ICT Technologies for Tactile Images and 3D Models for Improvement of Accessible Tourism

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Abstract:
The importance of ICTs lies in their ability to open up a wide range of services, transform existing services and create greater demand for access to information and knowledge, particularly in underserved and excluded populations, such as persons with disabilities. Research has found that the participation of persons with disabilities in tourism is limited due to many factors such as the inaccessible tourism environment, the nature of transport services, the language barrier and the lack of tourism awareness towards persons with disabilities. This paper provides an overview of the compilation of ICT technologies and traditional markings of tourist facilities, in accordance with the good practices for using tactile maps and images implemented in the project Alternative Touristic Experience. The essence is to digitize the most important cultural and historical monuments in Bitola, R. North Macedonia and create tactile signs (images and 3D models with descriptions in Braille) for those objects for improvement of accessible tourism. The physicality of the scale model opens possibilities for tactile utilisation, allowing blind and visually impaired people to appreciate all the details of a specific architecture. Tactile signs will be placed in front of the cultural-historical monuments on pedestal.

Keywords:
ICT technologies, tactile images, tactile 3D models, accessible tourism

1. Introduction

Information and communications technology (ICT) is a term that refers to mainstream technologies such as mobile and fixed-wire telephones, computers, tablets, radio, television and the Internet [1]. With the advent of ICTs, new hopes are emerging for Persons with Disabilities (PWDs) [2]. When using ICTs that are adapted to the abilities of everyone, disabled persons are able to participate in all aspects of social life on more equal terms which is important for an inclusive and barrier-free Information Society [3].

Accessible tourism is largely encouraged to make it easy for all persons to enjoy tourism experiences [4]. Tourism for persons with disabilities refers to the use of general and basic mainstreaming framework for ensuring that persons with disabilities have access to the physical environment, the transportation system, information and communications channels, as well as to a wide range of public facilities and services.

Accessible tourism is a very big market. And, as the population ages, it will get even bigger. Some older estimates predicted that, by 2020, 25% of travel and leisure spending will come from people who have some form of disability [5]. There is also a multiplier effect here: people who are elderly or who have a disability often take other people along when they are travelling. Accessible tourism is a very big market, which brings growth and jobs. Investing in it can open up a market of millions of people with disabilities across the world [6].

However, despite this potential, the tourism activities continue to present many restrictions for people with some form of disability or specific need, and there is still much to contribute and improve in this area. Many restrictions are derived from the type of disability, which, in many cases, results in physical accessibility barriers, such as transportation restrictions, inaccessibility to some locations or

increased security risks. Others derive from communication barriers, namely the lack of relevant descriptions for certain groups of people with specific needs, as well as the inappropriate way in which the information is often presented, in regard to the specific characteristics of the target population. In both situations, Information and Communication Technologies (ICTs) can play a very important role. These technologies could be the key to overcome several limitations of the target group, by helping disabled tourists access relevant information and by presenting that information appropriately, taking into consideration their interests, disabilities and limitations.

The main target of the project Alternative Touristic Experience (acronym: ALTER TRIP) is to promote the conversion of the cross-border area to an easily accessible, without exclusions, tourist attraction, supporting the sustainable development and the cultural heritage in the cross border area. The project is implemented by the Association of Persons with Physical Disabilities of Bitola, Demir Hisar, and Resen - MOBILNOST Bitola, and funded by IPA CBC Programme "Greece - Republic of North Macedonia 2014-2020".

ICT technologies represented in the paper and implemented in the ALTER TRIP project include accessible signing of tourist facilities – creation of tactile images and tactile 3D models of ten cultural and historical monuments in Bitola, R. North Macedonia. Using these models, blind and visually impaired visitors from everywhere in the world will be able to recognize monuments through tactile sensations. The technologies were developed by the authors of the paper as experts of the GAUSS Institute – Foundation for New Technologies, Innovations and Knowledge Transfer from Bitola, R. North Macedonia, which provided funds for implementation of these technologies.

2. Tactile perception of environment as a best practice for improvement in accessibility

A key objective of good practices in terms of universal accessibility is to reinforce the competitiveness of tourism destinations. To enhance visits by the visually impaired in the Paul Klee Museum (Bern), detailed audio descriptions of selected works are provided. The visitor can also enjoy high-relief reproductions of works by Paul Klee, in an attempt to develop art through tactile means. The centre also offers assistance to visitors with hearing disabilities by means of sign language [7].

Bordeaux has three large-scale tactile maps or models of the most interesting areas of the city in terms of their monuments and architectural attraction. These plans are both good to look at and good to touch (in order to highlight details, the scale of the model has been modified to enlarge elements such as decorative fountains and the vertical scale of monuments) [7].

