WAVEOUT

NAVIGATE THE WORLD THROUGH SPATIAL SOUND

Quick info

Developed by: Dreamwaves

Headquarters: Austria

Year of Release: 2022

Awards: Born Global Champion Award 2023 (Top 15), myEUspace 2022 (Top 10), Social Innovation Tournament 2022 (Winner), Altice Internacional Innovation (Inclui) Award 2022 (Winner), Gewinn Best Austrian Small Companies 2021 (Top 100), MyGalileoSolution 2020 (Top 20), VCO Mobility Prize: Digitization and Automation 2019 (Top 5)

Website: https://www.dreamwaves.io/

Product type: Mobile application; navigation system

Space technologies: GNSS

Primary application: Visual impairments

What does WaveOut do?

WaveOut is a mobile application which uses spatial audio to provide hands-free navigation instructions to pedestrians (visually impaired and sighted alike) and cyclists. Its main feature is a navigation interface which allows users to select an end location, then uses directed audio cues to inform users whether they are on the correct path and when they should turn or adjust their course. In addition to the audio cues, there is the option to hear verbal instructions.

Because WaveOut uses spatial audio, which seems to consistently be coming from a certain direction when wearing headphones, individuals who are blind or visually impaired can use the app to hear which direction to travel in. While non-spatial audio can be directed (a sound can come from just the left earbud, for example), it is not externalized (it seems to come from inside the user's head) and it does not account for the user's orientation. Spatial audio combined with augmented reality can ensure that a sound always seems to be coming from north, for example, even as a user turns and moves. As an individual follows the direction of the sound, there is no need to read instructions or look at an on-screen map, making the navigation experience entirely accessible for those who are blind or visually impaired.

For individuals who are sighted or visually impaired, there are three on-screen display options as the user navigates (in addition to not viewing the screen at all). The first is written instructions which specify how far to walk and when to turn or cross a road, the second is a high-contrast map illustrating the route, and the third is an augmented reality option which shows the user's current view with directions superimposed.

In addition to its navigation abilities, WaveOut also offers an "Around Me" feature which lists points of interest near the user. Points of interest include historical sites, parks, restaurants, shops, tourist attractions, and other notable locations in the user's vicinity. Each is classified with a set of tags which describe the site as well as its distance from the user. Users can also search by tag to find points of interest which meet certain criteria.

How does WaveOut work?

The satellite positioning behind WaveOut's navigation technology works similarly to other mobile navigation apps. WaveOut relies on the Galileo satellite navigation system, in addition to other GNSSs. A global navigation

satellite system (GNSS) is a constellation of satellites orbiting Earth which provides positioning information. These systems can be local or global (generally overlapping to provide more precise data), and they send out signals which mobile phone GNSS receivers can receive. When the phone receives a signal, it is able to calculate how far it is from the satellite; it can then triangulate after receiving signals and therefore distances from multiple satellites in the system, allowing the phone to sense the user's exact location. As the user moves, the phone and relevant GNSS systems continue to communicate to update the user's location in the navigation app.

Also, like other navigation apps, WaveOut uses a machine learning algorithm to determine the shortest route to an end destination. This algorithm (solving a multi-armed bandit problem) compiles the times multiple users took to complete segments of their routes, then runs through possible combinations of segments to determine which combination of turns and roads will be fastest.

Once a GNSS connection communicates a user's location to the app, the user's position as well as data from the phone's back-facing camera is used to determine which direction the user is facing. The app then communicates with the user's headphones to produce spatial audio.

Spatial audio is capable of producing sound in 360 degrees so that individual sounds seem as though they are consistently coming from a certain direction, thereby directing the user in that direction. This is used both to tell the user that they are headed in the right direction (through regularly spaced markers which, as a user passes through, make a noise) and to notify the user that it is time for them to turn or change course.

