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ORIGINAL RESEARCH PAPER

Designing a mobile tourism program and achieving sustainable development

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Abstract: Today, the use of mobile applications has flourished a lot. Many businesses have moved to application design to increase their relationship with customers. Iran has also made good progress in the field of application design. One of the areas that has recently been addressed in our country is the creation of applications in the field of tourism, hotels, museums and accommodation centers. The development of ecotourism as one of the most attractive types of tourism, in addition to economic, social and cultural consequences, can also have significant environmental effects. These effects will have many destructive consequences in human and natural environments and will cause environmental instability and ultimately instability of ecotourism if carelessness, lack of formulation and implementation of preventive measures in the form of strategies, standards and continuous evaluations. In this article, the design of a tourism app for zoo is considered, with features such as suggesting a route to visitor, providing images of different animals in the zoo, and offering various audio-visual services for users along with images and textual information.
KEYWORDS: smart zoo, tourism, mobile applications, sustainable development, location-based systems (LBS)

1. INTRODUCTION

Today, the internet provides tourists with many opportunities to search for interesting information to plan various activities. Recent developments in information and communication technology (ICT) allow tourists to obtain interesting information on their travels via the internet. According to (Wagner et al., 2013; Fataei et al., 2016), about 50% of the proposed tourism systems are designed for mobile devices. As many ICTs came to tourism industry's aid, smart phones and their applications have led to the development of tourism industry (Smirnov et al., 2015; Kourandeh et al., 2013).

Recent technological advances have enabled mobile devices to provide significant accessibility to mobile device users. Energy is one of the most important resources for such devices, and despite the significant increase in the popularity of mobile devices, such as smartphones, their use is severely limited by battery capacity (Fataei et al., 2011).

The tourism industry is one of the most important economic activities in the present century, which has brought many economic and social resources to different countries of the world. The development of ecotourism as one of the most attractive types of tourism, in addition to economic, social and cultural consequences, can also have significant environmental effects. If these effects are not managed and preventive measures are taken in the form of appropriate solutions and continuous evaluations, they will have harmful consequences in human and natural environments and will cause environmental instability and ultimately instability of ecotourism.

Tourism and mobile internet together create a new concept called Mobile Tourism. Its services include location-based and personal services, which distinguish mobile tourism services from tour guides and available resources. Table 1 shows some examples of mobile tourism programs appropriate for providing tourist services during the trip. The examples are related to 'information resources' and 'location-based services', which are very effective in this regard. Researches (Smirnov et al., 2015; Bay et al., 2005) provide a comprehensive analysis of intelligent tourism recommendation systems. These systems are classified using recommendation methods, interfaces, user settings, and so on, but did not consider, or superficially

address, sources of information used to provide information to tourists about interesting places.

There is a lot of research on Ambient Intelligence (AmI) app in museum guides, and the ultimate goal of all of these approaches is to find connection between visitors and artworks they seek at a particular time. However, many of these solutions require strong interaction between visitors and technology i.e., visitors must be close enough to the artworks to be identified, even point their devices at a particular object, or wait for other visitors to complete their interaction.

Because artworks are usually in the environment, the main purpose is to locate the visitors. Multiple technologies can be used to determine the location of visitors, the main goal of which is to provide best accurate information about the artwork visitors are viewing. Therefore, context tagging and RTLS are two very practical options (https://play.google.com/store/apps/details?id=com.mirasafzar.nationalmuseum, http://irannationalmuseum.ir/fa/). The problem with this system is that it only works outdoors and is not a suitable technology for providing an indoor museum guide. Some approaches try to solve the indoor location problem using technologies combined with GPS. In Cyberguide (Ghiani et al, 2009), users' location is detected using infrared sensors but they require direct vision between the user and the sensors, so it does not work properly in crowded places.

In RFID and NFC technologies, each object in the museum is tagged. The tags contain a unique identification number near the object. If visitors want to receive information about a work of art, they must hold their device near the tag. The system then identifies the object and loads relevant information. The need for connection between devices and tags makes these solutions less transparent to the user because it requires direct user interaction. In addition, if multiple users want to see information about the same artwork, they must do so each one at a time. Bluetooth resolves the peer-peer connection between RFID tags and users (Abowd et al, 1997).

