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Smart White Cane for Visually Impaired People for Hearing Recreation in Tourist Environment

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Abstract. The tourist cities apply technologies to strengthen and facilitate the communication of the tourists with the sporting, cultural, scientific and other aspects of a city. Smart tourism is the innovation and the adoption of information and communication technologies in tourism. The Smart white cane gives smart tourism to Blind people. The smart white cane is a white cane for blind people supplemented with Electronic Travel Aids, Electronic Orientation Aids, and Position Locator Devices. This paper proposes a smart white cane for visually impaired people for hearing recreation in tourist environments (smart tourist white cane or Smart White Cane for Smart Tourism).
Keywords: Smart Tourism, Smart White Cane, edge Computing.

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1 Introduction

Smart tourism is the innovation and the adoption of information and communication technologies in tourism. Smart tourism additionally must consider natural attractions, cultural (music festival), accessibility of transportation, amenity characteristics, ancillary services (banks, hospitals), innovative hubs for electric vehicles with a mobile app to check the availability status of charging cars, and the infrastructure of professional sports. Smart tourism is the optimal administration of the personnel or object related to Tourism by using technologies like the Internet of Tourism Things, data-mining, artificial intelligence (chatbots, deep learning, machine learning), Virtual reality and augmented reality, 3d printing, blockchain, gamification, cybersecurity, robotics, combinatorial optimisation, and others to enhance the quality of the Tourism.

A significant product of smart tourism is the smart white cane. The smart white cane is a white cane for blind people supplemented with technologies such as Electronic Travel Aids (ETAs), Electronic Orientation Aids (EOAs), and Position Locator Devices (PLDs) [17, 34, 43, 59].

Electronic travel aids (ETAs) are devices that transform information about the environment that would normally be relayed through vision into a form that can be conveyed through another sensory modality. Electronic orientation aids (EOAs) are devices that provide orientation before or during travel. They can be external to the user and/or can be carried by the user. The Position locator devices (PLDs) include technologies like GPS, European Geostationary Navigation Overlay Service (EGNOS), and others [12].

In this paper, we propose a smart white cane with diverse technologies to facilitate the tourism of blind people.

2 Smart Tourism

The components of Smart Cities are smart government (smart economics, smart open data, smart infrastructure, smart disasters, smart tourism, E-Government), smart energy, smart healthcare, smart transportation, smart building/home, smart mobility, smart society / smart people / digital citizens, smart education, smart foods production / smart farming, smart industry/manufacturing, smart environment, smart water, smart waste, smart life, smart security (Secure city). So that a city can be considered smart must comply with various elements, components or metrics.

Smart tourism is the innovation and the adoption of information and communication technologies in tourism. Smart tourism additionally must consider natural attractions, cultural (music festival), accessibility of transportation, amenity characteristics, ancillary services (banks, hospitals), innovative hubs for electric vehicles with a mobile app to check the availability status of charging cars, and the infrastructure of professional sports. Smart tourism is the optimal administration of the personnel u object related to the Tourism by using technology like the Internet of Tourism Things, data-mining, artificial intelligence, combinatorial optimisation, Machine Learning, and others to enhance the quality of the Tourism.

The Technology Components of Smart Tourism are (Figure 1):

- Information and Communication Technologies for Tourism (ICTT). ICTT is the technology used in tourism. For example, Internet of Tourism Things, data-mining, artificial intelligence, combinatorial optimisation, machine learning, software engineering, and others. Internet of Tourism Things (IoTT) is a digital interconnect of not computational and computational Tourism-Objects (Museum, theatre, statues, monuments, temples, serene mountain area, waterfalls, spring pools, Islands, beach, mall, parking facilities, airports, bus stations, train, subway, hospitals, emergency services, park, universities, and others) using Wireless Sensor Networks, RFID technology, GPS, cell phones, sports devices, and all tourism devices with the Internet.
- Data Science. Data Science analyses the data obtained from the technology devices applied to the tourism objects, extracting value from stored data, and formulating predictions through the patterns observed to serve for decision-making of Smart Tourism.
- Environmental Impact. The Environmental Impact is the tourism impacts that affect the area, vegetation, air, water, land, animals, and all the environments [4].
- Tourism Policy. Tourism policy is a set of discourses, decisions, and practices driven by governments, sometimes in collaboration with private or social actors, to achieve diverse tourism objectives [58].
- Smart Hotel. A smart hotel is an intelligent hotel with a range of information technologies working together to let the guests have an honourable and convenient vacation environment. It allows guests to have a profound image of the hotel and the city and the country [31]. The elements of a smart hotel are intelligent rooms [37], food (smart restaurant, smart kitchen), drinks (smart bar), entertainment, maintenance department, department of administrative services, department of Personnel Service, smart laundries, smart public areas (terraces, balconies, Pools).
- Smart tourism destinations. Smart Tourism Destinations cored in massive tourism resource data centre, supported by the Internet of Things and Cloud Computing, focused on enhancing tourists experience through intelligent identification and monitoring [6].
- Smart Government Services for Tourism. The smart government is the electronic government with open data that optimised the tourism budget for civil works (smart infrastructure) and priority services for tourism's well-being. Smart healthcare, Secure cities, and others.

