

# Accessibility of National Cultural Heritage to Deaf Tourists

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**Abstract:** Individuals with hearing impairments face numerous obstacles when engaged in touristic activities or using infrastructure and services in touristic spots. When tourism is considered a social good of first necessity, new concerns arise and pressure for inclusion in the sector stimulates the advance of innovative solutions for inclusive tourism. There are also economic interests in inclusive tourism, an unexplored market niche that might compensate the expected drop on the tourism growth rate in comparison to recent years in Portugal. The ICHT project – Inclusive Cultural Heritage Tourism – aims to promote the accessibility of deaf tourists to cultural heritage by embedding new technology-aids, online and on-site, to raise awareness, to attract deaf tourists, to assist them while visiting us, and to exploit their experience as a new dissemination channel. ICHT is focused on creating digital tools and digital content in sign language to be available online, on mobile devices and on-site at cultural touristic attractions in the North of Portugal through innovative channels like games, holography, and collaborative platforms. ICHT advocates the integration of novel high-tech sign language user interfaces in tourism destinations and stimulates local operators to learn the basics of sign language communication to welcome deaf tourists in Portugal. ICHT brings in R&D world-class results in the field of automatic sign language translation qualifying Portugal to guide Inclusive Tourism worldwide and become a pioneer leading the Tourism of the Future. The full system includes an on-site application using holography, a game to play on a mobile device (before, during, and after visiting the attraction), an online collaborative platform to assist deaf and non-deaf tourists, and a set of International Sign training courses. The ICHT system will be available in five pilot installations at Torre dos Clérigos, Lello bookshop, Maia Zoo, Port wine cellars, and Viseu thermae. ICHT brings a new approach to teach sign language to the professionals in the touristic sector opening new opportunities for a more inclusive society. The sign language training together with the assistive technology tools developed by ICHT generate inclusive environments for the deaf. ICHT has the potential to become a PIN project in the Tourism sector.

**Keywords:** inclusive tourism, sign language translation, accessibility, user interfaces, holography

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## 1. Introduction

Deaf individuals face several obstacles in the practice of touristic activities, access to information, and use of services and infrastructures. This is caused by a low diffusion of Portuguese Sign Language (LGP) among the hearing community, but also because communicating in spoken/written language is highly demanding for the deaf (Escudeiro, et al., 2015). Due to this shortage of knowledge of both LGP and Portuguese among these two communities, communication between the deaf and non-deaf is not always effective; it often fails and prevents the deaf community from fully communicating and accessing information (Escudeiro P., et al., 2013). This is also extended to other foreign deaf individuals. Contrary to what one might think, there are over 300 sign languages in the world, making it harder for deaf individuals from different origins to communicate between them too (Oliveira, et al., 2019).

Under such circumstances, and due to the growing number of tourists and the demand for globalization, there is a need to develop tools to promote inclusive tourism, by improving access to touristic information in everyone's first language. The touristic sector must hold appropriate conditions to assist and welcome every tourist, regardless of the language in which they communicate, so they can fully benefit from their visit and experience (Santa, 2020).

The main objective of the Inclusive Cultural Heritage Tourism project (ICHT) is to raise awareness of sign language and promote inclusive tourism, by encouraging the learning of the basis of the Portuguese sign language (LGP) and International Sign (IS) by local touristic operators. and by improving access to our cultural heritage in everyone's first language. The outcomes of ICHT will advance international mobility and social inclusion of the deaf in two core dimensions: (1) assure an interface to facilitate the bidirectional communication using sign and spoken languages in parallel and (2) stimulate the flexibility and preparedness of tourist operators to welcome deaf tourists. The bidirectional communication using sign and spoken languages simultaneously will

be implemented through assistive technology tools grounded on an automatic bidirectional translator for tourism (ATT). Touristic operators and the local communities, we have access to training and an online community of practice to develop communication skills in sign language (LGP and IS).

