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# Smart Audio Tour Guide System using TTS

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**Abstract**

The global positioning system (GPS)-enabled mobile phones provide the location-based tourist guide applications for indoor or outdoor environment. In this paper, we develop the location-based audio tour guide system using speech synthesis provided by the server-based text-to-speech (TTS) engine. The mobile audio guide travel application provides real-time tour information in multilingual versions at the major tourist attractions. The developed audio tour guide system is consisted of the tour guide service system, the wiki-based tourist information collection system, the tour information DB, the server-based TTS engine, and Android and IOS mobile apps. The developed tourist guide system is very helpful for tourists and enhancing self-guided tours of outdoor locations. The audio tour guide services also provide safe and comfortable route and path guidance for pedestrians and handicapped or elderly people. One of the essential components for an audio guide system is the geotagging tour information. We are building the location-based tour information DB and photos for smart audio tour guide in the major walking tourist spots in Jeju and Seoul.

**Key Words**: smart tourism, audio tour guide, text-to-speech (TTS), location-based service (LBS), context-awareness.

## 1. Introduction

Digital tourism is supported by digital technology for tourist activities before, during, and after the trip. Smart tourism provides the real-time and personalized tour information based on information and communication technologies (ICT) such as big data, Internet of Things (IoT), cloud computing, and artificial intelligence (AI) [1]-[4]. Smart tourism destination is an evolution of the concept of smart city applied to tourism destinations [5]. The GPS-enabled mobile phones provide location-based mobile tour apps such as tour guide and storytelling services. The mobile tour guide app provides tour information to help travelers to find and navigate points of interest (POI) around their trips. The smart travel guide systems using landmark ranking systems have been proposed to offer diverse online travel services [6]. IoT and big data analytics for smart tourism and sustainable cultural heritage with a context-aware recommendation system has been proposed [7]. The augmented reality (AR) on smart device has been proposed to provide POI information and contents triggered by Beacon ID [8]. It provides the virtual space in which tourist can explore and can have seasonal experience by using AR, VR and MR technology. An offline mobile application for places identification with AR has been proposed to give a pleasant experience to their visitors [9]. The traffic or street lights provide tour guide information using visible light communications (VLC) [10].

Geographic Information Systems (GIS) provides various information of location by combining position data and attribute data of object having geographical position. The pedestrian navigation provides safe and comfortable route and path guidance for pedestrians and handicapped or elderly people. The implementation of pedestrian network data in the tourist attractions without vehicle networks has been proposed using spatial and non-spatial data on GIS [11].The smart tour guide service platform based on GIS and mobile tour guide app have been proposed to provide digital tourism of pre, during, and after trips [12]. Spatial data includes GPS trajectories, points of interests (POIs), and geotagging tour information and nonspatial data includes profiles and friends' lists, region names, postal codes, road names, and speed limits. In this paper, we apply the two technologies of LBS and GIS so that user can use the desired tour information such as POI, point of story, point of risk, point of photo, etc.

Deployed 5G networks and sensors in the smart city enable the smart mobility by managing flows of people, cars and goods [9]. The user data show tourists' interests, motivations, patterns of travel planning, and residential experiences. Jeju special self-governing province, Korea, is building a big data platform and plans to provide smart tourism services by installing free WiFi and Beacons at the major tourist attractions. We can discover the position information and confirm the flow of tourists based on the activity performed through their mobile terminal such as the smartphone, WiFi ID, and Beacon ID. The traditional manual analysis methods

such as questionnaire survey have the high cost and low efficiency. Big data has a high potential in prediction of searching the tour information before his/her travel or after reaching the destination and employs routing systems of his/her phone before or after reaching the destination. We can analyze the users' position information and the flow using traveler's movement trajectories and visited spot data in the major tourist attractions defined as the point, line, and zone tourist attractions on GIS [12].

The text-to-speech (TTS) system translates letters, sentences, numbers, symbols, etc. into a human audio [13]. The advantage of this system is that it is easy to implement and accept other actions, and is an efficient system that can provide information for the visually impaired. In this paper, we develop the location-based audio tour guide system using the server-based TTS engine.

## SMART AUDIO TOUR GUIDE USING A SERVER-BASED TTS ENGINE

The location-based tour guide is very useful for tourists, enhancing self-guided tours, and enhancing the tourist's travel experience. The multilingual audio tour guide system provides tourist information optimized for tourists using tourist context information such as language, age, gender, preferences, and local information such as date, time, location information, and weather on tourist spot as shown in Figure 1. The location information is obtained by GPS coordinates, Beacon ID, and WiFi ID, etc. The audio tour guide system extracts the optimal tourist information from the tourist information database and provides that to individual tourists.