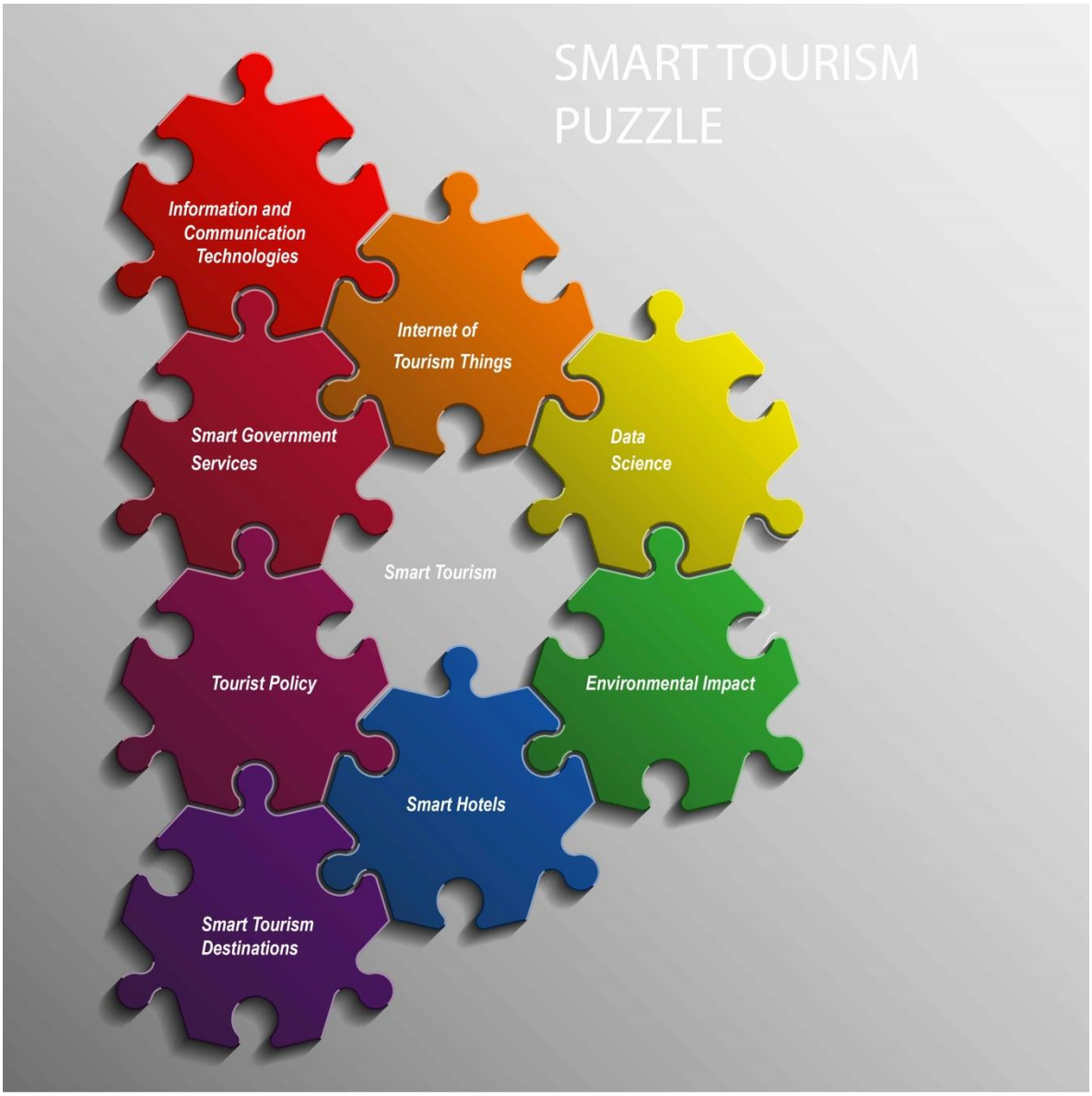

Figure 1. Smart Tourism Puzzle (components).

Smart Tourism in a Smart City has two kinds of problems and ways to resolve them:

- Tourism-Hard problems. All issues where there can be optimised (maximisation or minimisation) of tourism's resources. The Smart Tourism-Hard Problems is the management of the Tourism with Technology to optimise or monitor in real-time by the Information and Communication Technologies the physical infrastructure, aspects related to the tourism objects.
- Tourism-Soft problems. A fuzzy concept is used to drive specific government tourism agendas and others. The Smart Tourism-Soft Problems are the tourism problems that handle information inaccurate or incomplete, with uncertainty and ambiguity, volatile, poorly understood and dynamics (public tourism policy, administration, decision-making, tourism reforms).

Table 1. Smart Tourism indicators.