The ICHT system will be installed in five different touristic venues in the North of Portugal as a proof of concept. The general ICHT model is prepared to be easily replicated in other installations; we expect to have several more ICHT installations during the next five years promoting Portugal as an inclusive tourism destination of excellence. Exporting the model to other countries will be the next stage. To prepare for this next step, ICHT involves partners from Switzerland, Italy, and Germany, European countries where our diaspora is well established.

The use of technology as a pillar of communication and integration of the deaf in cultural heritage tourism is an innovation at the national and international level that is expected to become a significant flagship of the Portuguese touristic sector.

## **2. Principles of inclusive tourism**

Tourism is one of the most important engines of the Portuguese economy with the potential to promote socio-economic development and innovation. In accordance with the National Touristic Strategic Plan that guides the sector development until 2027, there are still a few aspects to consider for improvement, such as mobility conditions to support tourists visiting Portugal and dissemination of information about national touristic offers. These relate to developing inclusive tourism and to the importance of cultural heritage.

### **2.1 An accessible touristic sector**

The tourism industry has proven to be non-inclusive and non-accessible on different occasions, highlighting its socially exclusive nature. Individuals with disabilities face barriers to their communication and full participation in cultural life, making social interaction an obstacle rather than a benefit or satisfaction. To improve accessibility and reduce this lack of integration, the touristic sector can be more inclusive by ensuring that every deaf individual can communicate autonomously, enabling access to information in their first language when visiting cultural sites (Gillovic & McIntosh, 2020).

Portugal has been advocating for a more inclusive and accessible touristic sector, in accordance with responsible policies. In 2019, Portugal was considered the world's first Accessible Tourist Destination by the World Tourism Organization, taking the first step towards becoming the world's most inclusive destination in the future. To achieve this, cultural sites must have tools and information available to welcome sign language users, and tourist operators should have the minimum skills of sign language to communicate with them. By adapting our services and infrastructures and consequently expanding our offer, we develop competitive, responsible, and inclusive tourism (Calheiros, 2020).

Inclusive tourism is defined by the engagement of every individual, namely those whose mobility is impaired, in the consumption, production, and benefits of tourism (Biddulph & Scheyvens, 2018). It is also defined by its transformative nature and the possibility to better address inequality (Scheyvens & Biddulph, 2017). Another way of transforming the touristic sector and making it more inclusive is to ensure that locals visit those cultural sites. Domestic tourism can increase social inclusion, economic benefits and foster local checking of touristic demands (Scheyvens & Biddulph, 2017).

The ICHT project is not limited to helping deaf tourists that travel abroad; it is designed to help overcome overall communication barriers faced by national and international tourists and allow translation into a different sign and spoken languages. This mediation through assistive technology will boost inclusive cultural tourism, grasping the opportunities of this growing market (Santa, 2020).

### **2.2 An approach towards inclusive and responsible tourism**

Responsible tourism relates to the concern with all forms of tourism and the interests of all parties. As such, responsible tourism is a tourism initiative, defined as "a behavioral trait ... based on the basic principles of respect for others and their environment" and as a "tourism management strategy embracing planning, product development, management, and marketing to bring about positive economic, social, cultural, and

environmental impacts” (...), “enabling local communities to enjoy a better quality of life through increased socio-economic benefits and improved natural resource management” (Mathew & Sreejesh, 2017).

Thus, responsible tourism “builds on appropriate sustainability-based strategies and policies” and works “as a tool to minimize negative social, economic and environmental impacts whilst maximizing the positive effects of tourism development” (Mathew & Sreejesh, 2017).

Responsible tourism relates to the enhancement of everyday quality of life, inclusiveness, engagement, accessibility, and competitiveness (Mathew & Sreejesh, 2017), relying on practices of inclusive tourism. ICHT project embraces the concept of responsible tourism which enhances inclusiveness and culture.

### **3. Methodology**

The ICHT project aims to promote accessibility to Portuguese cultural heritage attractions to the deaf community through the development of an innovative digitalization approach. The ICHT methodology and the outcomes of the project will enhance and value inclusiveness and culture, but it will also assist entrepreneurial ventures of the local touristic operators and advance the Portuguese tourism sector and economy.