The developed audio tour guide system is consisted of tour guide service servers, tour information collection servers, a tour information database (DB), a server-based TTS engine, and mobile apps as shown in Figure 2. The tour guide service system selects the optimal tour information based on the user's context information and provides the multilingual audio guide through the server-based TTS engine to the user's mobile apps. As well as travel experts and local tourism experts, tourists can write their travel experiences as tourist information based on their travel experiences using a wiki-based tourist information collection system. The tour information DB stores the multilingual geotagging tourist information audited and updated by the administrator of tour information collection servers. The server-based TTS engine supports multilingual audio guide and provides audio tour guide service by request of mobile app. We also use Geographical Information System (GIS) to create and display the geotagging tourist information. The smartphone with GPS capability is used as a user client. Before, during, and after the trip, the user can use the tour guide service provided by the system using the mobile app of his/her smartphone. Before the trip, the user can select and save the guide spots while experiencing the audio guide service at his/her favorite recommended travel destination. After the trip, the user can provide travel experiences along with traveled trajectories to other users, such as friends and acquaintances, as recommended trips.

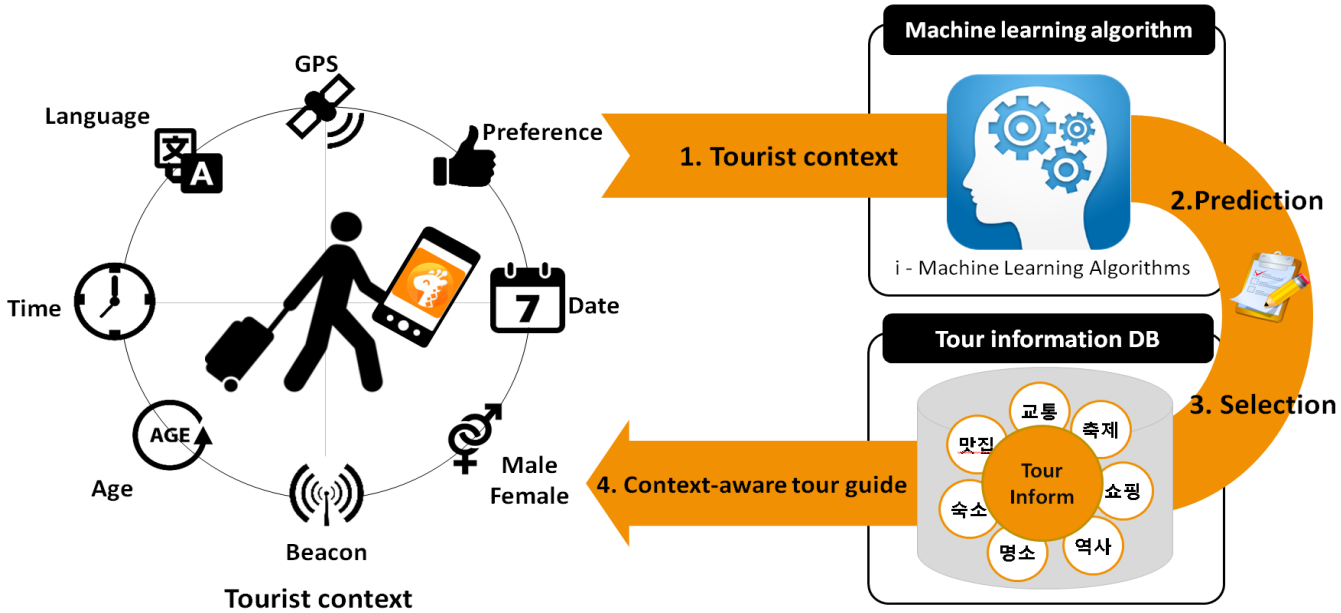


**Figure 1.** Context-aware audio tour guide

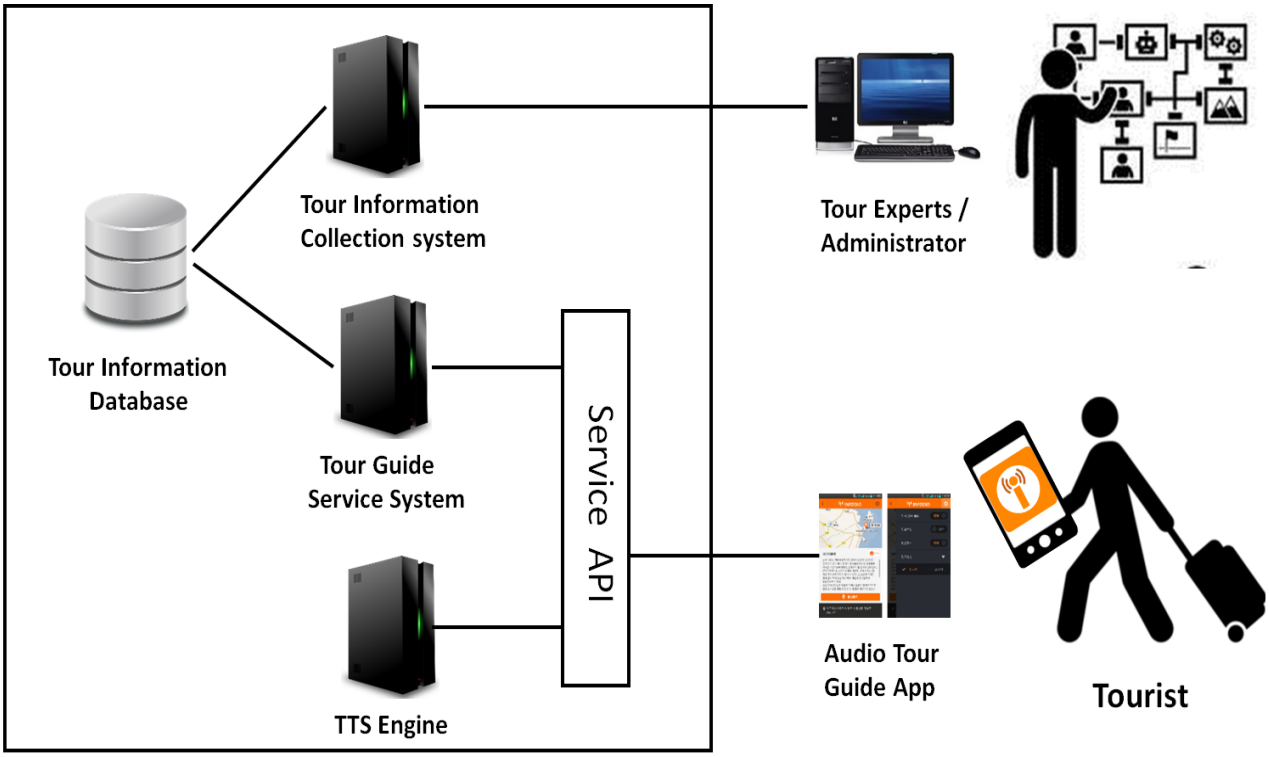


**Figure** 2. The block diagram of the developed audio tour guide system

**Wiki-based Tour Information Collection System using Google Docs**

The most difficult problem in the tour information services is to build and update a variety of experiences of travelers to the database. In this paper, we use Google Docs' remote collaborative document authoring tool to allow multiple authors to collaborate and create tour information. Figure 3 shows an example of the tour information created using Google Docs [15]. The tour information is consisted of