AUDIOM: AN AUDITORY WEB-BASED GEOGRAPHIC MAP VIEWER SHOWING COVID-19 STATE DATA AND A TRAVEL MAP

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ABSTRACT

Audiom aims to provide an interactive auditory interface to present spatial relationships from geographic data through the web browser. Any of these maps could be embedded next to an existing visual map and show the same data in audio. There are two maps that are presented here, a COVID-19 state by state choropleth map, and a travel map showing buildings, streets, and other information that one may find in a Google map. The motivation was to create an interface where users can functionally answer questions evaluating spatial knowledge, such as: What state bordering California has the highest number of COVID cases? Or What clock face direction is Wells Fargo when standing on Joya restaurant? These maps are meant to communicate the same information as the visual representations of the same map data. All the sounds were designed to help users functionally use the interface and were based on past research projects as well as audio games - games that can be played completely in audio. Both interfaces extensively combine speech with audio to provide precision and context that is difficult to present exclusively through sounds, such as exact values, distances, and names. Most testing has been performed on blind and visually impaired individuals (BVIs) and feedback from users outside this population is desired.

1. MEDIA CONTENT EXAMPLE

Note that both these examples require headphones. The videos may be outdated, but show a good representation of the interface as of June 2022. For the latest information, visit audiom.net. To provide feedback, email audiom@ski.org, or submit feedback using the button at the top of every page on audiom.net.

1.1. Audiom Address Search:

Video:
https://www.youtube.com/watch?v=kY6w7U2uxYc&feature=emb_imp_woyt
Demo:
https://audiom.net/

Click the Login or Signup button and either create an account or use:
audiom@ski.org
for the email and
Audiom1!
for the password.

There are some videos on this page that show the maps in action. To search for an address, enter the address in the edit field and click the "Go" button or press the Enter key. There is an autocomplete to help find the address. A good location we use is:
Joya Palo Alto

Once you log in, there will be an edit field; type the above text, press the Down Arrow key, and press Enter. The screen will change and present: "Loading…" for about 10 seconds. If the page does not load after 20 seconds, refresh and it should load after 10 seconds. The web page will eventually show a visual map and a button that says "Audio Map On". The interface focus should be on this button by default, but if not, click on the button. Press the arrow keys to move around, and press "p" to turn on and off the sounds. Once you log in, a tutorial can be found at:
https://audiom.net/tutorial

The other commands are found by pressing "h" when focused on the audio map button (these will always be the latest commands), and are described below.

1.2. COVID-19 Map Viewer:

Video:
https://www.youtube.com/watch?v=vISYiHcZM-U&feature=emb_imp_woyt

Demo:
https://audiom.net/map?source=covid_daily
Note that you need to log in using the above info before clicking on this link, or you may only see a blank page.

2. AUDIOM DESCRIPTION

Audiom aims to provide an interactive auditory interface to present spatial relationships from geographic data through the web browser. Any of these maps could be embedded next to an existing visual map and convey the same data via audio. The team is building a software development kit that can be used by other applications and can modify the experience. There are two maps that are presented here: (1) a state-by-state choropleth map of COVID-19 cases; and (2) a travel map showing buildings, streets, and other information that one may find in an Apple or Google map. The motivation was to create an interface where users can functionally answer questions evaluating spatial or geographic knowledge, as described in [1] and [2], such as: What state bordering California has the highest number of COVID cases? Or…What clock face direction is Wells Fargo when standing on Joya restaurant? The interface is meant to be useful in daily life and communicate the same information as the visual representations of the same map data. All the sounds were designed to help users functionally use the interface and were based on past research projects as well as sound design approaches that are commonly used in audio games - games that can be played completely in audio [3]. Both interfaces extensively combine speech with audio to provide precision and context that is difficult to present exclusively through sounds, such as exact values, distances, and names. Most testing and evaluation of the interfaces in Audiom has been performed by blind and visually impaired individuals (BVIs); as such, additional feedback from users outside this population is desired.