There are many approaches to creating a museum guide in which two solutions to the problem can be identified. The first is the direct physical interaction between the visitor and the artwork. The second involves access to information without voluntary interaction by the visitor, in which the system automatically provides information depending on the location of the visitor (Bay et al, 2005).

There are many special attractions in the zoo, so the idea of creating a zoo using interactive technology can make the zoo visit experience much more delightful for visitors. Many zoos now provide a paper map to the visitors, and the visitors have to determine the direction or their location. The problem is that map reading is confusing for most visitors; they may easily get lost in the zoo or not be able to visit all the animals by the end of the visit. In order to improve the navigation of visitors, interactive maps can be used on their mobile devices (Fataei et al, 2016).

In 2003, the Aalborg Zoo used Bluetooth tags to allow parents to track their children at the zoo using an innovative Bluetooth tracking system (Shi, 2010). At the entrance, parents rented the tags for their children and recorded the necessary information along with the contact information on it. They received a text message on their mobile phone with a code to use when inquiring about the child's whereabouts. Unfortunately, this innovation did not gain much popularity because instead of putting the main focus on the zoo's activities, it was used more to ensure the safety of children.

In 2008, Zoo Ranger was designed as a video tour guide system, providing visitors with location-based informative and entertaining videos, audio, photos, and animations about zoo animals and exhibitions using GPS technology. With this tool, zoo enthusiasts can learn more about the zoo animals, and the activities of the zoo's guards and staff during the visit (https://www.cnet.com/news/zoo-tracks-children-with-bluetooth-tags/).

The main achievement came in 2009 when iPhone apps were developed for zoos. Woodland Park Zoo released the first iPhone app (https://www.chesterzoo.org/our-zoo/) allowing visitors to track their location at the zoo, learn more about animals, and access daily activity schedules to make the most of the zoo. The Houston zoo is the second largest zoo in the world after Woodland Park Zoo in Seattle providing visitors with this service (https://blog.zoo.org/2009/10/zoo-iphone-app-is-available.html). The Houston Zoo free iPhone app uses real-time GPS coordinates to display users' location in the zoo, allowing visitors to access and view zoo animal photos and videos on a daily basis.

One main problem of tourists is to provide proper tourism services and find a convenient and fast route to the sights. Most visitors and travelers look for tours with good tourism services; however, there are no tourism services in places such as museums or zoos that can provide users with appropriate and accurate information.

Tourism is one of the fastest drivers of economic development in the world, which plays an important role in achieving the goals of sustainable development. In modern society, mobile social media is a platform for communication and decision making for users and the source of big data about travel. Obtaining and analyzing travel data can provide customer-oriented information about travel destinations and comprehensive services for both tour operators and tourists. It has a positive impact on the sustainable development of society, the economy, the environment and the humanities. In this article, a tourism application has been designed in the environment of the zoo, which has features such as suggesting a visitor-to-visitor route, providing images of

different animals in the zoo, the possibility of providing various audio-visual services to users along with images and textual information. This article aims to develop a mobile zoo information system for Pocket PCs and smart phones. Visitors to such a zoo will be able to use their mobile devices or borrow pocket PCs from the zoo. The zoo information system provides them with other multimedia information such as audio materials and video clips of animals and their natural habitat maps. For this purpose, a large amount of information is required, such as facts and characteristics of species, and any additional background information. Unlike standard information, often provided at zoos by information boards or brochures, in this system, the visitors can obtain a completely comprehensive collection of information (texts, maps, and multimedia elements such as photographs). In addition, based on gender, age and the first four routes they choose for visit, the suggested sub-route is also displayed for the user.