title, contents, classification, coordinates, hash tags, and so on. We write contents of tour information in Korean and then translate it into English, Chinese, and Japanese. The contents may be created by travel experts, local tourism experts, and tourists based on their tour experiences. The contents based on the traveler's experience give a various and dynamic tour guide for the same attraction so that they will lead to let people revisit the place. In this paper, undergraduate students and international students at Jeju national university have created the multilingual 2,561 contents in 26 Olle courses [16].

We classify the tour information as point of interest (POI), point of route plane (PORP), point of story (POS), point of risk (POR), point of photo (POP), and point of event (POE). POIs represent not only restaurants, cafes, and accommodations but also tourist information centers, toilets, first aid, sperm, and shelter necessary for traveling. RORP is the important places for the pedestrians for pedestrian route guidance (RG) to travelers that provides pedestrian-navigation information such as directions, stairs, and landmarks of the reference points in the environment. PORP is used to provide audio landmark-based spatial routing [14] for tourists who are not familiar with location-based tourism information. Audio guide service using PORP improves pedestrian safety, reduce potential accidents, and promote mobility and accessibility. POS is the tourist spot where storytelling contents are provided at tourist attractions developed by travel experts, local travel experts, and tourist. The storytelling contents for the same POI can be variously created according to the creator. POR is the tourist spot of explaining to tourists about dangerous points for walking tours. The POR is created so that it can be guided taking into account the weather information, time, and the user's condition. POP is a photo zone in the tourist spot set by travel experts, local travel expert, and tourist. In the port zone, we provide photographs and information for taking pictures. POE explains events such as festivals in the tourist spots. The coordinates of the tour information are GPS measurement data and data from maps at spots.