#### **3.1 Concept**

This project addresses the priorities of the National Touristic Strategic Plan, including the promotion and deployment of contents and promotional information about cultural heritage; development of digital content and technological applications to extend the touristic experience in the territory; valorization and touristic activation of national intangible cultural heritage; support to the creation of new creative, technological businesses covering the smart specialization domains established by the national strategy for smart specialization; creation and promotion of clusters to develop goods and services for the tourism industry; internationalization of Portugal as an authority supplying goods and services for tourism; capacity building and training human resources in tourism; digitalization of the touristic offer; and promotion of inclusive tourism.

ICHT exploits the previous experience of the research team in automatic translation of sign languages to develop unique innovative tools that will boost and qualify the region as a worldwide reference in inclusive cultural tourism addressing the deafness in the North of Portugal. We will develop the ICHT system, an informatics system to support deaf tourists visiting cultural heritage spots, with two core outputs: (1) an online platform to engage with deaf tourists and promote our country’s inclusive tourism and (2) an automatic bidirectional sign language translator for touristic activities.

The ICHT system is an application to be installed on-site at cultural heritage touristic destinations, providing information and ludic activities to deaf and non-deaf users through a bilingual interface (avatar and hologram) available in Portuguese, English, Portuguese Sign Language (LGP), and International Sign (IS), used as a lingua franca. The on-site installation is bundled with an online platform to assist the tourists visiting us and the local touristic operators in welcoming the tourists. The ICHT online platform will offer two sign language MOOCs, one on LGP, another on IS, addressed to tourists and touristic operators willing to learn the basics of each one of these sign languages. The purpose of these courses is to provide touristic operators and deaf foreign tourists with the basics of LGP and IS to enable communication between deaf and non-deaf in touristic activities. Through this online platform, it will be possible to inform and involve the visitor, sending invitations to events in the region during the visit, or suggesting participation in post-visit activities offering new destinations in the country. Besides the tourists, this platform will be at the service and to the benefit of the group of institutions with interest in inclusive tourism – the cluster for inclusive tourism (CIT). This cluster will transmit through a collaborative online platform enabling synergies and multiplying results, at the same time it provides guidance, assistance, and support to everyone in every time, in their language.

The automatic bidirectional sign language translator for touristic activities (ATT), a core component of the ICHT solution, will be integrated into the ICHT system to assure a user interface (avatar) in any sign language. The pilot installations in Portugal will offer instant communication with deaf tourists in Portuguese sign language as well as in IS but the system is based on artificial intelligence and is open to learning any other sign language. The innovative character of our proposal will bring the Portuguese tourist sector into the spotlight as a unique approach to inclusive tourism. This visibility will not only promote tourism but create conditions for an extended

application of our technology for the access of deaf tourists to cultural heritage while raising awareness for sign language.

### 3.2 Objectives

The ICHT project aims to promote accessibility to our cultural heritage by deaf tourists by embedding new technology aids, online and on-site, to raise awareness, to attract deaf tourists, to assist them while visiting, and to exploit their experience as a new dissemination channel. This project is focused on creating digital tools and digital content in sign language to be available online, on mobile devices, and on-site at cultural touristic attractions in the North of Portugal through innovative channels (e.g., games, holography, and collaborative platforms).

For that purpose, ICHT will pursue a set of specific objectives, such as reducing the communicational gap between deaf and non-deaf people. By reducing communication barriers, it will contribute to promoting inclusive tourism, access to culture, and a better quality of life for the deaf. Another objective is to raise awareness for sign language and to overcome LGP low diffusion among the hearing community through the courses available for touristic operators. In concrete, ICHT will pursue the following specific objectives:

- Allow touristic operators to learn the basis of Portuguese Sign Language and International Sign, to welcome and assist every local and foreign tourist,
- Develop an automatic bidirectional sign language translator for tourism, to support communication,
- The possibility to translate to and from any sign or spoken/written languages,
- Easier access to information and in every user first language,
- Guidance through the overall of the touristic experience, from the moment they choose their destination,
- Provide an innovative sign language user interface based on computer vision, machine translation, holography, and 3D animations.

