

## Original Research Article

# Using Augmented Reality to Enhance the Nature-Based Tourism Experience for the Blind

## (Gilan Province in Focus)

Hamideh Beigi\*

*Assistant Professor, Geography and Urban Planning Department, Literature and Humanities Faculty, University of Guilan, Rasht, Iran.*

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**Abstract** Nature tourism, with its unique landscapes and features, can pose numerous challenges, particularly for blind individuals. However, augmented reality (AR), as an emerging technology, offers the potential to provide this group of tourists with unique sensory and visual experiences, enabling an immersive interaction with nature through sensory compensation.

This study focuses on the design and evaluation of an AR system aimed at assisting blind tourists in visualizing objects and spaces associated with nature-based attractions in Gilan Province. Through audio narration and tactile 3D models, the system offers a rich, interactive experience of natural environments for blind individuals. The present research is applied in its purpose and descriptive-qualitative in its methodology. For data collection related to producing audio narration, observation, and note-taking methods were employed. Interviews and closed questionnaires were also used to evaluate the effectiveness of the AR technology. Findings indicated that the optimal type of narration for conveying visual impressions in nature tourism experiences for the blind is the "general-specific" narration. This type of narration effectively conveys visual impressions through informative, relational, and precise sentences about locations, distances, directions, textures, and colors. Additionally, suitable materials for constructing 3D tactile simulators of nature include newspaper coated with real or semi-real substances such as soft sand for simulating beaches, river pebbles for representing elevations, and damp cotton for simulating water.

Based on feedback from the study's sample group (12 blind individuals who completed their studies at the University of Guilan), the use of AR technology was deemed effective in aiding blind people to visualize natural tourist attractions and enhancing their tourism experience. Among respondents, 58% strongly agreed, 33% agreed, 8% were neutral, and 0% disagreed or strongly disagreed with the system's impact. This research identifies opportunities and challenges in using AR for sensory compensation in blind tourism and offers practical recommendations for the development of similar technologies in other tourism and recreational areas tailored to the blind community.

**Keywords** *Sensory compensation, Accessible tourism, Augmented Reality, The Blind, Gilan Province.*

**Introduction** Tourism is one of the world's most significant industries, playing a considerable role in enhancing the quality of life, cultural interactions, and economic growth (Karoubi et al., 2020, 64; Seidaiy & Rostami, 2013, 96). However, this industry has yet to fully address the needs of all societal groups. Participation in cultural, recreational, leisure, and sports activities is essential for everyone, and these opportunities should be accessible to all members of society. Yet, people with disabilities are often excluded

from a broad array of these opportunities (Basouli, 2020, 52). Among them, blind and visually impaired individuals face severe challenges in accessing tourism experiences, often missing out on the enjoyment of natural and scenic environments (Hersh & Johnson, 2008). As a cultural, social, and economic activity, tourism is critically important, and equal access to it could greatly improve the quality of life for blind and visually impaired individuals (United Nations World Tourism Organization, 2016). Such access has positive impacts on physical and mental health, fosters

\* Corresponding Author: h.beigi@guilan.ac.ir

social interactions, and enhances a sense of belonging within society (Darcy & Dickson, 2009). However, due to visual limitations, visually impaired individuals are often deprived of these experiences (World Health Organization, 2011).

Based on the principles of accessible tourism and “tourism for all,” individuals with disabilities in any of the five senses have an equal right to enjoy the benefits of tourism. Accessible tourism, by providing necessary facilities for disabled individuals, including the blind, deaf, mute, elderly, pregnant women, and children, allows everyone, from children to the differently abled, to experience tourism opportunities fairly and with dignity (United Nations World Tourism Organization, 2016). Some of the first organized efforts to make nature-based tourism accessible for people with disabilities began in the early 20th century. For instance, in 1916, the U.S. National Park Service developed programs for people with disabilities in national parks (Meldon, 2019). Around the same period, European countries like Germany and the UK also started creating nature-based tourism facilities for people with disabilities. During the 1960s and 1970s, increased public awareness of the rights of individuals with disabilities brought further attention to nature tourism for disabled individuals, leading to the establishment of numerous non-governmental organizations promoting accessible tourism services (Smith, 1987). Since the 1990s, with the expansion of the concept of “accessible tourism” and the development of protective laws for people with disabilities, there has been a marked increase in attention to nature-based tourism for the disabled. Today, many tourism destinations strive to enhance accessibility and offer tailored services for this group of tourists (Darcy & Dickson, 2009).