> *"WaveOut is unique in combining its navigation abilities with spatial audio so that users can hear which direction to travel in."*
>
> *-Hugo Furtado, founder and CEO of WaveOut*

The app's visual augmented reality option uses the phone's built-in camera to observe the environment around the user, then add directions (based once again on the user's position) onto the images which the camera produces. This visual output updates as the phone camera updates, making it seamlessly adapt as the user moves and turns.

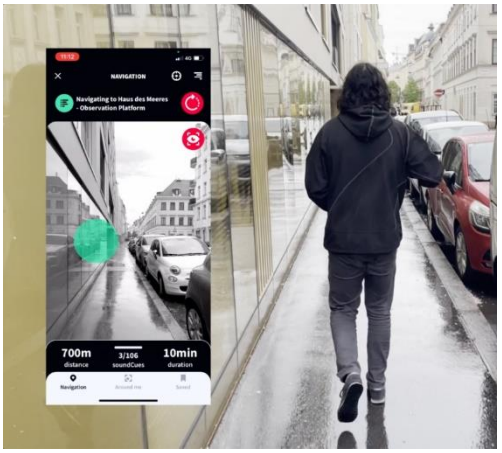
Who can WaveOut help?

Anybody can use WaveOut, regardless of disability status, and the app employs universal design principles so that all users can benefit. WaveOut was originally designed with blind and visually impaired individuals in mind as one of its user bases. Through WaveOut, blind and visually impaired individuals can navigate without relying on visual cues from their environment or from the app and can learn about their surroundings through audio descriptions. The app is also designed to leave hands free for a white cane, guide dog, or other hazard detection aid.

While not its original intention, WaveOut could potentially also be useful to individuals with motor impairments. Because it provides a hands-free navigation experience, individuals who lack motor control of their hands or who rely on their hands to use a mobility aid while moving can also use WaveOut to navigate safely.

How is WaveOut being implemented?

As of July 2023, WaveOut is available to consumers worldwide (wherever GNSS navigation is available) as a free mobile app through both the Apple App Store and the Google Play Store. Currently, English, Portuguese, and German language options are supported. While searching for destinations requires an internet connection, navigating to saved destinations does not.



Credit: Dreamwaves

An Interview with Hugo Furtado, WaveOut's Creator

What was your motivation behind creating WaveOut?

The motivation came from two passions that I have. I worked in augmented reality in the past; I did my PhD in visual augmented reality that helped surgeons perform closed chest cardiac surgery. We made a very difficult task very easy by allowing the surgeons to see something inside the body that they normally couldn't see. For me, this was an eye-opener on how you could use digital content embedded in the real world. My other passion is sound. I love music, so I did sound design for films, and at some point, I thought, "what about audio augmented reality?" That was the motivation to start figuring out the technology. I don't like to do things just because, so I started thinking about use cases. I thought about using audio augmented reality for navigation, and from there, the application to blind people felt natural.

> *"We want people to see the world through their ears."*

Do you have a favourite feature of the app?

My favourite feature is the concept itself: you have something around you telling you where to go. I think another great feature, which we didn't invent but we did put in, is the "Around Me" feature. When you select it, you start listening to spatial audio describing the shops and places of interest around you as well as the streets that that come by when you're walking. I think that's very nice.

How does WaveOut use satellite technology?

We basically live on GNSS location data, which comes from satellites. We are very heavily dependent on the positioning that we receive from satellites. From then on, we fuse that with computer vision, phone sensors, and headphone sensors. The full location algorithm is then customized to make it even more precise. But we really live on GNSS, and the better it is, the better our product is. We put a lot of our focus into trying to use Galileo to get better accuracy. Satellite technology is basically the core of the algorithm.

Have you faced any challenges in your product's development? Has it been difficult convincing stakeholders that accessibility is important?