### 3.3 Characterization and technical foundation

The ICHT project delivers two core products: an automatic bidirectional sign language translator for touristic activities (ATT) and an informatics system to support deaf tourists visiting cultural heritage sites (ICHT System) Figure 1. The ICHT system will be set up in pilot installations as a proof of concept, at five destinations in the North of Portugal: Torre dos Clérigos and the Lello bookshop in Porto, the Zoo in Maia, the Port wine cellars in Gaia, and the thermae in Viseu. The touristic experience will be supported on-site, by the ICHT System, and online through the ICHT Collaborative Platform.

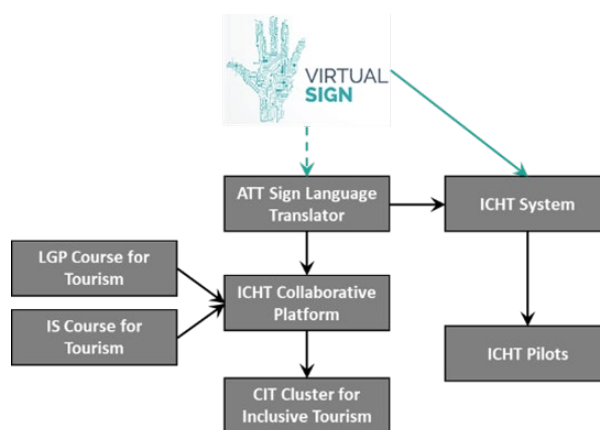
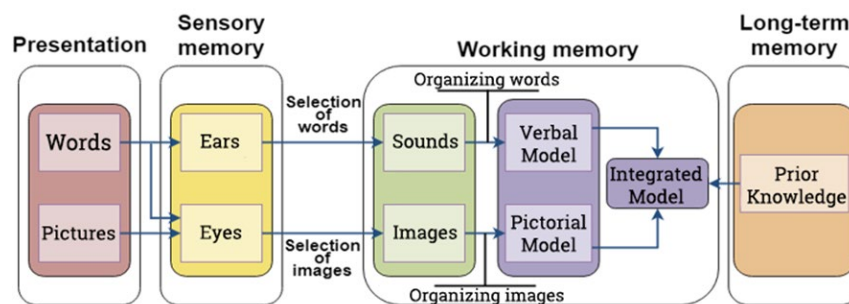


Figure 1: ICHT innovations

The ICHT system will implement a generic ICHT model to be developed to accommodate any cultural heritage touristic destination. This model will be wrapped by a methodology, illustrating the tasks, the resources, and the skills required to set up ICHT at a new touristic destination. This bundle, together with the ICHT system, the model, and the deployment methodology will be the backbone of a new service to be provided by the promotor assisting the rise of multiplier effects, synergies, and new opportunities in inclusive tourism. The ICHT application will include a serious game that will provide an engaging experience to tourists and promote the region.

The construction of our model was based on the theory proposed by Mayer (2005), as shown in Figure 2, which supports the development of Serious Games, further adapted to the characteristics of the deaf. We choose to use the principles based on serious games for the following reasons:

- This principle proposes the combined use of images and words, which allows the brain to process more information in working memory. In this way, people learn better from words and images, than just with words. In this context, words include written and spoken text, and images include videos, animations, and static graphics,
- In the process of deaf education, which has sign language/signs as a means of communication, images are essential for understanding educational concepts and, when they are used together with words, support students in the learning process. Due to the visual-gestural characteristic, the gestural languages can be presented together with the language of the country, respecting the physical structure of each of these languages, forming two informational processing channels necessary for bilingual education.



**Figure 2:** Mayer's (2005) multimedia information processing model adapted to a deaf person perspective

We will develop two courses on the basics of LGP and IS designed for communication in cultural heritage settings. These courses will be available through the ICHT collaborative platform for any user wishing to learn LGP and/or IS basics and be ready to communicate with everyone.