Augmented Reality (AR), as one of the most advanced emerging technologies, has brought significant changes across various sectors. By overlaying digital layers onto the real environment, AR has impacted fields such as education, gaming, healthcare, and tourism (Azuma, 1997). AR combines virtual and real data in a three-dimensional and interactive format (Rafizadeh Akhavian et al., 2016, 20). Rather than simulating the real world, AR enhances it, providing new perceptions and defining unexpected abstract relationships between actions and outcomes (Foroutan Yekta & Rezvani, 2019, 24). In recent years, this technology has gained attention in the tourism industry, offering opportunities to enrich natural environments with additional informational and experiential layers (Lensing & Broll, 2011).

One novel application of AR is in tourism for the blind. The use of AR in enhancing the tourism experience for the blind, especially in natural settings, presents a unique opportunity to offer meaningful, interactive experiences for this segment of the population (Allcca-Alarcón et al., 2023). Previous

research indicates that AR-assisted technologies have considerable potential to improve the tourism experience for the blind. Tools such as tactile models, touchable images, and audio narratives can help blind individuals better familiarize themselves with natural environments and have a meaningful experience of nature tourism (Klatzky & Lederman, 2003). When combined with AR, these tools can create even richer, more interactive experiences. AR can provide precise and dynamic information about natural environments, offering the blind a closer-to-reality experience (Guerrero et al., 2020). For example, 3D sounds, audio descriptions, and tactile interactions can enable blind individuals to experience natural settings in a meaningful way. This technology can deliver experiences typically inaccessible to the blind, such as the sensation of being in a forest, hearing birdsong, and feeling a gentle breeze (Poria et al., 2011). Additionally, the role of intentional narratives, expressed through evocative messages and interpretations of nature’s landscapes, can significantly impact the perception and interpretation of these experiences for blind audiences (Hemmati et al., 2022).

The Gilan Province, endowed with natural resources, is continually regarded as an attractive nature tourism destination. However, due to a lack of accessible tourism facilities, some individuals are unable to benefit from the scenic appeal of these sites, among them the blind. To create equal opportunities for nature-based tourism in Gilan Province and improve tourism facilities, this study was piloted across three accessible natural tourism sites in the province: Lonak Waterfall in Deylaman, Khaleh Sara Beach by the Caspian Sea in Talesh, and the Selkeh Wildlife Sanctuary in Someh-Sara.

This study seeks to answer the question: How can the application of augmented reality in nature-based tourist attractions enhance the perception and tourism experience of the blind? To explore this, we draw upon sensory compensation theory to address adaptive strategies that enhance the perception and enjoyment of experiences, particularly for individuals with visual impairments, through alternative senses such as touch and hearing. The AR technology employed in this study aids the blind in visualizing the main tourist attractions of each site. Through providing detailed descriptions and audio narratives of the landscape and environment, experienced through headphones, the technology enables interactive experiences similar to those of other tourists. These narratives are supported by appropriate background sounds (the natural sounds present at the tourist site). Additionally, 3D models of the main tourist attractions are provided to blind visitors, allowing them to better understand the shapes of natural phenomena and elements of the site.

This study aims to fill the research gap by identifying optimal AR structures for enhancing the experience of blind tourists in nature. It addresses three key questions: 1) What narrative structures effectively convey visual impressions to the blind? 2) What materials are suitable for constructing interactive 3D models that convey visual information to the blind? and 3) To what extent can augmented reality assist blind individuals in visualizing nature-based tourist attractions?

## Research Background

In the field of Accessible nature tourism and using the “Sensory Compensation” approach, one notable case study comes from Yosemite National Park in the U.S. In this study, blind and visually impaired visitors were able to gain a deeper understanding of the natural environment by relying on their senses of touch and hearing. For example, feeling the texture of rocks and hearing the sounds of waterfalls helped them experience the park’s features in a more tangible way (Rosenblum, 2000). Another study was conducted in Olympic National Park in the U.S., where deaf and hard-of-hearing individuals used their visual and tactile senses to recognize details of the natural surroundings and engage meaningfully with the environment. Tactile interaction with leaves and observing animal movements allowed them to gain a deeper understanding of the park’s ecosystem (Franco et al., 2017). Additionally, a case study in Glacier National Park in Canada demonstrated how individuals with physical disabilities used mobility aids and adaptive equipment to actively engage with natural environments. For example, specialized wheelchairs facilitated their access to scenic paths (Cattaneo & Vecchi, 2011). Another study conducted by Putri et al. (2020) focused on Tanah Lot Temple in Bali, Indonesia, where a sensory and linguistic media interface called “Dimantra” was designed for blind visitors, resulting in positive feedback on the sensory-linguistic media approach used in the study.