At the Saint André cathedral, before entering the discreet south-facing side door, visitors can explore through touch various reliefs with religious scenes. Inside, they can touch the wrought iron railings beside the altar, and the stone base of a baptismal font, which also has a stand to enable visually impaired persons to detect it with the tip of their cane. Outside the building, there is a tactile map of the area surrounding the cathedral, including the City Hall [7].

The Grand Theatre is one of the most beautiful theatres in France. Most of the interior is accessible, except for the conference rooms. Furthermore, there is a tactile model of the building and an audio description system. The visit to Porte Cailhau is comfortable and safe for wheelchair users, with no uneven surfaces or narrow paths. The square, on a slight upward slope, has benches and a tactile map of this historic area, and leads to the church of Saint Pierre [7].

On June 9, 2022, a tactile model of the ensemble of the Nativity Cathedral and Bishop’s House, included in the UNESCO World Heritage List, was opened on the territory of the Suzdal Kremlin [8].

On February 11, 2021 two tactile models of Saint Basil’s Cathedral (also known as The Church of Intercession of The Holy Virgin) were installed at the premises of this Moscow’s heritage site. Using these models, visually impaired visitors of the worldwide-famous architectural masterpiece will be able to study the church in full detail [9].

The oldest city in Switzerland can be experienced through touch due to the historic centre tactile model. The model helps people who are blind and visually impaired to get an idea of what the Chur historic centre is like. At the same time, it is a useful tool for city tours and an attraction for children. The bronze model is located in the Chur city centre on Martinsplatz [10].

3. Development of the tactile signs

The following steps were applied to create the tactile signs:

- **Photographing objects**

The selected 10 cultural/historical monuments in Bitola that needed to be marked with tactile signs were photographed from different angles. For this purpose, two high-end DLR cameras and a professional drone were used. Furthermore, using photogrammetric measurements, dimensions were obtained for the objects, which served in the creation of the realistic 3D models.

- **Processing objects and making digital tactile images of objects**

Graphics for tactile representations should be clear and contain only relevant information, based on an understanding of what its task is. Visual information that is irrelevant to the meaning or purpose were omitted. During conversion, the Guidelines and Standards for Tactile Graphics, 2010 published by the Braille Association of North America (BANA) were followed [11]. For the needs of the project, tactile images with Braille description and 3D models printed with 3D printer intended for internal use were created. The final step in the production of tactile representations were tactile signs resistant to external weather conditions and other influences which will be placed in front of the cultural-historical monuments on pedestal.

- **Create draft tactile models**

All digital tactile images were printed on swell paper in at least one copy. The draft models were reviewed and approved by the Contracting Authority. Braille embossers use lines made up of individual Braille dots, whereas designs printed on swell paper have more fluid, continuous lines that retain more detail. As an example, a tactile image of the Clock tower and the building of the Museum in Bitola were developed with this methodology, as shown in Figure 1.

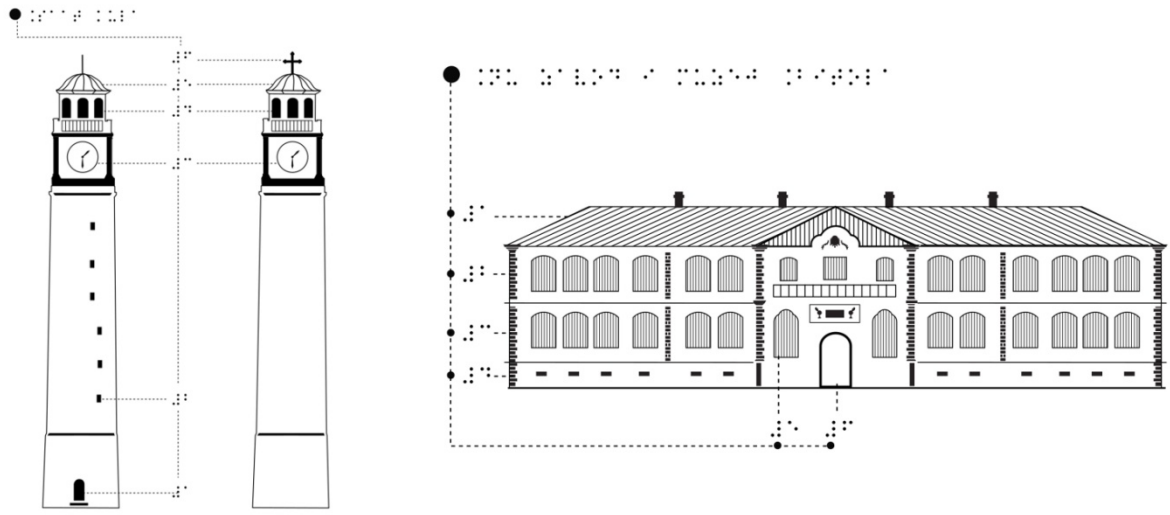

Figure 1: Tactile image of the Clock tower and the building of the Museum in Bitola

- **Image/object description and guidance**

A blind person feels the raised lines and surfaces in order to obtain the same information that people who are sighted get by looking at pictures. To be able to identify something by touch, a further information is required – a description. The tactile description can be roughly divided into two parts: 1. Image (or object) description where the content of the image/object is presented, and 2. Image (or object) guidance, where the image or object that is touched by the blind person is described and it is explained what should be expected while touching different parts of it.