It was very easy to convince people that blind people need better navigation. That's very intuitive. It's also easy to convince people that bikers should not look at their screen and could benefit from audio navigation. I think it's not so easy to convince people that anyone could benefit from hands-free navigation. Navigation is a challenge for everyone. Even using the visual maps on most navigation apps takes effort. What we do is try to make that effortless. If you need to go left, you hear a sound from your left and you recognize what it means. You just follow the music. People constantly ask me, "Why would I want that when I can already hear verbal directions on other navigation apps?" Why not put your phone in your pocket if you already have verbal instructions? You can't pinpoint why, but it doesn't work well. It's tougher to convince some people, but at the end of the day, everyone feels the pain.

While it's compelling, and true, to point out that blind people need more support, fundraising can still be difficult. For traditional venture capital investment, accessibility projects are always a niche, and for conventional VCs, this market is too small. We had to make it part of our strategy to show that hands-free navigation is also useful in many other situations and for a large user base. The fundraising mindset is also changing now that impact investment is more popular.

It's also challenging to develop an app for blind people because it's much more effort than a normal app. You have to be careful with many more factors, and your design must be much better. It takes three or five times longer to develop than non-accessible projects, so you need to accept that you might make slower progress than you want.

How did you work with blind or visually impaired people while you were designing the app?

This was a key point for us. We've worked with blind and visually impaired people since development began. I started coding this spatial audio because I thought it was interesting and then decided to apply it to navigation, as I said before. The first thing that I did after realizing the concept could work was to go out and talk to people. Before starting to build an app for blind and visually impaired people, I wanted to understand what challenges they face, in their own words. I discovered I was very ignorant. Sighted people have a feeling that blind people face fewer challenges than they actually do. We see blind people on the street, moving around, but these people are only a tiny fraction of the of the blind and visually impaired people in the world. After talking to some blind people, I realized that navigation really is a huge challenge for them.

Then I gathered a team, and we started doing workshops where we had more structured interviews. We provided current navigation tools to blind and visually impaired people and asked them to navigate to a certain address. We observed which aspects were difficult, then went through feedback rounds and code design rounds. At every step, we tested the product with blind and visually impaired people.

Do you have any plans for new features to add to WaveOut or new projects to pursue in the future?

Definitely. We have so many ideas. We are in the process of developing indoor navigation with a content management system where building owners can log in and define their own routes. For example, supermarket owners could draw the route that a blind person needs to take to buy a typical set of groceries. They will be able to tell users to stop in certain locations to hear what a product is and pick it up.

We're also talking to tourism offices to implement a similar feature outdoors. We want to promote accessible tourism by creating routes through their cities where you can hear the stories from the monuments and points of interest around you. The content management will be similar to the indoor version. You can define a route which takes you through certain streets, indicate points of interest, and add audio to tell the story behind a point of interest. If the user goes closer, they can hear more details. We're hoping that these new types of content management will both improve the user experience and make the app more marketable to businesses.

> *"I used to say to people that of course sight and vision are super important; there's no question about that. That being said, you see in 180 degrees, but you hear in 360. Hearing is the only other sense that's spatial and 3-dimensional."*

Any parting thoughts you want to share?

The way I see it, navigating is a task. If you go to a restaurant and your friend says, "I know where it is. Just follow me," it's always much easier than if you are navigating. You have to pick up a map, look at it, and look at the world around you. You can learn to get better at it, but it's a task. We want to ensure it's no longer a task. If you want to go somewhere, you can just walk, relax, and know you'll get there on time. You don't have to expend any effort; instead, you can look around and enjoy the world. That's the paradigm shift that we would like to enact.

ABOUT

This article is part of the "From Space to Earth: innovations enabling accessibility on Earth" project under the United Nations Office for Outer Space Affairs Space for Persons with Disabilities initiative. This project aims to raise awareness of the benefits of space technologies, spinoffs and related innovations in addressing challenges of disability, and to foster international and interdisciplinary collaborations on technological solutions to advance accessibility and empower persons with disabilities. This project contributes to the implementation of SDG 10: Reduced inequalities.

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