Although no research on this topic has been conducted in Iran, relevant studies have been identified by reviewing the country’s academic and scientific information systems.

In his master’s thesis, Moradi (2020) explored the experiences of blind individuals in Geotourism in Iran, specifically focusing on adventurous Geotours involving rafting and desert trekking in Isfahan and Shahrekord. This research assessed how blind participants accessed travel information, navigated routes, maintained safety, and observed the attitudes of tourism professionals toward blind Geotourists on these tours. The findings indicated that the tours were not designed or planned with the blind in mind, highlighting a lack of trained specialists and inadequate delivery of information. Additionally, no safe, adapted

pathways were provided at tourist attractions, and activities suitable for blind visitors were absent.

Omidi Khankhedani (2015), in his study on “The Potential for Developing Accessible Tourism in Museums,” examined the challenges faced by blind visitors in Shiraz’s Natural History and Technology Museum. The research focused on the facilities and infrastructure necessary for developing accessible tourism. Findings revealed that the museum did not meet accessibility standards, underscoring the need for improvements to help blind visitors fully appreciate the exhibits. These enhancements include audio files, Braille, and tactile models to facilitate access.

Similarly, a study by Tahmasebi (2017) on “The Investigating of the Challenges of Domestic Religious Tourists with Disabilities in Mashhad, Focusing on Wheelchair Users and the Blind,” highlighted several obstacles, including insufficient trained staff to cater to special needs, limited awareness among sales and reception staff about disability regulations, a lack of accessible bathrooms in hotel lobbies, limited accessible showers, a shortage of emergency call buttons for hotel staff, few accessible elevators, and a lack of reliable travel information for disabled individuals. These issues illustrate that the surveyed hotels adhere to only a few global standards. Given the central role of accommodation in travel, the implementation of accessibility standards in hotel design, along with adequate staff training, could significantly improve travel experiences for individuals with disabilities.

Regarding the use of augmented reality (AR) in Iran’s tourism sector, Feiz et al. (2022) conducted a study titled “Challenges and Solutions for Implementing New Technologies in Iranian Marketing (Case Study: Augmented Reality Technology).” This research examined the challenges and solutions for implementing AR in Iran’s marketing industry. Findings revealed two main themes with six sub-themes: challenges from the perspectives of customers, service providers, and technology, as well as solutions from each of these perspectives.

## Theoretical Foundations

### • Definition and understanding of blindness

Blindness generally refers to a condition where a person has no vision or a significantly reduced capacity to see. According to the World Health Organization (WHO) (2019), blindness is typically categorized into two types: legal blindness and complete blindness. Legal blindness is defined as having vision in the better eye, even with correction (e.g., glasses or lenses), of less than 20/200. This level of vision means that a person sees at 20 feet and someone with normal vision can see at 200 feet. Complete blindness, on the other hand, is characterized by a total lack

of light perception, meaning the individual cannot see at all (Thylefors et al.,1995).

#### • Perception and cognition in blind individuals

Perception is a mental process where sensory experiences gain meaning, allowing individuals to understand relationships and the significance of objects (Nadaf Fard, 2000). Due to the strong reliance on sight for spatial assessment and receiving substantial environmental information, sighted individuals typically do not need to retain as much information mentally since they can readily re-assess their surroundings visually. However, blind individuals must create a different understanding of space by combining data gathered from other senses (Farzin & Sheibani, 2010). They first rely on verbal cues to understand their environment, requiring a general-to-specific approach to their surroundings. Blind individuals understand their environment based on tangible information and accessible facts and encounter fewer challenges in environments they can directly experience and explore. However, understanding distant, inaccessible objects or spaces - like celestial bodies, clouds, horizons, or microscopic organisms such as bacteria - is difficult for them. This understanding resembles how individuals imagine life on other planets, relying solely on auditory information and descriptions (Zangeneh, 2013). Blind individuals interpret spaces through recognizable environmental markers, such as sensory cues, mental images, and stereotypes.

#### • Sensory markers

Blind individuals use tactile, auditory, and olfactory markers to identify and memorize environmental features. These markers help them to recognize their location, making them essential for spatial orientation. Hence, these markers should be prominent enough, both physically and functionally, to be memorable and serve as reference points in conjunction with other architectural elements. By memorizing these markers, blind individuals create a mental map, connecting different spaces. Therefore, initial visits to a new space may not lead to a complete understanding unless they have prior descriptions of the environment (Hossein Nejad, 2015).