Smart tourism Indicators	**Description**
Total natural attractions	Astronomy (Solar eclipses, Midnight sun, Northern Lights), Beaches, Biomes and ecosystems, Bird watching, Botanical tourism, Caves, Exotic wildlife, Geographic records, Hot springs, space (Zero-G, Edge of space, Sub-orbital flight, Orbital flight, Trans-orbital flight), Karst, Mountain ranges, National parks, Outdoor life, Paleontology, Science tourism, UNESCO Global Geoparks Network, UNESCO World Heritage List, UNESCO World Network of Biosphere Reserves, Volcanoes, Waterfalls, Waterways, Whale watching.
Total cultural (music festival) in a year	Religion (Buddhism, Christianity, Churches of Ethiopia, Hinduism, Islam, Judaism, Sikhism, Zoroastrianism, Painted Monasteries, Sacred sites of the Indian sub-continent, Cemeteries, Imperial tombs of the Ming and Qing dynasties), Architecture (Castles, Delta Works, Florida lighthouses, Fortifications, Chicago skyline guide, New Mexico Pueblos, Le Corbusier World Heritage), Art (Visual arts, European art, Modern and contemporary art, Murals and graffiti, Art and antiques shopping), History (Archaeological sites, Old towns, Ghost towns, Industrial tourism, History of justice, Pioneer villages, UNESCO World Heritage List, Nuclear tourism, Military tourism, Indigenous peoples of North America, Military museums, Mining tourism, Spies and secrets), Ethnic groups (Celts, Sami culture in northern Scandinavia, Roma culture in Europe, Indigenous heritage, Indigenous Peoples Trail in Nepal, Indigenous cultures of North America, Indigenous cultures of South America, Minority cultures of Russia, New Mexico Pueblos), Spectator sports (American football, Australian football, Baseball in the United States, Basketball in North America, Cricket, Football in Europe, Handball in Europe, Ice hockey in North America, Motor sport, Olympic Games, Rugby football), Fiction tourism (Assassin's Creed Tour, Game of Thrones tourism, Horror fiction, James Bond tourism, Literary travel, Breaking Bad Tour, The Wire Tour, X-Files tourism), Music (European classical music, Jazz, Music festival circuit, Music in Britain and Ireland, Nordic music, Rock and roll, Salsa dancing in Latin America), Games (Chess, Xiangqi), Holidays (Christmas and New Year travel, Easter travel, Christmas markets, Halloween, Day of the Dead, Chinese New Year/Golden Week holidays in China, Travelling during Ramadan), Others (Alcoholic beverages, Art and antiques shopping, Big things in Australia, Cryptozoology, Fringe phenomena, Japan's Top 3, Monarchies, The Most Beautiful Villages of France, Museums, Musicals, Nightlife, Off the beaten track in Japan, Ohio State Parks, Places with unusual names, Reenactment and LARP, Touring prestigious and notable universities in the U.S., Trams in Melbourne, Signs, Steam power, Stand-up comedy, UFOs, Underground works, UNESCO Creative Cities, UNESCO Intangible Cultural Heritage, United Nations).
Accessibility of transportation	speaking buses, accessible apps, braille labels on the stop buttons, high-contrast features, talking elevator controls, room keys that make it easy to tell which end goes in first, central call center, hotels with screen reader or software for zooming, screen reader or software for zooming, guided tour, large history and art museums sometimes hold special hands-on tours for blind and visually impaired people, gift shop, dog guide, deaf or hard of hearing (HOH) may benefit from some specific features, such as lights on fire alarms, restaurants and stores have employees that use sign language, public services to be accessible by wheelchair, coins are intentionally designed to be easily recognisable by touch.
Amenities characteristics	High-Speed Internet, Walk-in Closet, Soundproof Walls, Balcony or Patio, In-Unit Washer and Dryer, parking, pool, fitness center, secured community access, recycling, Walkability (to easily walk to nearby amenities and locations like shopping centres or schools, striking or unique design).
Ancillary services	Bank, package shipping services, hospitals.
Innovative Hubs	An innovative hub for electric vehicles with app mobile to check all the availability status of the vehicle´s charging cars.

There are diverse works on Smart Tourism: Main and O'Connor [39] propose Smart hospitality; they mention that the hospitality and tourism industry fails to take advantage of the marketing intelligence gathered during visitor stays. Camacho, Borrajo, and Molina [8] present Intelligent Travel Planning (ITP), a multi-agent planning system to solve Electronic Web problems in the Web, whose main goal is to search for useful solutions in the Electronic-Tourism domain to system users. Godart [22] uses the Travelling Salesperson Problem (TSP) as a starting point to plan trips.

Buhalis and Deimezi [5] examine the e-Tourism developments in Greece as a country that is gradually embracing e-commerce. They examine the level of ICT diffusion in Small and Medium-sized Tourism Enterprises (SMTEs) as well as whether the level of online presence is sufficient to cover for the lack of a Destination Management System (DMS). Maruyama et al. [40] present a personal navigation device that calculates tourist routes called P-Tour.

Shiraishi et al. [51] propose a personal navigation system that computes and shows the best route to the next destination and facilitates the composition of a schedule for visiting those destinations taking account of various requirements such as relative importance among destinations, time restrictions, travel expenses, and so on.

Adomavicius and Tuzhilin [1] propose Intelligent Tourism recommender systems. Ten Hagen et al. [54] propose a collection of Tour Building Blocks (sights, restaurants, and others). Medical tourism consists of patients traveling overseas for cosmetic surgery, and medical treatment [11]. Lee, Kang and Park [36] present a tourism tour planning system for a province in Korea. Vansteenwegen and Oudheusden [57] use the OP to solve Tourist Trip Design Problems (TTDP).

Castillo et al. (2008) [9] present a multi-agent-based system for planning tourist visits. Lee, Chang, and Wang [35] present a recommendation system that allows planning, personalised travel routes to Tainan City, China. Yu and Chang (2009) [30] developed a framework for the personalised recommendation of hotels, restaurants, and POIs. Sebastia et al. [48] mention that e-Tourism is a tourist recommendation and planning application to assist users in the organisation of a leisure and tourist agenda.

Kawai, Zhang, and Kawasaki [29] propose an advanced tour recommendation system, which includes the extraction of famous spots from the Web and route search based on the visibility of scenery along a route. Kawai, Zhang, & Kawasaki [29] propose an advanced tour recommendation system, which includes the extraction of famous spots from the Web and route search based on the visibility of scenery along a route. Kawai, Zhang, and Kawasaki [29]propose an efficient tourist route search system that recommends the path simply connecting several tourist spots and recommends the path with beautiful scenic sights. Souffriau and Vansteenwegen [52] demonstrate how existing models from the field of Operations Research fit the tourist trip planning problem, and enable a wide range of tourist trip planning functionalities.