The system runs in any modern browser, such as Chrome, Firefox, and Safari on any platform, e.g., Windows, Mac, Android, and iOS, and requires a keyboard and headphones to use. Audiom requires no special installation, and one only needs a URL to begin using the system. The main premise behind the Audiom experience is that the user is an avatar moving through the coordinate plane, interacting with objects under and around the current user position. Pressing the Up Arrow key will move north by the designated distance; likewise, Left Arrow moves west, Right Arrow moves east, and Down Arrow moves south. Each time the user moves into a new position, a short sound plays, representative of the object the user's avatar is on top of, combined with the names of objects spoken in speech. A more extensive description of the Audiom interface can be found at the website (audiom.net), in [4], and [5].

The COVID-19 heatmap in Audiom has two interfaces– a tabular view and a geographic view–and is based on iSonic [2]. Our evaluation study compared spreadsheet tables vs. the iSonic-like interface (with both a tabular and geographic view), and found the seven BVI participants were 20% accurate when using a table and 95% accurate when using the audio interface when answering geographic questions. Participants using the iSonic-like Audiom interface found the tabular view combined with the geographic view extremely effective. They also appreciated the sounds mapped to statistical values that were present on both the views. Many of the iSonic features, such as the sonic sweep quickly playing sounds in part of the map, are not present in our implementation of an audio map, mostly due to their questionable effectiveness, or difficulty to create. The Audiom interface does extend the iSonic interface by allowing users to use their own screen reader, which is preferred by users, and by having the user move through the geographic map by kilometers rather than by jumping to a new state each key press [4]. Allowing movement by kilometers allows for basic shape recognition, and makes recognizing borders much easier [4]. Another difference is that Audiom uses a procedurally generated group of oscillators, rather than sampled sounds (which iSonic uses), because sampled sounds are large to download, may not render well on all hardware, and have limited support in the browser. The simplification of the iSonic interface into the Audiom interface seemed to minimally increase performance in [5] from 95% to 100% accuracy when answering one geographic question, although more testing needs to be performed. Audiom also takes significantly less time to learn than iSonic, as the entire one-hour study session of [5] was the same length as just the training time designated for iSonic.

The travel interface in Audiom is based on the Team interface, and also combines audio game conventions, such as free movement and multiple modes of navigation [3], [4], [6], [7]. Users enter an address into the search box and press the Enter key, and a bounding box of data is downloaded from OpenStreetMap [8]. Users then press arrow keys to navigate around one meter at a time through the map. The step size can be increased or decreased by pressing "+" or "-" respectively. Pressing "p" will turn on looping surround sounds of objects, such as the sound of cars to represent a road. The sounds are played using the PannerNode in the Web Audio API, and use the default HRTF model to control sound volume [9]. This spatial audio was also presented in the Team system to represent nearby objects [7]. In Audiom, speech messages of intersection names, a scan of the area, and information about current objects were also combined with the audio, similar to Team. The main difference between Audiom and Team is the use of free movement. Team controlled user movement to make the user follow roads, but Audiom leaves following roads up to the user. User testing from [4] revealed that users did want to be blocked sometimes when moving out of objects, so in the current Audiom version, borders around an object can be turned on by pressing "b" and selecting the object from the menu. To turn off borders, "b" can be pressed again. This will allow users to navigate around the polygon or along a road without going outside the object's borders. When the user hits the border, a collision sound plays, and the user remains at their current position. Borders reduce the number of keystrokes it takes to traverse a shape in half, as users don't need to retrace their movement. In Audiom, roads are converted into polygons to give them some dimension, similar to how they are one or two pixels on a visual map. To access items on the map, an object menu can be opened by pressing the "m" key, and a Nearby Objects menu can be opened by pressing "shift+m". In these menus, first-letter navigation or up and down arrow keys move through the items, and the Enter key selects the item. Escape exits the menus. A scan can be done of nearby objects by pressing "s".

The Audiom interface aims to functionally allow the acquisition of spatial knowledge from geographic information through audio. Maps have been extremely expensive and difficult for BVIs to obtain, leading to many BVIs only interacting with fewer than one map a year on average [10]. With Audiom, BVIs can create a map of anywhere in the world for free, and hopefully obtain enough spatial knowledge to have a mental overview of the space. Choropleth maps can also now be represented in an easy-to-understand interface on the web, creating the new baseline for accessibility for geographic web viewers [11].

3. ACKNOWLEDGEMENTS

4. CONFLICT OF INTEREST STATEMENT

BB is the founder of XR Navigation, a company aiming to commercialize Audiom. Learn more at audiom.net.

5. REFERENCES

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