These markers can be popular functional features or simply elements that provide distinct sensory information through touch, scent, or sound. Elements like obstacles, stationary objects, building structures, path boundaries, or floral areas that emit specific scents often serve as directional aids (Malakoutian, 2004).

#### • Mental images and stereotypes

People experience mental imagery to various extents (Grütter, 2023). This mental imagery represents an absent object or event, including visual imagery and sensations formed through other senses. For blind individuals, these stereotypes help anticipate possible situations in new spaces, fostering confidence and comfort in navigating these

environments. The spatial range they perceive is narrower than that of sighted individuals but often encompasses a deeper level of qualitative detail (Farzin & Sheibani, 2010).

#### • Sensory compensation in blindness

In psychology, compensation is a mechanism through which individuals consciously or unconsciously counterbalance weaknesses, disappointments, desires, or feelings of inadequacy in one area with achievements in another (Adler, 1964; Horney, 1950). Sensory compensation, specifically, is a phenomenon observed in the brain, where one sensory system enhances to compensate for the loss or impairment of another. According to sensory compensation theory, we integrate sensory information to interpret and understand our surroundings. This process begins with sensory organs receiving environmental input and concludes with perception (Hossein Nejad, 2015).

The process includes several stages:

1. Sensation: Visual, auditory, taste, smell, and touch senses are stimulated.
2. Attention: Certain stimuli are selected for focus.
3. Perception: The brain interprets selected stimuli.
4. Memory: Interpretations are stored in memory.
5. Thinking: Memory representations are processed through reasoning, judgment, and decision-making.

The olfactory sense plays a crucial role in spatial recognition, as each space has a unique scent profile, which aids navigation based on airflow and spatial orientation. Blind individuals are highly sensitive to smells, which form part of their environmental connection. Absolute blindness enables individuals to sense the warmth of sunlight and its specific scent through touch and smell (Nadaf Fard, 2000). In some cases, this olfactory sense is so acute that they can distinguish environments and people by their unique scents (Zangeneh, 2013). This attribute is beneficial in nature for sensory compensation.

Hearing is a distant sense, informing us about events occurring at a distance (Fulmer, 2002). In addition to recognizing the source's distance and direction, people can determine whether the source is stationary or moving. Auditory information also conveys surface texture, spatial volume, and fullness, enhancing spatial perception in nature (Grütter, 2023). Blind individuals prioritize auditory cues over olfactory ones for environmental analysis (Fulmer, 2002). Observations show that the auditory system plays a pivotal role for blind individuals, despite their use of multiple sensory systems.

Interviews with blind individuals reveal that they find waterfall sounds soothing and prefer quiet environments to listen to nature's sounds. Birdsong and flowing water significantly enhance their connection with nature. Many natural sounds emerge with seasonal changes, making the sounds of wind, rustling leaves, and bird migrations

reminders of nature's cycles and the importance of savoring moments.

Touch plays a vital role in spatial exploration for blind individuals. It is a unique sense that underpins the perception of vision, hearing, smell, and taste, historically regarded as the "mother of all senses" (Pallasmaa, 2010). Blind individuals enjoy tactile exploration of varied plants and prefer smooth, consistent surfaces and simple textures. Blind individuals can recognize only portions of large objects by touch, and piecing together fragmented information can be challenging. Scaled-down models of larger objects provide significant assistance, enabling focus on key points and aiding comprehension of interrelationships (Fulmer, 2002).

#### • Media influence on perception

Perception is purposeful and culturally influenced, often reflecting the values and mindset of the perceiver (Shahcheraghi & Bandarabad, 2016). Media's ability to shape perception and behavior is well-studied within social psychology and communication, as media can significantly influence beliefs and societal norms through information dissemination (McCombs & Shaw, 1972). As a powerful tool for meaning transmission, media plays a crucial role in directing the tourism industry (Hemmati, 2024), and shaping external realities to influence audience perspectives (Hemmati & Khalili, 2024, 34). Today's world often blends reality and simulation, reflecting the virtual environments enabled by technology since the 1980s.

Virtual reality (VR) has become an empowering tool for blind individuals, offering unique sensory experiences, especially through auditory and multisensory formats. Blind individuals traditionally rely on non-visual senses such as hearing and touch for environmental awareness (Lahav et al., 2015). A noteworthy application of VR is simulating natural environments, where auditory stimuli like waterfalls, birds, and wind allow blind individuals to feel connected to nature and recognize seasonal and environmental changes (Boisadan et al., 2020). VR can also facilitate social interaction, enabling blind individuals to engage in social skills training and participate in group activities within simulated environments (Ghali et al., 2012).