Fernandes [16] deployed a prototype of a Serious Game for Android to enable the study of the effects on tourists of an application. Chakraborty, Hashimoto, and Chakraborty [10] presented a computational framework of multiple route generation technique for a pedestrian navigation system incorporating user's preference based on computational intelligence approach, Particle Swarm Optimization (PSO), an evolutionary algorithm, has been used for the generation of multiple routes with different characteristics. The Smart Tourism Destinations [6] aim is to utilise the system to enhance tourism experience and improve the effectiveness of resource management towards maximising both destination competitiveness and consumer satisfaction while also demonstrating sustainability over an extended time frame.

The tourist trip design problem refers to a route-planning problem for tourists interested in visiting multiple interest points. Gavalas et al. [21] survey models, algorithmic approaches and methodologies concerning tourist trip design problems. Smart tourism is a social phenomenon arising from the convergence of information technology with the tourism experience [28].

Hunter et al. [28] introduce the constructivist paradigm and associated research methodologies as another toolbox for interpreting how smart tourism works as a form of soft power. The implications revealed by constructivism are that through smart tourism ecosystems, destination commoditisation, experience and image formation. Smart tourism is defined as tourism supported by integrated efforts at a destination to collect and aggregate/harness data derived from the physical infrastructure, social connections, government/organisational sources and human bodies/minds in combination with the use of advanced technologies to transform that data into on-site experiences and business value-propositions with a clear focus on efficiency, sustainability and experience enrichment.

Lu et al. [38] mention that the tourism recommender systems are programs that attempt to recommend the most suitable items (products or services) to particular users (individuals or businesses) by predicting a user's interest in an item based on related information about the items, the users and the interactions between items and users.

Gul and Topcu [24] develop a touristic suggestion model (Analytic Hierarchy Process and Technique for Order Preference by Similarity to Ideal Solution TOPSIS multi-attribute decision-making methods) for tourist candidates concerning their expectations and preferences about tourism.

Cacho et al. [7] describe a smart city initiative presenting a mobile tourist guide developed for Natal, Brazil. Sukhbaatar [53] proposed the Iterated Local Search Algorithm to tackle the Time-Dependent Multi-Constraint Team Orienteering Problem with Time Windows. They applied the model and algorithm to the mobile tourist tour recommendation system (UBTourPlanner) to plan a tour for Ulaanbaatar city.

Scott et al. [47] provides a review of eye-tracking as a technique for measuring attention and discusses its theoretical basis, advantages and disadvantages, data collection procedures, analysis methods, and application in tourism and hospitality. Micera and Crispino [42] propose a framework for analysing the destination image-building process, where the sentiment analysis is integrated with social network analysis tools and social media analytics, making them accessible and functional for destination management choices. Tüzünkan [56] mentions that Smart tourism provides the adaptation of smart technologies with tourism, the Internet, cloud computing, mobile communication technologies, artificial intelligence, fast wireless communication, Geographic Information systems and Virtual Reality.

Tripathy et al. [55] present a viable Internet of Things (IoT)-based solution framework (iTour) for independent tourist mobility. Wu, and Cheng [31] examine the relationships among technology attachment, the dimensions of experiential relationship quality, experiential risk and experiential sharing intentions by using structural equation modelling (SEM) and hierarchical regression analysis (HRA) of a convenience sample of 525 guests during the check out from the LINQ Hotel & Casino in Las Vegas. They assist smart hotel management in developing and implementing market-oriented service strategies to increase the dimensions of technology attachment and the dimensions of experiential relationship quality, decrease experiential risk and create experiential sharing intentions. Matsuda et al. [41] propose a tourist emotion- and satisfaction-estimation system (EmoTour) to estimate the emotional status and satisfaction level of users susceptible to rating their activities (e.g., tourists during sightseeing from Germany and Japan). EmoTour employs the combination of behavioural cues and audiovisual data collected by an eye-gaze tracker, physical-activity sensors, and a smartphone. In detail, the following high-level features were derived from each modality and fused to build a final classifier: eye movement, head tilt, and footsteps from behavioural cues; and vocal and facial expressions from audiovisual data.

Dorcic, Komsic, & Markovic [13] provide a systematic review of the most recently published academic research on mobile technologies and smart tourism applications. Farsani, Ghotbabadi, and Altafi [15] investigate that the tourists are interested in agri-tours (agritourist) and both tangible and intangible agricultural heritage from tourists' perspectives. Qin et al. [45] use Big Data technology and the Call Detail Record data with the mobile phone real-time location information to monitor the tourist flow and analyse tourists' travel behaviour in scenic areas.

3 Smart White Cane for Smart Tourism or Smart tourist white cane

There are a set of techniques, knowledge and resources aimed at the blind and visually impaired, the appropriate means for the correct use of technology to promote their autonomy and full social, labour and social integration Educational. It encompasses both the simplest and easiest to apply materials and the most complex and needing prior knowledge for use. Study their conditions and problems, for the purpose.

The most well-known tools are Tracking Stick, Guide Dog, Braille System, Pekins Braille Machine, Braille Printers, Cramer Abaco, Talking Calculators, Braille Arithmetic Box, Computer with a Screen Reader, phone with a synthesised voice, talking or High Relief clocks, among others.

The white cane is a touch tool made of synthetic fibres that guides the steps of the blind, letting you notice what type of surface you are walking on and providing you with information about its location. Traditional types of white cane are long cane (designed as a mobility tool, allowing the detection of obstacles to a user's path), "Kiddie" cane (designed for children's use), identification cane (Symbol Stick, allows to alert about the visual weakness of the wearer, it is only a tool of mobility), help cane (provides physical stability to a visually impaired user).