Table 1. Examples of mobile tourism applications

No.	Name& Link	Details	Platform
1	PSiS (Gavalas et al, 2014)	It is a tour planning support system that provides the most appropriate tourism products according to the specific characteristics of the tourists. Before the trip, a tourist communicates with the system through a special web application, and during the trip, a special mobile application for android smartphones can be used.	Android OS Web app
2	ARTIZT (Anacleto et al, 2014)	An innovative museum guide system, in which a ZigBee protocol is used to determine user's location information. Visitors use tablet devices to receive their children's information and interact with other elements in the environment. The system is obtained with a spatial accuracy below one meter.	Prototype
3	TAIS (García et al, 2011)	Or Tourism Assistant- is a mobile app, from 'Travel Guide' category and is based on Smart-M3 platform. This program includes a set of services used to provide tourists with offers about places of interest, and includes customer programs, information services on places of interest, tourism services and public transportation services.	Android OS
4	Berlin Zoo (Smirnov et al, 2014)	This application works by transmitters installed in the site. For example, when a visitor points their mobile phone at an animal such as a gorilla, leopard … the application automatically sends information to the user. The app also notifies visitors of when animals are eating and walking in the net area.	Android OS
5	Smart Zoo (https://www.zoo-berlin.de/app)	It is one of the zoo apps in Poznań, Poland, with features such as: interactive maps with the ability to track and find animals in the zoo, descriptions on how animals live, QR code scan in the zoo, news related to zoo events and so on.	Android OS
6	Iran National Museum Guide (https://play.google.com/store/apps/details?id=com.sz.smartzoo&hl=en , http://smartzoo.eu/index_en.html)	'Iran National Museum Guide' app displays information about selected objects of the museum on the smartphones of visitors. One of the main features of this app is that by scanning the QR code installed next to each object, the information display system displays the location of discovery, determines the historical period on cultural periods timeline, displays the location of the object on the museum map, provides detailed information and related images, and also plays detailed audio information with the possibility of rewinding.	Android OS

2. DESIGNING A LOCATION-BASED RECOMMENDER SYSTEM IN THE ZOO

Services provided to users in mobile tourism are basically information services and guidance on finding routes, which can be provided through mobile terminals such as mobile phones or PDAs that use technologies such as UTMS and GPRS. Users can receive guidance and navigation services through these terminals and based on the criteria already specified in the system. The technology provides services to tourists and increases their satisfaction.

In this article, we discuss the design and implementation of the proposed system. The discussion is divided into two main parts. 1- Designing a location-based recommender system in the zoo, 2- Initial design of a mobile zoo tourism app.

2.1. Architecture of the proposed system

In this section a location-based recommender system at the zoo is proposed. The structure of the proposed system is shown in Figure 1. Below, the different stages of the proposed system are discussed.

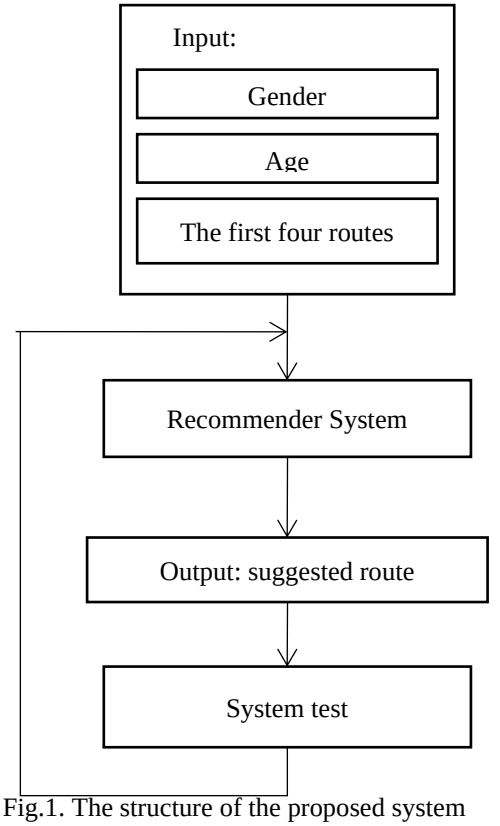

Fig.1. The structure of the proposed system

3.1.1 Input

The system is designed to suggest based on gender, age category and the first four routes. Therefore, to create a database, gender, age category and the first four routes in the comments are categorized as shown in Table 2.