### Research Methodology

This research, aimed at examining the impact of augmented reality (AR) on enhancing the tourism experience of blind individuals in natural settings, was conducted using a qualitative, descriptive approach, combining library research (for theoretical foundations) and field methods. The stages of this study included: 1) data collection and 2) data analysis. Data collection was divided into two parts: a) gathering data at selected tourist sites to build narratives and b) collecting data

regarding the effectiveness of augmented reality for blind individuals.

In the data collection phase focused on natural tourist attractions, three sites were selected to represent diverse natural attractions: Lonak Waterfall, Khale Sara Beach 57, and Selkeh Wildlife Sanctuary in Gilan Province. To create narratives for these attractions, experiential data were gathered through field visits to the three chosen sites. These data included a list of natural attractions in each area, descriptions of the sites from morning to evening, tourist activities conducted at the locations, and memorable sensory impressions associated with being at each site. Observational methods were used to gather experiential data, supported by note-taking techniques; additionally, ambient sounds in nature were recorded and documented. The descriptions of each tourist attraction were then combined with background sounds to create an audio narrative, designed to assist blind listeners in forming mental images of the tourist sites and actively experiencing them.

To gather data for analyzing the effectiveness of augmented reality, a purposive sampling method was used. For this purpose, 12 blind individuals who had completed their studies at the University of Guilan were selected. After testing and experiencing the AR content created, data were collected through interviews and closed-ended questionnaires. The questionnaires employed a five-point Likert scale, with options ranging from 1) Strongly Disagree, 2) Disagree, 3) Neutral, 4) Agree, to 5) Strongly Agree.

After data collection, the information was organized and grouped into tables. Data were then analyzed based on several variables, including: 1) the quality of the narratives, 2) the quality of narrative sound, 3) the quality of supporting background sounds, 4) the quality of 3D models, and 5) the overall effectiveness for blind individuals.

### Discussion

#### • Effective narrative expressions for conveying the visual image of an object to blind individuals

The narratives for each region were crafted based on the natural shape and scenery of the area from morning to evening, the tourism experiences conducted there, and the memorable feelings associated with visiting each destination. Before being evaluated by blind tourists, these narratives were analyzed by three tour guides from Gilan Province and one specialist in language and narrative literature. This analysis aimed to enhance the effectiveness of conveying the appeal of tourism through narrative form to blind tourists. According to the analyses conducted, the narrative framework used in this study consisted of various types of sentences: general, informational, interactive, and descriptive, covering locations, directions, textures, and colors.

### • General narratives

Narratives with a general structure were designed to be more organized, clearer, and less complex. This model extends a general observation of a subject to specific details supporting that observation. This model was chosen with the understanding that the target audience - blind individuals - tend to rely more on imagination in their daily lives, so the information should be as accessible and understandable as possible.

“The sand on the shore glistens like a rare jewel under the sunlight, displaying nature’s unmatched beauty. The sand is golden, like strands of sunlight flowing between one’s fingers, evoking warm, summer days with every step, as the warmth of the earth settles in the heart.”

Based on the above excerpt, taken from an audio narrative about the Caspian Sea coast in the Khale Sara area of Talesh, it can be seen that the information is conveyed from a general concept - the color of the sand - to a description of how this color is interpreted through human senses.

### • Informational narratives

Informational narratives consist of useful and interesting sentences that cover both general and specific information about a particular subject. Therefore, the narratives related to natural attractions in this section are structured to provide both general information (such as the location of the attraction, its value and reputation among tourists, and reasons why it has become a notable destination) as well as specific details (such as the types of birds that can be observed or the available tourism facilities, along with descriptions of the unique features of the attraction). An example of such informational narratives is as follows:

“Hello dear visitors, welcome to the tourist attraction of Lonak Waterfall. This attraction is located amidst dense forests right next to the mountain road from Siyahkal to Deylaman. You can leave your car in the parking area and reach the waterfall with a 3-minute walk through the woods. Lonak is a twin waterfall that cascades from a height of 6 meters. Lonak has a unique beauty, and there are all kinds of facilities available, ranging from amenities and hygiene services to local entertainment. Traditional bread and local foods are also sold next to the waterfall. The kebabs here are quite delicious and famous; so, don’t miss the chance to enjoy kebabs by the waterfall, especially since the nice weather and pleasant cool humidity will whet your appetite.”