There is a variant of the traditional white cane called the Electronic White cane. There are two electronic cane models: the Tom Pouce [small] that detects objects four meters away with vibration alerts. There is also the Teletacto with 15 meters of range,

greater description of the space, detects profiles and recognises shapes). Tom Pouce and Teletacto measure the distance of objects by laser and transmit information through sounds and vibrations through a hand-attached device, complementing a traditional white cane's functions.

iSonic (vibratory cane for the Blind, is a basketball that allows the user to warn the proximity of obstacles to waist height in their path, using supersonic sensors. It can also detect 10 colours and their intensity, transmitted by voice prompts). Mygo (a blind cane that serves as an electronic guide dog, carries a video camera and proximity sensors that track the surroundings. The information obtained is sent to headphones).

NAVI project (using a Kinect®, visual data from the environment such as figures, colours, speed and various parameters, which are processor by a computer that the attendee carries on his back, the information is translated into verbal indications and warning vibrations on a belt that reports on proximity and characteristics).

Virtual White cane (tool connected to a joystick that interacts by touch. You can emit sounds, explore 3D virtual worlds based on real-world ambient maps. The software becomes a computerised white cane for the blind, smart cane for the Blind (detects obstacles and facilitates movements, by incorporating an ultrasonic sensor that outputs audio messages to indicate to the user direction to walk to avoid obstacles).

MyMap (Robot-cane that serves as an assistant for blind people to improve their walking in the city. It works by mediating a sensor that reads the location coordinates using GPS, determining distances and direction, and emitting a sound that guides the path, the place controls and the selection of options).

Eye Stick (cane with sensors for the disabled, cane with a sensor at the tip, able to recognise if there are objects around it to warn if you have to follow that path or move. Identifies the type of terrain, ladder, or large obstacles. Each signal or obstacle is transmitted to the user by vibrations so that they can recognise exactly what it is.)

There are diverse works on smart white cane:

Shiizu et al. [50] proposed an intelligent white cane based on RFID tag, coloured navigation lines and pre-recorded voice to notify the area information supporting the visually impaired independent walk.

Faria et al. [14] proposed an electronic white cane named Smart Vision system, oriented to give the ability to move around in unfamiliar environments based on Geographic Information System and RFID technology.

Palleja et al. [44] created a bioinspired electronic white cane based on the whiskers principle for short-range navigation and exploration. In this proposal, the data is acquired from low-size terrestrial LIDAR and tri-axial accelerometer to generate tactile information using electromagnetic devices (tactile belt).

Gallo et al. [17] proposed white cane's complement based on multimodal augmented haptic feedback to extend the haptic exploration range. This device used a hybrid range sensor to obtain information over two haptic feedback systems.

Wang and Kuchenbecker [60] presented a haptic cue device to prevent the presence of low-hanging obstacles. This device can be attached to traditional white canes. The detection is based on an ultrasonic range sensor with vibration feedback.

Khan and Kumar [32] proposed a solution for visually disabled people to solve their navigation problems to a certain extent. The proposal is based on reaching its destination with the help of Google Maps. The device is based on Bluetooth-enabled white cane and the Google Maps API navigation through Arduino's card via buzzing sensations.

Halim et al. [25] proposed GPS electronic white cane to enhance blind people mobility without distance coverage limitation. The proposal is based on ultrasonic sensors to measure the distance and actuator (servomotor) to produce a radar system; if there are obstacles near the white cane, this device generates vibrations.

In table 2 and 3 are the related works and patents of the smart white cane.

Table 2. Related works.

Authors	Kind of cane	Description
Khan and Kumar [32]	White cane	Bluetooth-enabled white cane
Pallejà [44]	White cane	bioinspired electronic white cane based on the whiskers principle for short-range navigation and exploration
Faria et al. [14]	Electronic white cane	Based on Geographic Information System and RFID technology
Wang, Kuchenbecker [60]	Complement to a white cane	Haptic cue device to prevent the presence of low-hanging obstacles
Shiizu et al. [50]	Intelligent white cane	An RFID tag, coloured navigation lines and pre-recorded voice
Gallo et al. [17]	Complement to a white cane	multimodal augmented haptic feedback

Table 3. Patents.

Authors	Country	Description
Aleksander [2]	United States of America	An improved white cane with an elongate body and a proximal end adapted to be held by or secured to a human user and a distal tip, and a noise generator located proximate.
Gassert et al. [20]	United States of America	Electronic Travel Aid (ETA) for blind and visually impaired persons based on the detachable handle of a white cane. This device provides risks warning of collision at trunk or head height.
Seymour-Osman [49]	United States of America	A dual-mode cane including a low-friction surface at an angle less than or equal to a transition angle
Hubachek [27]	United States of America	Walking cane with the elongated tubular main shaft of light, covered by translucent white light.
Hopkins [26]	United States of America	White cane with barcode scanning, sonar, colour sensory, laser depth finding capacity and audio production mechanisms and digitising technology. This cane can detect and prevent audio or vibratory output through obstacle detection, drop-offs, colours, or barcode sites.
Ryoo et al. [46]	United States of America	A wearable apparatus focused on converting the vision signal into a haptic signal and a voice guiding service can be provided through a network. This device can be mounted on glasses or white cane and a haptic signal processing module wore on a skin.
Gamerman [18]	United States of America	A high precision measurement sensor based on Spatial Recognition Device (SRD) can detect and navigate objects and obstacles similar to traditional white cane without contact. This device can provide route guidance based on GPS and collision avoidance, accelerometers and other sensors.