This platform will be connecting simultaneously all those developing, working, and using inclusive tourism offers. This platform will guide the tourists across all their touristic experiences from seeking destinations to giving feedback and assisting other tourists once back at home. The platform will be incorporated with the ICHT game. The game will start from the moment the tourist shows to be interested in the destination. Tourists may continue playing the game as long as they like. They will keep collecting points/rewards when interacting with others through the collaborative platform, which will also be a core element for the dissemination of the ICHT service. All the ICHT destinations will be promoted on the platform.

The ATT translator is the foundation of the ICHT System, and it will be integrated into the ICHT system to assure a user interface (avatar) in any sign language. By developing on top of the VirtualSign platform, the ATT will evolve to cope with all the specific features required for the ICHT system. The VirtualSign platform relies on artificial intelligence technologies, linguistics, and computer animation, being able to learn and support translation between any sign/spoken language pair. As such, the ATT translator will be an enhanced version of VirtualSign to handle all these features as required to deploy the ICHT system (Escudeiro, et al., 2013).

The ICHT system will offer an innovative sign language user interface based on computer vision, machine translation, holography, and 3D animations that, altogether, create an environment that can be explored by both deaf and non-deaf users using their first language. This will be a unique solution worldwide since there are no other solutions available on the market.

### 3.4 ICHT strategy

The ICHT implementation plan is based on a strategy comprising six activities:

- 1. Sign Language Automatic Bidirectional Translation-ATM Model (A&D of the model; Translation methodology; Resource gathering video samples for sign recognition in LGP, IS and GSL; Sign recognition from video, computer vision, AI);
- 2. User Interface Design (Design a novel UI for deaf tourists; Design UI architecture, op modes; Implement a prototype (wireframes/mock-ups); Validate the ICHT UI with end-users).;

- 3. Inclusive Cultural Heritage Tourism System (A&D of ICHT system; Enable VirtualSign for ICHT (computer vision, mobile); Q&A module; Holographic sign language UI; Develop the game; Develop the hologram UI; Develop beacons/game protocol; Geo-ref, beacons module; Deploy ICHT pilot venues);
- 4. Collaborative Cultural Heritage Tourism Platform (Develop collaborative platform; Develop content to promote inclusive cultural heritage tourism; Support deaf tourists; IS basics, short term MOOC; LGP basics, short term MOOC);
- 5. Inclusive Touristic Technology Assessment (Assessment plan, tool, resources; UX; Beta testing; Piloting);
- 6. Dissemination and Impact (Innovation and internationalization).

Activities that are related to the automatic translator development (1 and 2) are research-oriented and devoted to the development of the automatic sign language translation system and a novel user interface for tourist activities. The main task of activity 3 relates to the design of a creative and playful environment to communicate cultural heritage to deaf tourists, upgrading the VirtualSign platform to cope with the requirements of ICHT and ATT, implementing an interactive sign language holography interface, developing a geo-reference game to engage deaf tourists visiting cultural heritage venues, developing the content and deploying the pilot installations. ICHT supports the touristic experience of our end-users throughout all the experience, from the very first moment when they search for cultural touristic destinations, while their visit is undergoing and after the visit is concluded and they get back home. This round-trip support is available through our ICHT Collaborative Platform to be implemented at activity 4. Activity 5 has the responsibility to assess and validate the ICHT system and online collaborative platform. At activity 6 (Dissemination) we will promote the development of the Cluster for Inclusive Tourism.

#### 4. Quality scenario control

The Quantitative Evaluation Framework (QEF) is a generic quantitative evaluation model that will support the assessment of the ICHT serious game development and quality control (Escudeiro & Escudeiro, 2012). The QEF framework evaluates the ICHT serious game quality (ISO 9126 is the standard of reference) Scalet et al. in a three-dimensional space. A dimension aggregates a set of factors, and a factor represents a set of requirements. The quality of the game represents the system's performance from a particular point of view. The dimensions of the ICHT game are represented on a Cartesian quality space which includes functionality, adaptability, and usability. The requirements identified for each factor of the dimension they belong at the game quality scenario are:

At the Functionality dimension, whichever is composed of five factors namely Game Play, User Interaction, Features, Account, and Game Engine, table 1 illustrates all the identified quality criteria.