### • Interactive sentences

In addition to being informative, the content of augmented reality must also be interactive. Therefore, narratives should include descriptive, exclamatory, and interrogative sentences. These sentences are essential for creating a communicative, interactive, and friendly impact. A narrative that is communicative, interactive, and friendly can help listeners avoid feeling fatigued by the text. Examples of

communicative and interactive sentences can be seen in the following narrative:

“Can you hear the delightful sounds of migratory birds? At sunrise, you can immerse yourself in the morning beauty here. As the sun rises, its soft golden light transforms the wetland into a natural painting. Throughout the day, the sound of birds taking off and landing on the water’s surface and the fresh air truly energizes you, doesn’t it? If you pay a little attention, you can hear the chicks feeding. Do you hear that call? That’s the cry of the swan. Let’s take a stroll around the wetland and enjoy the sounds of the birds!”

Based on the excerpts from the above narratives, it can be seen that interrogative and exclamatory sentences during narration can encourage listeners to think and focus on the voice of the narrative, rather than drifting into daydreams or drowsiness. Communicative and interactive sentences not only effectively stimulate listeners’ concentration but also engage them in a feeling of comfort, tranquility, and welcoming of the attraction.

### • Sentences with details about locations, distances, directions, textures, and colors

Ideal narrative sentences should also provide precise information. The specific information that needs to be considered when conveying narratives to blind individuals includes details about locations, distances (measurements), directions, textures, and colors. The geographical location of an attraction is a significant point related to directions and distances. When describing an area, it is necessary to establish one location as a starting point and then describe the surrounding places. The starting point will be the endpoint after the explanation concludes. The same method applies to explaining directions. While describing locations and directions, distances (measurements) also provide essential information for accurate estimation. Portions of the narrative text related to this section are as follows:

“Now we are facing the waterfall. Lonak Waterfall consists of two small waterfalls side by side, which merge into a twin waterfall when there is a lot of water. The height of the waterfall from the rocky wall to the base is about 6 meters. As you approach Lonak Waterfall, a cool breeze caresses your face. The feeling of fine droplets of water from the waterfall on your skin and the refreshing scent is truly delightful. On both sides of the waterfall, there are layers of black rocks covered with branches of trees and forest plants. Beech, alder, and hornbeam trees are located in a forest called Lonak, above the waterfall. The waterfall flows into a river named Shamorod, which lies at the base of the waterfall. At the bottom of the waterfall, large rocks covered with moss can be seen amidst the waves of water. To the left of the waterfall is a stone staircase that easily leads you to the toilets, barbecues, craft, and souvenir booths, and restaurants in this area.”

From the narratives, it is observed that details regarding location, direction, and measurements are crucial for blind individuals to visualize certain objects. In addition to locations, directions, and measurements, precise descriptions of textures are also important. However, the description of texture does not need to be as detailed as that of location, direction, distance, and color since blind individuals can touch textures. Among the details, colors are the most challenging to describe. The reason is that most blind individuals have never seen colors, and colors are not something that can be perceived through touch or sound. Therefore, a specific method is required to introduce colors to blind individuals. In this study, colors were described by matching the mood of a specific color with a particular feeling or sense.

“... Black is a very strong color, much like the taste of coffee without sugar. Many also describe black as a dark color, akin to the darkness of a sorrowful heart...”

“... The sunset turned the sea sky orange. This beautiful and warm orange sky brings a sense of calm and healing. The tranquility it radiates is similar to the calm we feel when we return home after a long day of work and gather again with family...”

#### • **Effective materials for creating a suitable 3D model**

An effective 3D model must be accurate in shape and texture. To construct the base shape of the model, a flexible and moldable material is needed that can be easily adjusted. Newspapers can meet this standard. In addition to the base shape materials, decorative materials must also be well-selected to convey an authentic sense of natural landscapes, such as soft sand, hard sand, wet cotton, and artificial plants. In the construction of the model, newspapers were used to shape the base of the 3D model. The 3D model was secured with adhesive tape. After the base shape was prepared, it was decorated with soft marine sand, river pebbles, wet cotton, and artificial plants. Soft marine sand was used to represent the beach, river pebbles to form the rocks, and wet cotton to depict marine and river landscapes. Decorative materials should be as close as possible to natural landscapes to convey a genuine sense to blind individuals.

#### • **Effectiveness of augmented reality for the blind**

After writing the narratives according to the mentioned standards, an audio file of the narrative was produced. The narratives were recorded live at each attraction, and background sounds were also recorded live and separately, with subsequent noise clean-up. The audio file of the narratives was combined and synchronized with the background sounds. The created audio file, along with the 3D model of each attraction, was provided to the blind participants in this study. The effectiveness of the experience was then evaluated through a closed questionnaire written

in Braille based on a 5-point Likert scale: 1) Strongly Disagree, 2) Disagree, 3) Neutral, 4) Agree, and 5) Strongly Agree. The results were presented as percentages, and the outcomes from the test were obtained.