The smart white cane is a white cane for blind people supplemented with Electronic Travel Aids, Electronic Orientation Aids, and Position Locator Devices. This paper proposes a smart white cane for visually impaired people for hearing recreation in tourist environments (smart tourist white cane or Smart White Cane for Smart Tourism). This paper will create a smart white cane supported by plates and a sensor that will identify and orient the blind of the tourist space in which it is located, through prerecorded audio files stored in the cane, and, in this way, allow knowledge of these places and their history. The Smart tourist white cane components are (Figure 2):

- Tourism Attractions. Tourism attractions can be considered why tourists and excursionists visit a tourism destination and, as such, are considered basic tourism resources and visitor accessibility (physical access, public access, signage, sightseeing, touring, interpretation, printed information).
- TAGS RFID. Radio-frequency identification plates use electromagnetic fields to automatically identify and track tags attached to tourist attractions (the audio information of the tourism attractions).
- RFID reader's and BLE beacons. A white cane with Arduino is used as a tourist plate reader for RFIDs and its complemented with BLE beacons for site localization.
- Local SW & Infrastructure. Prerecorded audio files with descriptions for blind people (BBI APK) is used to guidereproduce the sounds in mp3s format of tourist attraction information.

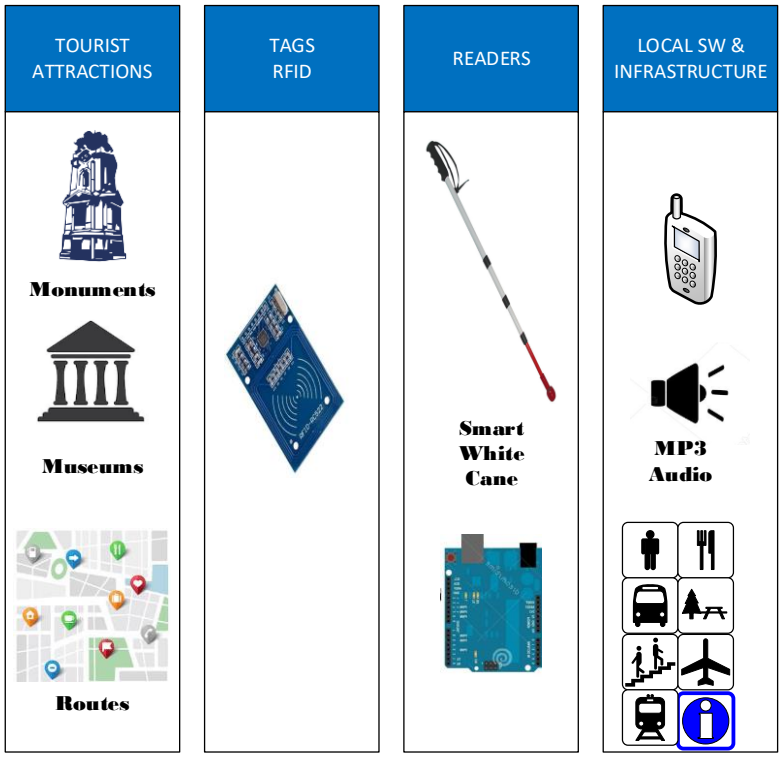

Figure 2. Smart tourist white cane process.

For the experimentation phase, an Arduino board was used to recognise the objectives made use of RFID boards, and for its connection and playback of the multimedia files, a second Arduino is used to interface a mp3 player, which reads a SD or USB memory with audio information. A BLE is implemented to know orientation inside a museum or building. Additionally, a small mobile application called the tourist mobile app for the Visually Impaired People (Figure 3) was developed, which once installed is configured where the smart tourist cane will be used. The application can add new tourist attractions and the playback of ads audios. It should be mentioned that tourism professionals will need to update, install and configure the tourist cane with the smartphone, as well as provide it to users.

The white cane consists of two main components: 1)a RFID detector placed in a case that tries to maintain it parallel to the ground. the case is parallel to the ground in almost 10cm, that is the maximum distance to detect a RFID plate and 2) Smart handgrip, it

contains a microcontroller working in Arduino, LiPo battery, two vibration motors for retro alimentation and indications and a mp3 mini player. Audio files are inserted in the system using a SD memory or USB stick.

Data flow is shown in figure 3, after power on white cane tried to read a RFID pad, if one is found a vibration alerts to the user. User can choose between to continue in the attraction after a intro audio or continue to the next. Finally, a right and left motors indicate next attraction and the process continues.