It is important to keep in mind that a tactile image/object is useless to a blind person without a proper description. The description can be printed in Braille or it can be in the form of an audio narration. It should also be taken into account that only a small percentage of blind people can read Braille, i.e. that percentage in Europe is around 5% [12]. In order to overcome the problem of Braille illiteracy, audio narrations (descriptions) were produced in Macedonian and English and will be

placed online on the izi.travel app platform. The tactile images are also accompanied by NFC tag, that a blind person can scan with her/his phone, after which an audio narration will be activated. In this way, tactile images are also made accessible to people who cannot read Braille, Figure 2.

Figure 2: Tactile image with tactile description

- **Production of tactile 3D objects**

For indoor use, copies of tactile 3D objects of 10 touristic cultural and historical monuments in Bitola, R. North Macedonia were produced, using the 3D printer shown in Figure 3. Although 3D printing is a promising technology in terms of materials used and production possibilities, according to our preliminary tests, it is still not suitable for outdoor use.

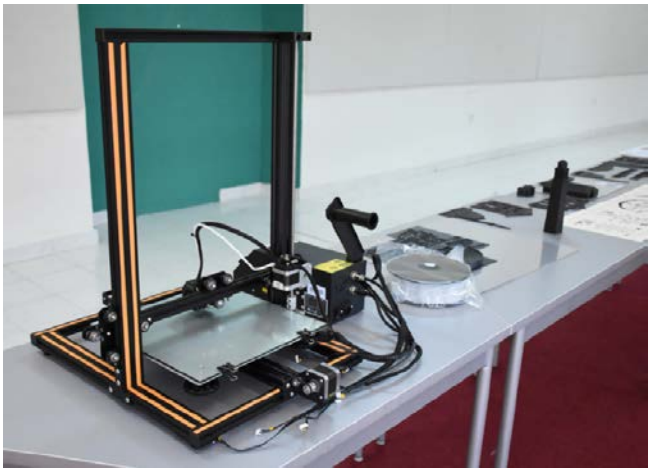

Figure 3: 3D printer used for tactile 3D objects

The most common 3D printing materials as ABS, PLA, proved to be insufficiently persistent in the climatic conditions in Bitola. The 3D printed models proved to be extremely suitable for indoor use, as many blind people had the opportunity to touch and get an idea of what the cultural and historical monuments in their surroundings look like for the first time in their lives. According to their

statements and world experiences, a 3D model is always better than a tactile image, because it gives better representation of the real appearance of the original object, Figure 4.

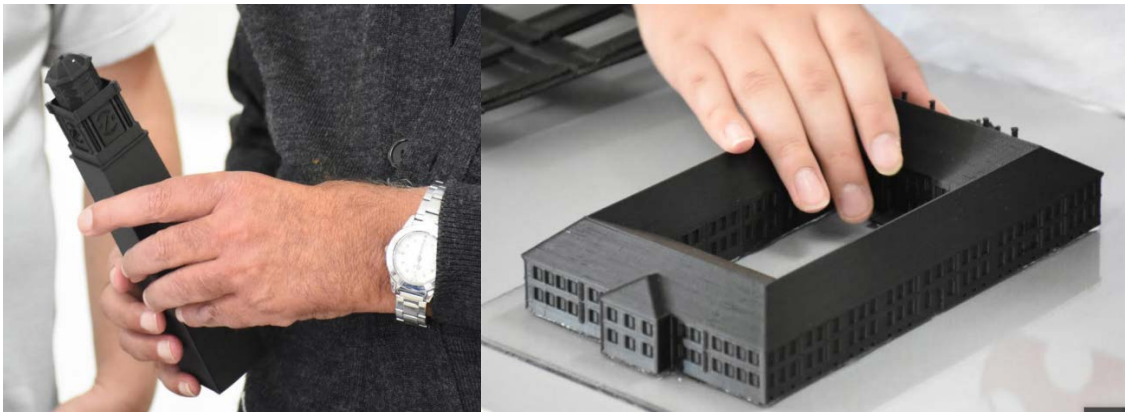

Figure 4: 3D tactile models of the Clock tower and the building of the Museum in Bitola

- **Production of touristic tactile signs**

The creation of tactile signs resistant to external weather conditions and other influences was the final step in the production of tactile representations of touristic cultural and historical monuments, Figure 5. The tactile signs are made of stainless steel on a CNC machine based on the printed 3D models.