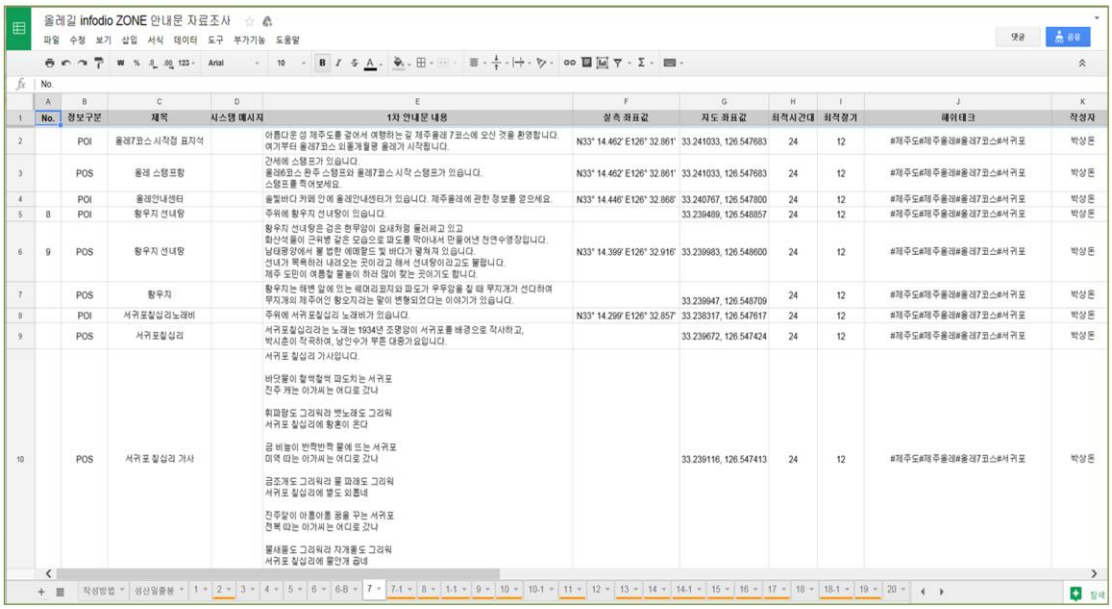


**Figure 3.** Contents of tour information created using Google Docs

**Audio Tour Guide Mobile Apps**

We develop audio tour guide Android and IOS apps on smartphones with WiFi, Bluetooth, and GPS capabilities. Figure 4(a) shows the main screen of the developed audio tour guide IOS app. Users can choose Korean, English, Chinese, and Japanese for using audio tour guide provided from the server-based TTS engine as shown in Figure 4(b). The mobile app transmits the service request message including the user context to the tour guide service system through HTTP API and the tour guide service system provides the optimal tour information to the user through JSON API. The user set the user context such as gender, and age, travel type, free or paid attraction as shown in Figure 4(c). The mobile app sends the received content to the server-based TTS engine and the TTS engine provides audio tour guide using the content to the user. The guide spots are displayed on the map in different colors according to their classification so that the user can see it well as shown in Figure 4(d). The audio guide service is now being serviced in Jeju Olle, Jeju Stone Park [17], and Seoullo 7017 [18] of the major walking tourist attractions in Korea. Figure 5 shows screens of the multilingual audio tour guide IOS app being serviced in Jeju Olle and Seoullo 7017. Figures 5(a)~(c) show Korean, Chinese, and Japanese audio guide spots in Olle 7 course, respectively. Figures 5(d)(e) show English audio guide spots in Seoullo 7017 and tour information, respectively. Tour information includes photos as well as a guiding text executed by the TTS engine.