Table 2. System input

Gender	Age category	The first four routes
Male	Young	1/2/5/7
		1/2/5/6
		1/3/4/5
		1/2/4/13
		1/3/13/12
		1/3/13/10
		19/18/17/16
		19/18/17/11
		19/18/12/13
		19/20/21/29
	Middle age	1/2/5/7
		1/2/5/6
		1/3/4/5
		1/3/13/12
		19/18/17/16
		1/3/13/10
		19/20/21/29
		19/20/22/23
	Young	1/2/5/7
		1/2/5/6
Female		1/2/4/13
		1/3/13/12
		1/3/13/10
		19/18/17/16
		19/20/21/29
		19/20/22/23
		19/20/22/24
	Middle age	1/2/5/7
		1/3/4/5
		1/3/13/10
		19/18/17/16
		19/18/12/10
		19/20/21/29

3.1.2 Recommender system

Gender, age category and the first four routes mentioned above have been used as input to the recommender system. To determine the route by the system using Bayesian classification, the probability of each of the first four routes is multiplied by the existing sub-routes.

According to Bayesian classification method, if A_1 to A_k are properties with discrete values, the values are used to predict a discrete class C. Consider an example with the observed property values a_1 to a_k. Our goal is to predict and select the category in which $P(C = c \mid A_1 = a_1 \cup A_2 = a_2 \ldots \cup A_n = a_n)$ is maximized. The simple Bayesian formula is:

According to the simple Bayesian formula, the value of $P(C = c \mid A_1 = a_1 \cup A_2 = a_2 \ldots \cup A_n = a_n)$ is calculated using the following equation. The numerator is calculated using training data. Since the denominator is the same for all classes, its value can be ignored. The greater the value of the numerator for each class, the more the class wins (Alizadeh et al, 2011).

The user enters the desired gender, age category and first four routes. The system compares the user's information with the existing gender, age category and first four routes and once it identifies which one they are equal to, it multiplies its probability by the probability of each of the available items and calculates the maximum. In this case, the route with maximum probability is suggested to the user.

3.1.3 Output

The route with maximum probability is considered as the output of the system for the user.

3.1.4 Evaluation

At this stage, the suggested route and the user's chosen route are compared. If they are similar, it can be concluded that the recommender system has made a good offer. In order to evaluate the system, the precision parameter is used.

$$\text{Precision} = \frac{\text{Correctly suggested number of routes}}{\text{total number suggestions}} \times 100$$

Since the database has limited samples, test samples can also be used as training samples, as follows. This way the system can modify itself simultaneously. For this purpose, the route taken by the system is added to the database. This is very common in systems with a small number of training samples.

2.2. Creating a database

To conduct this research, like other valid researches, a suitable and reliable database is demanded. Accordingly, a search was carried out to find a database. The database used in the various papers was researched and it was finally determined that there is no relevant database on the research topic. Therefore, it was decided to use the available Iranian zoos (Eram Zoo) to create the database. Unfortunately, Eram Zoo has limited routes and the animals of a group, like birds, are scattered in different parts of the zoo. Therefore, there is no database to use in creating a system that can offer a good suggestion to visitors based on first visits. Hence, a hypothetical map was designed using zoo maps available in different countries. Figure 2 shows the map. Considering different routes and how to place animals in these routes, it was possible to design a recommender system. Recommendation in this system is made based on some of the primary routes that the visitor takes.

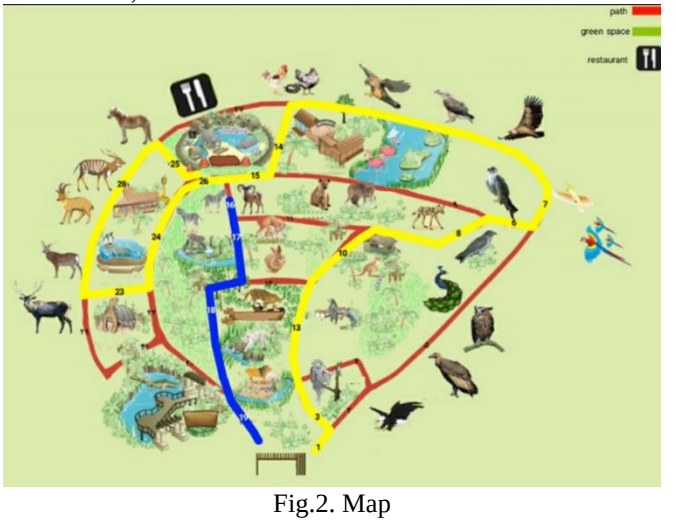

Fig.2. Map

In order to create the database, the designed map was shared in a group in Telegram messenger. In addition to the zoo map image, the following text was used to get help from members.