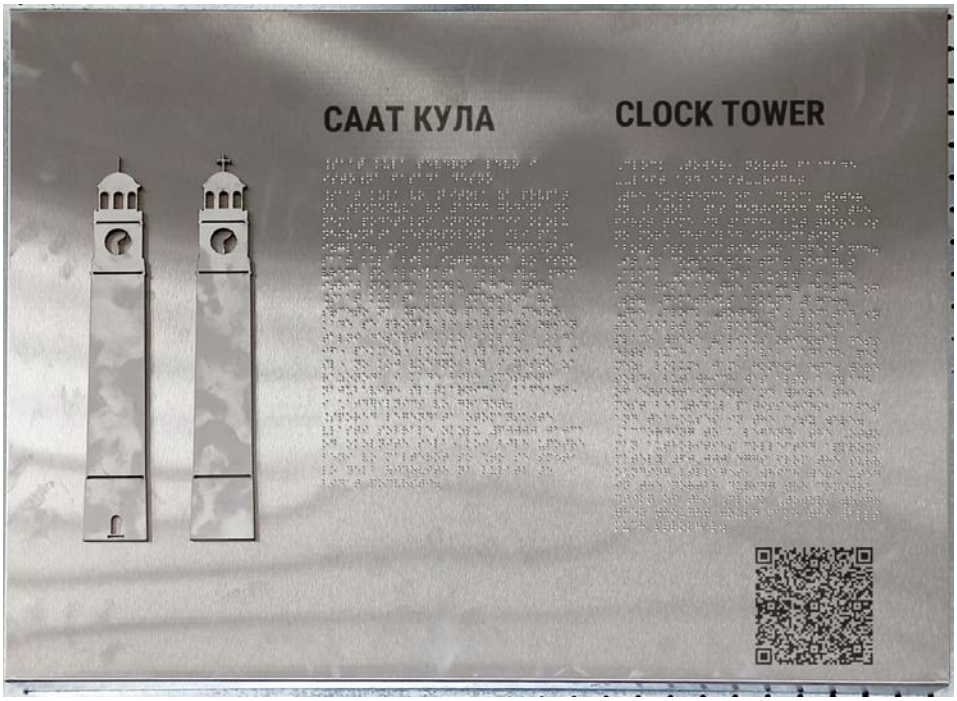

Figure 5: Stainless steel tactile sign

The design of the pedestal was in accordance with the accessibility standards, i.e., to be easily accessible to the blind and visually impaired people. The installation of the pedestals on the buildings will be realized by the Contracting Authority.

The pedestals are made of stainless steel and a tactile model of the object is placed on them, accompanied by Braille text in Macedonian and English.

What is important to note in this case is that the Braille text is only an indicative shorthand text for each object. The tactile images are also accompanied by QR code and NFC tag, that a blind person

can scan with her/his phone, after which an audio narration with full description for each facility will be activated. The audio narrations will be posted on the izi.travel app platform.

4. Conclusions

Tourism today is an integral part of the lifestyle of much of society. It carries significant weight in the economies of many countries and is one of the leading elements of international trade. Moreover, it is playing an increasing role in communication and in knowledge exchange. Given its nature and its impact, tourism should be accessible to all citizens. To enhance visits, tactile models are an important tool for blind and visually impaired people to perceive images and objects that otherwise are incomprehensible for them. Of course, verbal description or use of residual sight are always favorable, but may often be greatly complemented by the sense of touch. While touching the original objects would be best, this is not always feasible due to inappropriate scale, lack of tangible features or safety concerns.

For a long time, tactile models have mostly been created manually by skilled people. Today, the availability of ICT technologies opens possibilities for shifting from a manual to a computer-aided design process. In this regard the paper gave an overview of the implemented iterations for development of tactile signs for cultural and historical monuments in Bitola, R. North Macedonia.

As a further work a digital travel guide for people with disabilities is planned to be developed. For each of the ten selected objects (monuments) where tactile models will be placed, a digital tourist guide should be prepared according to texts and information that are publicly available on the Internet and are free to use. On all tactile models a QR code will be printed, and by scanning that code the user will be directed to the guide for that object. Besides being linked with QR code, the app will be linked using NFC tags. The NFC tags are devices which will be installed on the pedestal and the users will be able to open information by bringing a mobile device close to them. With this, cultural and historical monuments in Bitola will be accessible to the blind and visually impaired by integrating tactile exploration with audio data.

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