**Table 1:** Functionality evaluation criteria

Functionality				
Game Play	User Interaction	Features	Account	Game Engine
Display Ranking	Player will have access to a main menu	The game uses georeferencing	The Player can customize his Nickname	The player can create/publish custom assets
The game should allow interaction between players				
Personal Score can be consulted	Game has quick access to main functions	The game uses dynamic difficulty adjustment (DDA)	The Player can choose his Avatar	
During the game activate Augmented Reality			The Player can access account information	
Social Inclusion	The UI is intuitive		Impairment profile inference	
Send avatar to location	Provide input alternatives to mobility impaired user			
Move avatar accordingly to Player georeference				
Quiz to define if the player is deaf				

The adaptability of the game is defined by its quality of being able to adjust the interface to new conditions. This dimension aggregates four factors: Gameplay, Maintenance, Versatility, Accessibility. This game must be able to adapt to all platforms, technology, and all players (Table 2).

**Table 2:** Adaptability evaluation criteria

Adaptability			
Adjustment	Maintenance	Versatility	Accessibility
Game difficulty is adequately adjusted (DDA)	Application presents a set of interfaces and endpoints, adding the possibility of introducing new features	Application follows online store guidelines	Compatibility with the biometric sensor/beacons
The player feels the outcomes of their efforts/actions are fair		Application adjusts to screen resolution	Texts are converted to sign language to guide hearing impaired people
The player controls the game actions	The server must be scalable	Application is multiplatform	
The use of icons and sign language helps improves hearing impaired user playability			
Cooperative gameplay			
The use of colours scheme helps to improve the colour blind user playability			

The usability of a game is defined by the extent to which it can be used by its players to achieve the goals with effectiveness, efficiency, and satisfaction (ISO 9241). At ICHT serious game the quality criteria for the four factors identified at the quality scenario are Menu Navigation, Map Navigation, Content Quality, and Integrity (Table 3).

**Table 3:** Usability evaluation criteria

Usability			
Menu Navigation	Map Navigation	Content Quality	Integrity
Application user interface is simple and fast, without slowing down when the number of users is high	Easy access to real time map	All the messages are easy to understand	Consistency of server data and game data
	Easy to understand where avatar is located	Application is clear to colour blind users	Synchronization of users' location
		All content is related to the game	
Application runtime does not have errors, and unexpected errors should be handled		Texts are simple and concise	
		No messages should contain offensive content	
		Application is clear to hearing impaired users	
		The game provides sound and visual feedback for user action	
		A help button is provided	
		Game provides enough information to the players so that they can start playing	

The fulfilment level for each one of these requirements was discretized to pre-defined values that depend on the requirement. Some are simply assessed with either 0% or 100%, others rely on a 1-5 Likert scale, others are assigned to 3 (0%, 50%, 100%) to 5 percentage thresholds, such as 0, 25%, 50%, 75%, 100%. To reduce ambiguity when filling in the evaluation questionnaires all these levels are characterized for each requirement.

## 5. Conclusions

Communication for deaf individuals can be a challenge. Differences between sign and spoken languages are important barriers when accessing information, visiting cultural heritage venues, or using services and infrastructures. When coming across people who do not share the same language, deaf and non-deaf individuals strive to comprehend and be comprehended. These language barriers become more relevant every day as more and more information and services are being digitalized.

The ICHT project aims to promote inclusive tourism and raise awareness of sign language by developing an assistive technology that helps deaf individuals overcome communication barriers when accessing information. Enabling access to information in one's first language, either Portuguese or LGP, takes down the constraints due to the shortage of knowledge of LGP or Portuguese by the non-deaf or deaf. This will ensure a more inclusive society and will equip the Portuguese touristic sector to welcome and assist every deaf tourist.

It is expected that the ICHT project generates an innovative approach towards inclusive tourism. Within the Tourism 4.0 initiative by the Portuguese government, the ICHT project has the potential to be elected as a project of national interest in Tourism (PIN project) and to open doors to a significant part of worldwide tourism. By increasing the recognition of the Portuguese touristic sector worldwide, this project will support the national strategy for the touristic sector and the national ambition to guide the tourism of the future.

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