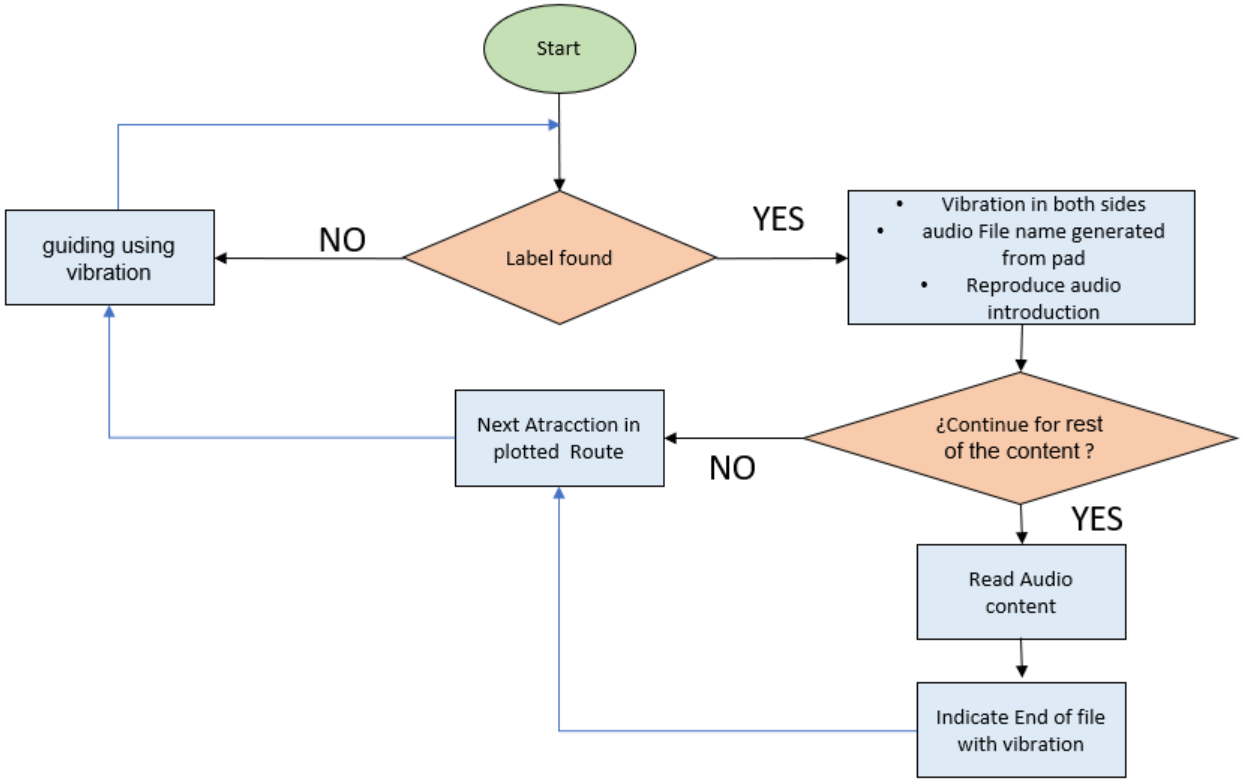

Figure 3. White cane Data flow

Hardware design is based in small component to carry a compact structure. LiPo battery to download weight is required and given its shape is located with the RFid detector near the floor. A small MCU provides communication with the system at handgrip using a serial protocol.

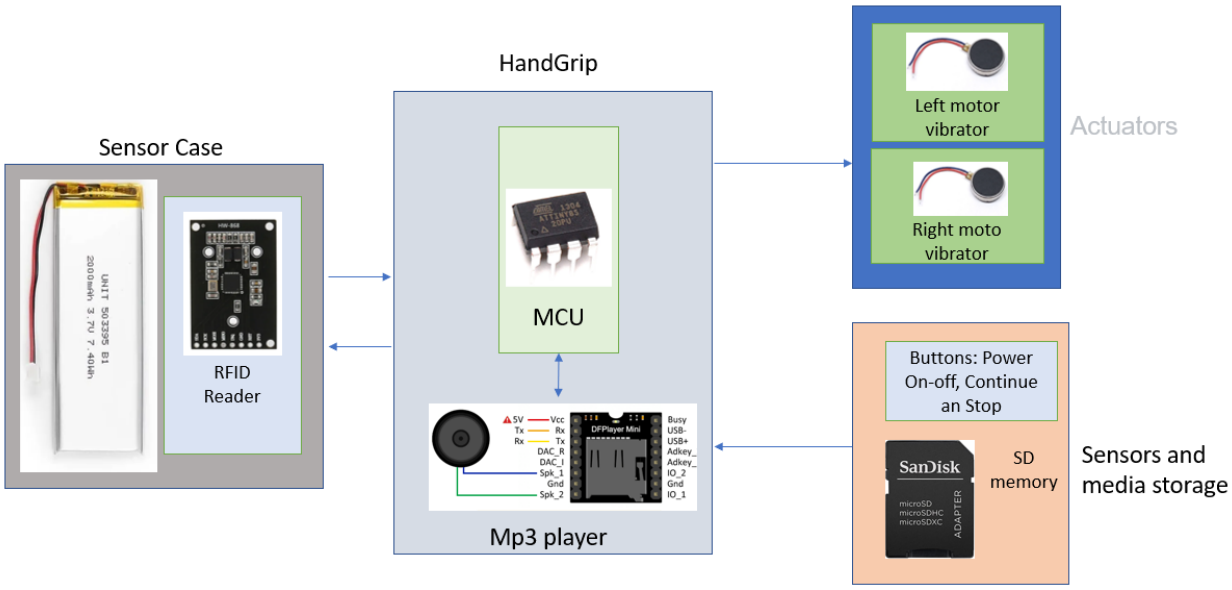

Figure 4. Electronic structure, the handgrip carries control elements and actuators, RFID and battery are near of the floor.

Inside the handgrip, microcontroller uses a mp3 player, two audio files are recorded for each attraction: one for introduction and the second for extended explanation. Additional instructions are recorded for guide. Vibration motor uses that information to indicate a route. Mp3 player offers a mini audio amplifier so no earphones are required (Figure 5).