The image above is a 2-D map of the hypothetical zoo. This map will be used to create a project database. If you were in a zoo with these animals, what route would you take to visit it? Please enter your name, gender, age, and route number in order.

For example: name: Farid, age: 38, and the route visited from right to left:

1/3/13/12/17/16/15/14/27/28/29/21/20/19

Friends and colleagues were invited to the group and were asked to answer the questions.

Route selection was carried out by 120 and 30 people to create database and to test the system, respectively. The database created using this method is shown in Table 3.

Table 3. Gender, age category, and selected routes and number of their occurrence

Gender	Number	Age category	Number	Four initial routes	Number	Selected sub-routes	Number
Male	65	Young	42	1/2/5/7	12	1/2/5/7/27/28/29/21/20/19	2
						1/2/5/7/14/15/16/11/10/12/18/19	5
						1/2/5/7/14/15/16/11/10/12/18/20/22/24/25/28/29/21/20/19	1
						1/2/5/7/14/9/8/11/16/26/25/28/29	2
						1/2/5/7/14/9/8/11/16/26/25/28/29/21/20/19	2

				1/2/5/6	5	1/2/5/6/8/10/12/17/16/26/24/22/20/19	3
						1/2/5/6/9/8/11/16/26/25/28/29/21/20/19	2
				1/3/4/5	5	1/3/4/5/7/14/15/26/25/28/23/22/20/19	3
						1/3/4/5/14/9/8/11/16/26/25/28/29	1
						1/3/4/5/7/27/28/29/21/20/19	1
				1/2/4/13	2	1/2/4/13/10//6/7/27/25/24/23/29/21/20/19	2
				1/3/13/12	1	1/3/13/12/17/16/26/25/28/23/22/20/19	1
				1/3/13/10	7	1/3/13/10/11/16/15/14/277/28/29/21/23/19	5
						1/3/13/10/8/6/7/14/15/16/17/18/19	2
				19/18/17/16	5	19/18/17/16/26/24/22/20/19	2
						19/18/17/16/11/10/12/18/20/22/23/28/25/26/16/17/18/19	2
						19/18/17/16/26/25/28/29	1
				19/18/17/11	2	19/18/17/11/8/9/14/7/5/2/1	2
				19/18/12/13	1	19/18/12/13/4/5/6/9/15/26/25/28/29/21/20/19	1
				19/20/21/29	2	19/20/21/29/28/27/14/15/16/17/12/13/3/1	2
		Middle age	23	1/2/5/7	3	1/2/5/7/14/15/16/11/10/12/18/20/22/23/28/25/26/16/17/18/19	3
				1/2/5/6	3	1/2/5/6/9/14/27/28/29/21/20/19	3
				1/3/4/5	1	1/3/4/5/7/27/25/24/22/20/19	1
				1/3/13/12	3	1/3/13/12/17/16/26/24/22/21/29/28/27/7/5/2/1	3
				19/18/17/16	4	19/18/17/16/26/25/27/14/9/8/10/12/13/3/1	3
						19/18/17/16/26/25/28/29	1
				1/3/13/10	2	1/3/13/10/11/16/15/14/27/28/29/21/23/19	2
				19/20/21/29	3	19/20/21/29/23/24/25/27/14/15/16/17/12/10/8/6/5/4/3/1	3
				19/20/22/23	4	19/20/22/23/28/25/26/15/14/7/5/2/1	2
						19/20/22/23/28/25/26/15/14/17/10/13/3/1	2
Female	55	Young	40	1/2/5/7	13	1/2/5/7/14/15/16/11/10/12/13/3/1	7
						1/2/5/7/27/25/26/16/17/12/13/3/1	1

