the driver about where they should be paying attention. Furthermore, to aid in differentiating it from the ‘emergency brake alarm’ the volume increases and also I used 1kHz so it is less attention-grabbing.

In addition to the ‘blind spot detector’, I made a ‘reverse parking sensor.’ As mentioned previously, self-driving cars can make mistakes, especially at slow speeds so it is important to have an earcon that informs the driver if the car is about to make a mistake whilst parking itself. Similar to the ‘blind spot detector’ I have used multiple presets to show different levels of intensity depending on how close an object is to one of the blind spots however to aid in the differentiation of the earcons, as the volume increases, so do the frequency.

My fourth earcon is an ‘overtake warning sensor.’ This system's goal is to warn the driver that the autonomous driving system is about to attempt an overtake of a car, bicycle, lorry, or another vehicle. My reasoning for using a delay was a practical one, due to road noise and other distractions a singular tone might not be easily audible however giving the tone decay means the driver is more likely to hear the tail end of it in case the driver misses the initial tone. I used 200Hz and 600Hz to create a more pleasant and calm reaction to the earcon as it may require the driver immediate attention but not necessarily their immediate action.

My final earcon is the ‘power consumption warning.’ The goal of this system is to alert the driver if the vehicle is requiring an excessive charge. Driving up a steep hill, driving on slick or slippery terrain, or driving at unusual temperatures are all examples of this. For this system, I used a metronome that activates a singular tone repeatedly. This is because overusing the battery on a self-driving car can damage it permanently so it repeats until the overuse of power stops (Ingram, 2021).

Personal Reflection.

My aim for this project was to create realistic earcons with realistic purposes for which I could imagine them being used in a practical setting and I believe I have achieved that. However, if I possessed more time I would like to work on more abstract earcons for similar uses and see how far I can push myself. Additionally, I did not feel like using wireless patch chords and sub-patching was that practical in my Max patches and so given the opportunity, I try to use more of those techniques I spent many hours learning.

References.

Articles.

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