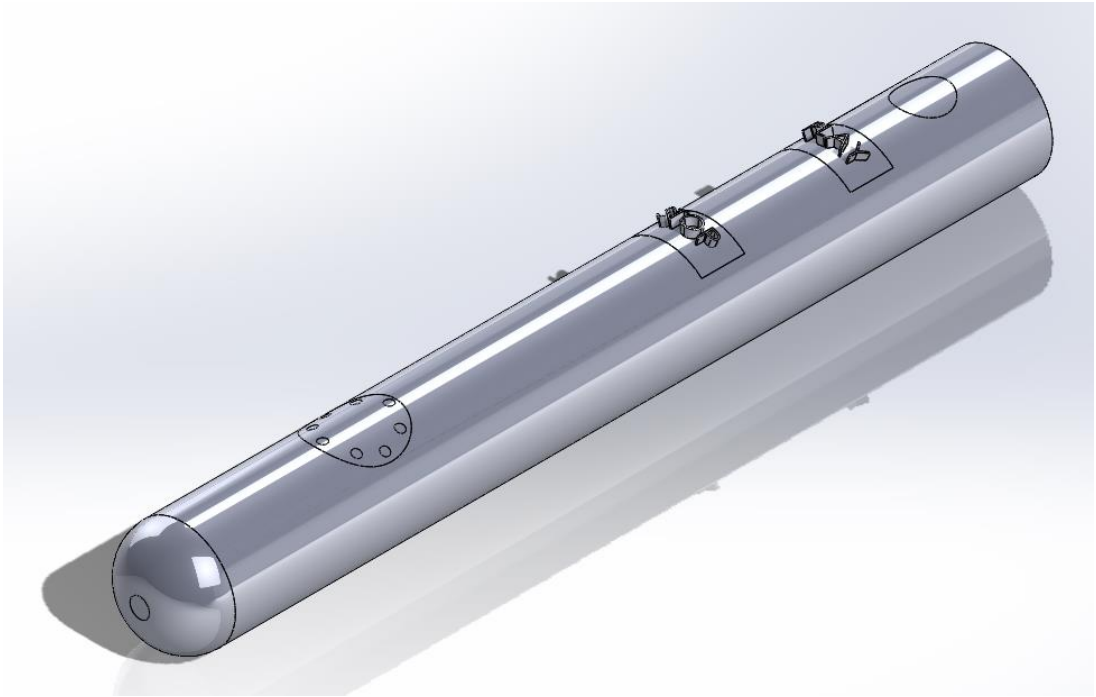

Figure 5. Handgrip 3d view, inside the box: microcontroller, two vibration motors, both at the sides and audio speaker, SD and USB slots are in the other side. SD is for media storage and USB is for energy charging.

Figure 6 indicates the human interface; such interface is located below the handgrip for ergonomic reasons.

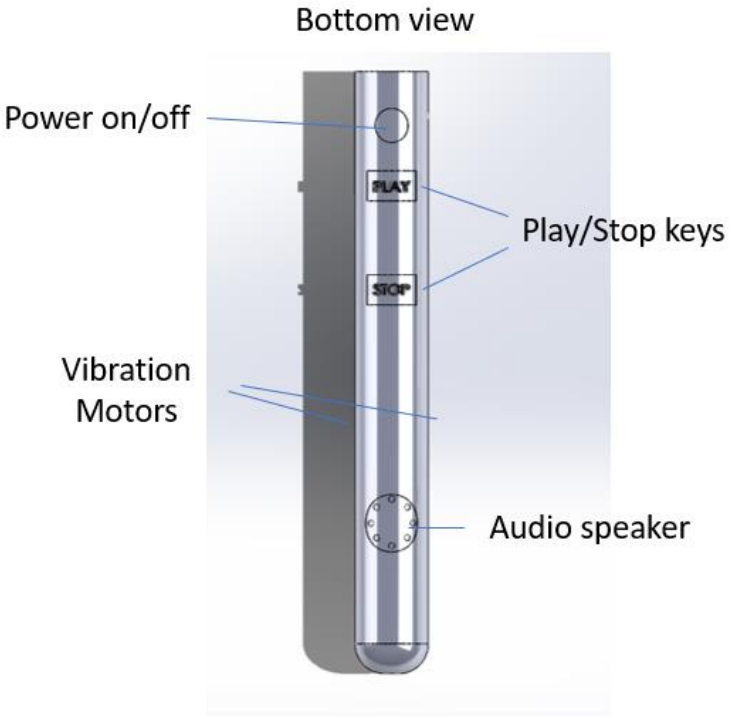

Figure 6. handgrip human interface details

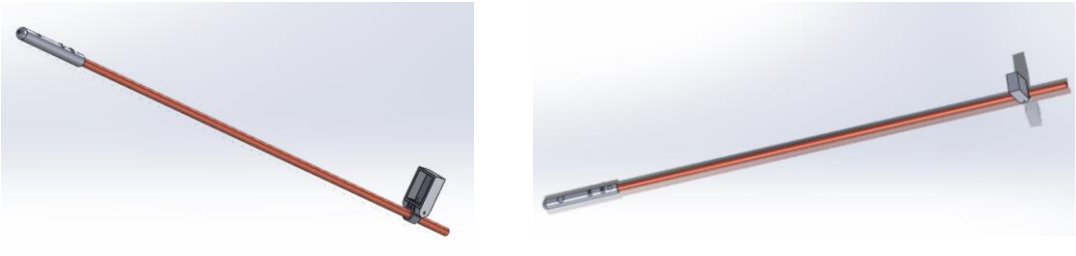

Figure 7. General view of the smart white cane for tourism.

4 Conclusions

Working The smart tourist cane proposal for people with visual weakness is an innovative idea, and it is suggested that the necessary smart tourist poles and accessories be provided by people working in museums, travel and various professions related to the tourism of a smart city. People will be responsible for updating the mobile app according to the language and monuments to visit by the visually impaired.

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Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest

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