# Towards a Generalized Acoustic Minimap for Visually Impaired Gamers

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## ABSTRACT

Video games created for visually impaired players (VIPs) remain inequivalent to those created for sighted players. Sighted players use minimaps within games to learn how their surrounding environment is laid out, but there is no effective analogue to the minimap for visually impaired players. A major accessibility challenge is to create a generalized, acoustic (non-visual) version of the minimap for VIPs. To address this challenge, we develop and investigate four acoustic minimap techniques which represent a breadth of ideas for how an acoustic minimap might work: a companion smartphone app, echolocation, a directional scanner, and a simple menu. Each technique is designed to communicate information about the area around the player within a game world, providing functionality analogous to a visual minimap but in acoustic form. We close by describing a user study that we are performing with these techniques to investigate the factors that are important in the design of acoustic minimap tools.

## CCS CONCEPTS

• **Human-centered computing** → **Auditory feedback**; *Accessibility technologies*; Accessibility systems and tools.

## KEYWORDS

Audio navigation tools; acoustic minimaps; blind-accessible games; visual impairments

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## 1 INTRODUCTION

Mainstream 3D video games are largely inaccessible to visually-impaired players (VIPs) because they often lack crucial accessibility tools [4, 17]. Although some recent mainstream games [6] have made strides in making certain in-game abilities accessible to VIPs, many crucial abilities still remain inaccessible. Among these is the ability for the player to perceive and understand the layout and shape of their surroundings, which prior work has established is crucial to granting VIPs with an enhanced sense of space, presence, and fun within the game world [1, 3, 23].

Video games often use *minimaps* to communicate information about the player's surrounding environment. A minimap is a small map that is visible in a corner of the game screen [25]. Minimaps help sighted players determine their local position and orientation within the game environment, as well as the contents and layout of the area. Specifically, as various authors have described [5, 12, 20, 25], minimaps offer players the following affordances:

(1) The surrounding area's shape.
(2) The surrounding area's size (scale).
(3) The presence and spatial arrangement of items in the area.
(4) The player's position and orientation within an area.
(5) Nearly real-time access to all of the information above (1–4).
(6) A sense of immersion within the game world.

A major accessibility challenge is to create a generalized, acoustic analogue to the minimap for VIPs. It should grant the same affordances that a visual minimap grants but using sound instead of visuals or haptics (the latter often requiring special hardware).

In this work, we develop and investigate four different methods of providing an acoustic minimap: a companion smartphone app, echolocation, a directional scanner, and a simple menu of points-of-interest. These techniques represent a wide range of possibilities for providing VIPs with a better sense of the space around them. Creating a generalized, acoustic minimap can help make the experience within games more fun and fulfilling for VIPs. We close by giving an overview of our planned user study.

## 2 RELATED WORK

Our work builds from a history of tools and techniques for communicating spatial layouts to VIPs, which were designed for both virtual (video game) environments and the real world.

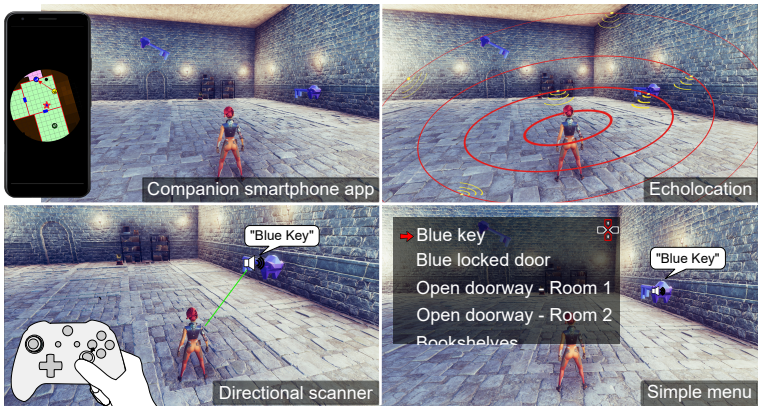


**Figure 1: Depictions of our four acoustic minimap techniques: a companion smartphone app, echolocation, a directional scanner, and a simple menu of points-of-interest.**

Regarding tools made for virtual environments, many audio-based games created for VIPs — games such as *Terraformers* [16, 22], *A Hero's Call* [15], and *Shadowrine* [10] — present the world and/or its contents in the form of lists and grids. However, mainstream games for sighted players do not confine users to such structures — they allow for free, unrestricted movement within a 3D game world. As a result, list- and grid-based presentations cannot be generalized to *any* type of environment or play style.

Regarding tools made for the real world, many mainstream blind navigation systems such as NavCog3 [18] and Microsoft Soundscape [11] give users a very limited sense of awareness of their surrounding environment. Although these systems provide users with a near-real-time sense (#5) of their position and orientation within an area (#4), they do not provide information about the area's shape and size (#1 and #2) and may provide only limited information about the arrangement of items within the area (#3).

Another technique is echolocation, which has been explored for both real [9, 14, 19] and virtual [1, 2] environments. Echolocation can allow individuals to learn about the structure of the area they are in, including the locations and physical properties of nearby objects [19]. As it satisfies the six minimap affordances from the Introduction. As such, we are currently exploring echolocation in the context of these six affordances.

## 3 ACOUSTIC MINIMAP TECHNIQUES

We created four techniques for facilitating an acoustic minimap that are inspired by existing tools and techniques for communicating spatial information via sound. Each technique is designed to communicate information about the area around the player within a game, satisfying the affordances of a visual minimap to varying degrees but in acoustic form. It is important to note that none of these techniques are intended to act as a perfect acoustic minimap tool. Rather, we are using the tools that we develop to discover which factors are important when designing an acoustic minimap.

The four techniques (shown in Figure 1) are as follows:

(1) *Companion smartphone app:* A smartphone-based tool that allows VIPs to survey a minimap of their surrounding area by dragging their finger along their phone's touchscreen. This technique is inspired by previous work exploring touchscreen-based maps for VIPs [7, 8, 24].
(2) *Echolocation:* A tool that allows players to emit a mouth click-like sound in all directions and uses the physical properties of the game environment to simulate reverb.
(3) *Directional scanner:* A tool that allows players to point the game controller's right thumbstick in any direction to hear what lies directly in that direction relative to the player. This technique is inspired by NavStick [13].
(4) *Simple menu:* A status-quo tool that presents a list of points-of-interest in the player's surrounding area. Players can "select" a menu item to place a looping audio beacon at the corresponding item's location.

## 4 USER STUDY

Our user study has three goals: (1) to determine what factors are important to designing acoustic minimaps within games, (2) to see how well each of the four techniques satisfies the affordances that minimaps should provide (#1–6 mentioned previously), and (3) to establish which technique(s) VIPs prefer and why.

We are developing a representative 3D adventure game in the Unity game engine [21] as a testbed for the four techniques. In our game, players must escape a multi-room dungeon by collecting keys and other objects to solve puzzles. We will ask participants to play the game using all four techniques: one per game level. We will then ask them to provide their general impressions of each technique and to evaluate each with respect to the six affordances.

We hypothesize that each of the four techniques will have its own advantages and disadvantages over the others, depending on the player's current goal and the type of environment they are in. Although much of the research community's focus has been on exploring simple menus (Technique 4) and echolocation (Technique 2), the research community can benefit from comparing them with each other and comparing them against other options (Techniques 1 & 3). Ultimately, we plan to use the insights from our study to develop a new set of principles for developing acoustic minimaps, which can make mainstream 3D games more blind-accessible and make gaming a more fun and fulfilling experience for VIPs.

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