#### • **Quality of narratives**

The quality of the narratives was assessed based on 1) the effectiveness of the narratives, 2) the informativeness of the narratives, and 3) the interactivity of the narratives. The percentage of effectiveness of the narratives, as depicted in Fig. 1, was as follows: 50% of the samples strongly agreed, 33% agreed, 17% were neutral, and 0% disagreed or strongly disagreed. The percentage of informativeness of the narratives was as follows: 66% strongly agreed, 25% agreed, 9% were neutral, and 0% disagreed or strongly disagreed. Additionally, in terms of interactivity, 58% of the samples strongly agreed, 42% agreed, and 0% were neutral, disagreed, or strongly disagreed. Therefore, based on the statistics, it can be stated that the augmented reality evaluated was adequate in terms of the quality of the narratives.

#### • **Quality of the audio file of the narratives**

The quality of the audio file of the narratives was assessed based on 1) the clarity of the narrator's pronunciation, 2) the clarity of the narrative volume, and 3) the immersion of the narrative sound within the background sounds. The percentage of clarity of the narrator's pronunciation, as depicted in Fig. 2, was as follows: 33% of the samples strongly agreed, 50% agreed, 17% were neutral, and 0% disagreed or strongly disagreed. The percentage of clarity of the narrative volume was as follows: 25% strongly agreed, 50% agreed, 17% were neutral, 8% disagreed, and 0% strongly disagreed. Furthermore, in terms of the immersion of the narrative sound within the background sounds, the percentages were as follows: 8% strongly agreed, 17% agreed, 42% were neutral, 33% disagreed, and 0% strongly disagreed. Therefore, based on the statistics, it can be stated that the quality of the audio file of the narratives was sufficiently qualified, although it requires some future adjustments, particularly concerning the balance between the narrative volume and the volume of the background sounds.

#### - **Quality of background sounds**

The quality of background sounds was evaluated based on 1) the ability to convey a genuine sense of the narratives, 2) the clarity of the background sounds, and 3) the coherence of the background sounds within the audio file of the narrative. The percentage of the ability to convey a genuine sense to the narratives, as shown in Fig.3, was as follows: 25% of the samples strongly agreed, 33% agreed, 25% were indifferent, 17% disagreed, and 0% strongly disagreed. Meanwhile, the percentage of clarity of background sounds was as follows: 25% of the samples strongly agreed, 58% agreed, 17% were indifferent, and 0% disagreed or

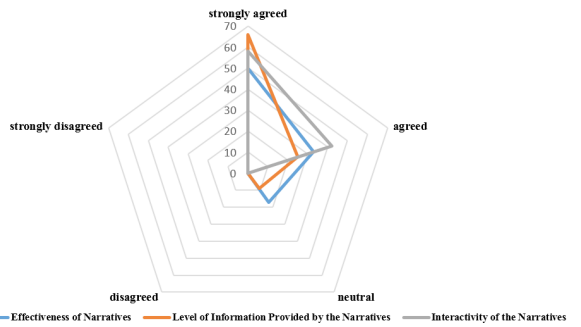


Fig. 1. Assessment of the quality of augmented reality narratives. Source: Author.

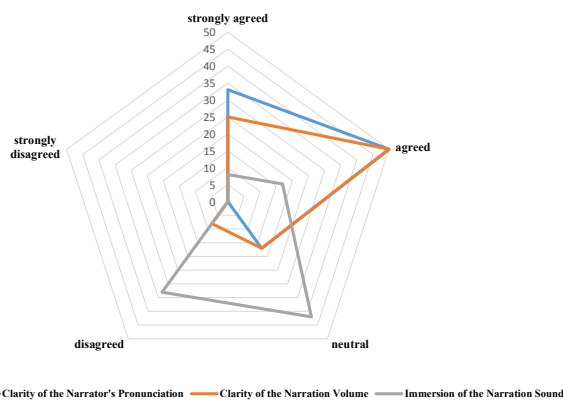


Fig. 2. Evaluation of the audio quality of augmented reality narrations. Source: Author.