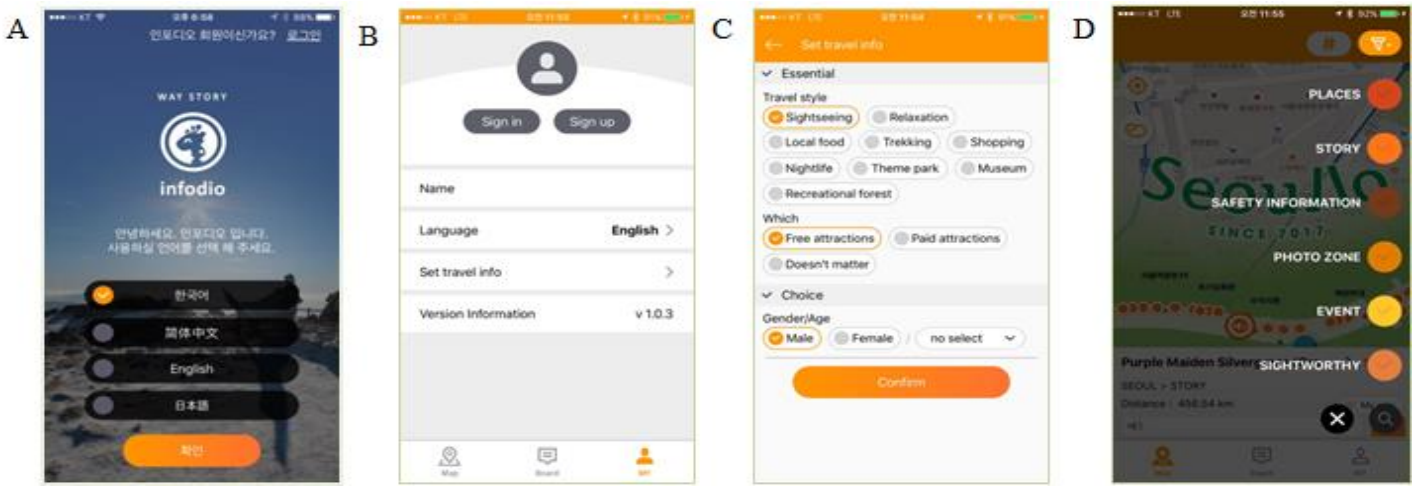


**Figure 4.** Screens of the developed audio tour guide IOS app: A, Main screen; B, My menu; C, User travel info; D, Tourist spot colors.

We provide audio tour guide service according to types of transport such as cars, bicycles as well as walking tourists. The mobile app calculates the speed of movement using GPS data and distinguishes between car trips, bicycle trips, and walking trips. Mobile apps automatically provide audio guide services based on travel type. We build tour information by separating the car travelers, cyclists, and hikers. We plan to develop a tour information system using buses in Jeju. During the trip, the system stores the trajectory and spots that the user traveled and provides to the user on the map after the trip. We express it in different colors according to types of transport. Figure 6 shows the movement trajectories and spots traveled from Jeju city to Seogwipo city. We moved from Jeju city to Seogwipo city by car and traveled the Olle 7 trail course on foot. The movement trajectories by car are represented in orange and the walk is represented in light green as shown in Figure 6(a). We express the timestamp, name, and types of movement according to the order of movement as shown in Figure 6(b). We analyze the movement trajectories and spots of tourists in tour place and the system can provide a personalized audio guidance service to tourists. The personalized tour guide using the user context such as location, visited places, time, date, day of week, weather provides the personalized routes through the most interesting spots in tourist place.


**Figure 5.** The screens of the developed audio tour guide app in Jeju Olle and Seoullo 7017: A, Olle 7 course; B, Chinese audio; C, Japanese audio; D, Seoullo 7017; E, Tour information.


**Figure 6.** The movement trajectories and the visited spots of the traveler: A, Movement trajectories; B, Visited audio guide spots.

## CONCLUSIONS AND DISCUSSIONS

Smart tourism provides the real-time and personalized tour information based on information and communication technologies (ICT) such as big data, Internet of Things (IoT), cloud computing, and artificial intelligence (AI). Jeju-do is building a big data platform and plans to provide smart tourism services by installing free WiFi and Beacons at the major tourist attractions. Big data has a high potential in prediction of searching the tour information before his/her travel or after reaching the destination and employs routing systems of his/her phone before or after reaching the destination. In this paper, we develop the location-based audio tour guide system using the server-based TTS engine. The developed system is consisted of the tour guide service system, the wiki-based tourist information collection system, the tour information DB, the server-based TTS engine, and Android and IOS mobile apps. In this paper, we use Google Docs' remote collaborative document authoring tool to allow multiple authors to collaborate and create tour information based on based on the their travel experience. We are building geotagging tour information and photos at the tourist attractions. The tour information is classified as POI (point of interest), PORP (point of route plane), POS (point of story), POR (point of risk), POP (point of photo), and POE (point of event). The developed system can provide a personalized audio guidance service in the major tourist attractions based on a personal travel experience to resolve the disadvantages of relatively inexpensive group tours. Travelers can select tourist information before the trip, use audio tour services based on the selected tour information during the trip. The system provides the user's movement trajectories and visited spot information to the traveler after the trip. We can analyze the users' position information and the flow using traveler's movement trajectories and visited spot data in the major tourist attractions defined as the point, line, and zone tourist attractions on GIS.

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