AESH

Accessibility Enhanced by Sound and Haptics

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ABSTRACT

The Accessibility Enhanced by Sound and Haptics (AESH) project is designed to analyze and refactor accessibility features within home gaming consoles using enhanced audio and haptic feedback to benefit those requiring the features. Initial tests gauged reactions and ease of use of the accessibility narrator by the test subject within the three major game consoles; PlayStation 4, Xbox One, and Nintendo Switch.

Research for haptic and audio response development continued with the Xbox One and was based on the ideas of psychological conditioning intended to invoke unconscious or semi-conscious responses to stimuli from the console. Audio development was based on core sound design techniques and audience response understanding. This relied on the idea of "bright" affirmative sounds and "dark" negative sounds. Haptic feedback research was based on video game control schemes and discussion about how users effectively interact with the controller to perform actions as well as receive feedback.

Enhancements and modifications were considered beneficial and audio considered beneficial but unnecessary. Each feature is important but would be beneficial to add for accessibility features on operating systems as they will give users that need it an extra level of customization and eliminate some feelings of discouragement related to the stigma of using accessibility-based features.

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INTRODUCTION

The AESH project sought to develop enhancements for the accessibility features on the modern gaming console; primarily the Xbox One, PlayStation 4, and the Nintendo Switch. Accessibility features with greater flexibility and user experience customization will broaden the amount of users with disabilities that may want to use the system but have been discouraged from doing so by either societal isolation or simple inability to functionally use the system. This project primarily develops for and focuses on user experiences for those that are hard-of-sight

Accessibility features are intended to provide greater amounts feedback to the user from the system in ways that cater to the user's needs. The AESH project uses audio modifications and the introduction of haptic response through the controller to provide the user with alternatives to the already present accessibility feedback options. The Xbox One features the most robust accessibility features relative to the other two consoles. The PlayStation 4 includes accessibility features limited to only common and frequently accessed windows. The Nintendo Switch does not include any accessibility features. While all three consoles perform their intended task of being a platform for digital interactive entertainment incredibly well, inclusion of those with greater sensory needs is of varying priority to each company.

AUDIO AND HAPTICS

For users that are hard-of-sight, audio and tactile based feedback are the primary forms of accommodation. This can be seen with portable audio devices providing descriptions in museums, braille, a white cane, etc. These tools and practices were developed to allow those that need them to operate as close to a societal normal as possible. Sounds for AESH were developed using a combination of classical and operant conditioning. A bright sound is played as positive reinforcement to indicate a reward from the system or a dark sound as positive punishment to indicate the input/action was invalid.

The existing audio enhancements modified for this project were:

- Narrator (Microsoft David as default voice)
  - Concise and Verbose versions
- Cursor Navigation Response
  - Affirmative and Negative responses

The haptic feedback was designed and developed with the console's controller in mind and would not require additional hardware for the user. The Xbox One Controller (*Figure 1*) was the device used in testing.

RESEARCH RESULTS

Initial research was done on the already existing accessibility features for each console through a user study. The person involved is hard-of-sight and unfamiliar with the navigation practices relating to each console. The same person performed each trial of the study. All trials began from the home page or initial landing screen for each console and the user was instructed to perform a specific navigational task. "Actions" were left to the user's discretion.

Trial 1: Xbox One

- Task: Navigate to Microsoft Store
  - Result: **Succeeded**
  - Comments:
    - Narrator's voice gave user excess feeling of stress, was too verbose and should cease speaking when cursor moves
    - Announcement of sorting order for structures would be helpful
    - Haptic feedback would be helpful to indicate cursor position behind the narrator's voice
- Task: Open a Game/Application and perform action within it
  - Result: **Partial Success (Not platform related)**
    - User opened app but was unable to perform action
  - Comments:
    - Microsoft does not mandate accessibility features be turned on along with Xbox's, so the application opened, and user was unable to perform any intentional action

Trial 2: PlayStation 4

- Task: Open My Profile and perform an action
  - Result: **Failed (Platform related)**
    - Accessibility feature announced use was not supported in the My Profile window so no action could be performed
  - Comments:
    - Narrator voice is far less stressful to listen to relative to Xbox and was more concise
    - Features were unavailable in areas of interface that were common for user interaction, but not mandatory

Trail 3: Nintendo Switch

- No trial performed as it was discovered the Switch does not included any accessibility features

Figure 1. Xbox One Controller w/ Motor Locations

DEVELOPMENT

Haptic feedback was developed using the vibration motors within the Xbox One Controller. The motors are designed to provide different vibration feedback (low freq left and high freq right). Using the Xinput API, motor speed values were set between 0 and 65535 (unsigned int) depending on cursor action (*Table 1*). 0 being off and 65535 being maximum speed.

Narrator modifications were based on the feedback regarding the narrator's conciseness. Each modification was timed against the default (*Chart 1*). The chart does not include representation for button presses or repeated action timings, but they are present in the "Total Time" row.

Table 1. Motor Speeds and Cursor Action (Speed Values are % of 65535)

Cursor Action	Active Motor	L Motor Speed	R Motor Speed	Duration (seconds)
Up	*Both*	*25%*	*50%*	*1*
Down	*Both*	*25%*	*50%*	*0.5*
Left	*Left*	*50%*	*0%*	*0.5*
Right	*Right*	*0%*	*75%*	*0.5*
Select	*Both*	*10%*	*20%*	*0.25*
Invalid Op	*Both*	*25%*	*50%*	*1*

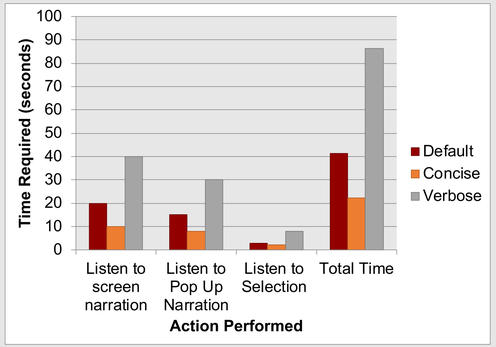

Chart 1. Graph of Narrator Timings Based on Modification Series

TESTING

Due to the nature of the Xbox operating system and Microsoft's proprietary development criteria, testing had to be done without a true connection between the integrated elements and the Xbox One.

Another User study was performed with the same person. Audio and Haptics were tested in presentation with general Xbox One home screen interactions. They were presented a simulated audio or haptic response when it should have been triggered by the cursor movement. The negative audio option was presented conceptually with the sound attached to the positive punishment concept as it applies to the Xbox One rather than practically in true interface experience

RESULTS AND CONCLUSIONS

- Additional audio responses, though beneficial were deemed unnecessary by the test subject
- Haptic feedback was considered extremely helpful in acknowledging cursor movement
  - Motor variations and vibration patterns would need to be reconfigured
  - Vertical direction feedback shook controller more violently than subject's preference
  - "Select" action response felt strange. Effective, but uncomfortable
  - Alternating side motor distinctions remained slightly too similar despite different speed percentages
- The combination of haptics and narration proved helpful
  - Lowered stress in subject as haptic feedback gave illusion of participation rather than simple "lecture and consider" concept
- Haptics and no narration was helpful to indicate cursor position
  - Though was unnecessary if the cursor could be seen without high contrast mode

Audible feedback is not as critical of an addition, but Haptic feedback and a more concise narrator would be the first features to implement. The additional features presented would allow the Xbox One to enhance its accessibility features to those that strive for the closest to normal configuration of the system

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