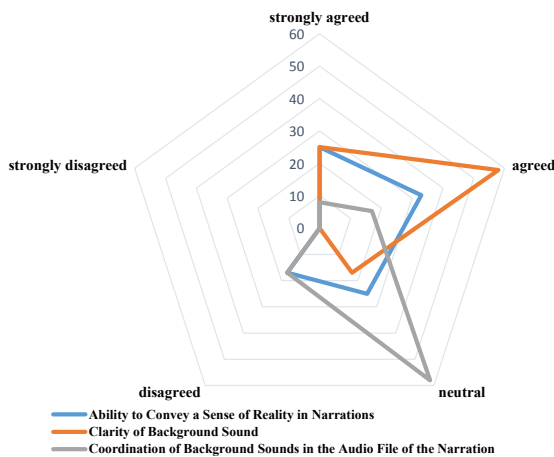


Fig. 3. Evaluation of the quality of background sound in the audio file of augmented reality narrations. Source: Author.

strongly disagreed. Additionally, regarding the coherence of background sounds in the audio file of the narrative, the percentages were: 8% of the samples strongly agreed, 17% agreed, 58% were neutral, 17% disagreed, and 0% strongly disagreed. Therefore, based on the statistics, it can be stated that the quality of the background sounds in the augmented reality was sufficiently qualified, although improvements in the balance between the volume of the background sounds and the volume of the narrative audio file are still needed.

### - Quality of 3D models

The quality of the 3D models was evaluated based on: 1) the effectiveness of the models in visualizing natural attractions, 2) the appropriateness of the model sizes as a tactile medium, and 3) the suitability of the textures of the models in conveying information about the tourist attraction. The percentage of effectiveness of the models in visualizing natural attractions, as depicted in Fig. 4, is as follows: 42% of the respondents strongly agreed, 33% agreed, 17% were indifferent, and 0% disagreed or strongly disagreed. In the evaluation of the appropriateness of the model sizes as a tactile medium, 25% of the respondents strongly agreed, 33% agreed, 25% were indifferent, 17% disagreed, and 0% strongly disagreed. Additionally, regarding the texture of the models in conveying information about the tourist attraction, 42% of the respondents strongly agreed, 33% agreed, 17% were neutral, 8% disagreed, and 0% strongly disagreed. Therefore, based on the statistics, it can be stated that the 3D models were qualified as a tactile medium for visualizing the three natural tourist attractions in this study. Overall effectiveness of augmented reality for the blind The overall effectiveness percentage of using augmented reality was as follows: 58% of the respondents strongly agreed, 33% agreed, 8% were neutral, and 0% disagreed or strongly disagreed. Therefore, based on the statistics, it can be stated that augmented reality has been effective and qualified as a sensory language-tactile medium for enhancing the tourism experience in nature for blind individuals.

### Conclusion

Promoting nature-based tourism for individuals with disabilities is an important step towards creating a more inclusive and equitable tourism landscape, offering significant benefits such as improved physical health and fitness, enhanced psychological well-being, increased social integration, and a greater sense of independence and self-efficacy. Making tourism accessible for the visually impaired in enclosed spaces,

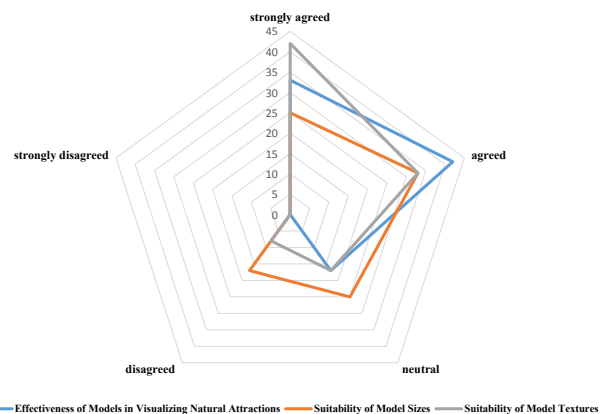


Fig. 4. Evaluation of the quality of 3D models in augmented reality. Source: Author.

such as museums, has been implemented in various parts of the world and Iran, and its planning and execution present fewer challenges. However, the presence of visually impaired individuals in natural environments, which are often unknown and filled with obstacles, faces many challenges. This research, drawing on the background of several studies conducted to organize nature tours for visually impaired individuals in the world and in Iran, utilized augmented reality to enhance the

experiences of blind tourists in nature. It employed effective narratives emphasizing the role of media in environmental perception, using informational, interactive, and precise sentences regarding locations, distances (measurements), directions, textures, and colors at three selected tourist attractions in Gilan province. Additionally, three-dimensional models covered with real or semi-real materials were used to convey and visualize the tourist attractions.

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