			1/2/5/7/14/15/16/11/10/12/18/20/22/24/25/28/29/21/20/19	2
			1/2/5/7/14/9/88/11/16/26/25/28/29/21/20/19	3
		1/2/5/6	6	1/2/5/6/8/11/16/15/14/27/25/24/22/20/19	4
			1/2/5/6/8/10/12/17/16/26/25/28/23/22/20/19	2
		1/2/4/13	3	1/2/4/13/12/17/16/26/25/28/23/22/20/19	1
			1/2/4/13/12/17/16/15/14/27/28/29/21/20/19	2
		1/3/13/12	5	1/3/13/12/17/16/15/14/27/28/29/21/20/19	5
		1/3/13/10	4	1/3/13/10/8/6/7/27/25/24/23/29/21/20/19	2
				1/3/13/10/8/6/7/14/15/26/24/23/29/21/20/19	1
				1/3/13/10/8/9/14/27/28/29/21/20/19	1
		19/18/17/16	3	19/18/17/16/24/22/21/29/28/27/14/9/6/88/10/13/4/3/1	2
				19/18/17/16/26/25/28/23/22/21/20	1
		19/20/21/29	2	19/20/21/29/28/25/26/16/17/12/13/3/1	2
		19/20/22/23	2	19/20/22/23/28/27/14/15/16/17/12/13/3/1	2
		19/20/22/24	2	19/20/22/24/26/15/14/7/5/2/1	1
				19/20/22/24/26/15/14/7/6/8/10/13/3/1	1
		1/2/5/7	3	1/2/5/7/14/15/26/24/22/20/19	2
				1/2/5/7/14/9/8/11/16/26/25/28/29/21/20/19	1
		1/3/4/5	3	1/3/4/5/6/9/14/27/25/24/22/20/19	3
		1/3/13/10	1	1/3/13/10/11/17/18/19/20/19	1
		19/18/17/16	5	19/18/17/16/26/25/28/23/24/26/15/14/7/6/8/10/13/3/1	2
				19/18/17/16/24/22/21/29/28/27/14/9/6/8/10/13/4/3/1	1
				19/18/17/16/26/25/28/23/22/21/20	2
		19/18/12/10	1	19/18/12/10/11/16/26/25/28/29/21/20/19	1
		19/20/21/29	2	19/20/21/29/28/25/26/16/17/18/19	2

2.3. Basic design of mobile zoo tourism app

Many people may believe that tourism apps are only suitable for certain functions such as hoteling or some tours. However, in addition to these uses, many places such as museums, exhibitions and zoos, which are somehow connected with many travelers throughout the year, will be able to use these apps. Simple and attractive user interface that helps to attract more audiences of any age has a wide variety of features accessible both online and offline, and accessibility in all conditions is essential to design a tourism application.

In basic design of the system, three main components are needed: the PDA device which supports the main program, GPS, and a database to store information about various zoo animals. The main page or startup page in basic design is shown in Figure 3. This page contains three items: Data entry, map, and animal information. The user enters each page by selecting any of these three items.

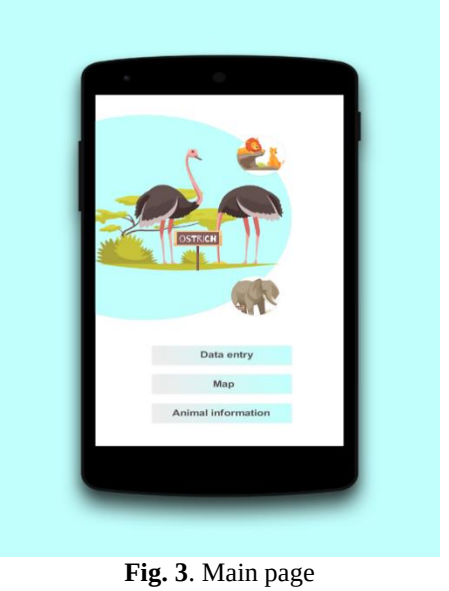

Fig. 3. Main page

The second page is the data entry page. The user must enter information including name, age, and gender. The image of the second page is shown in Figure 4.

Fig. 4. Data entry page

The third page contains the hypothetical zoo map shown in Figure 5. At the bottom of the page, the user is asked to enter the first four routes visited.

Fig. 5. hypothetical zoo map page

After the user enters the first four routes they have visited, the fourth page is displayed. On this page, the first four routes selected by the visitor are highlighted in blue and the suggested routes are highlighted in yellow. In the guide section of the map, these two colors are included with the necessary explanations. The image of the fourth page is shown in Figure 6.

Fig. 6. Suggested routes page

As mentioned, there is an animal information link on the first page, clicking which the user can access information about different animals. The fifth and sixth pages show different information such as pictures, food, etc. of lions and eagles. Figures 7 and 8 show this information.

Fig. 7. Show information page

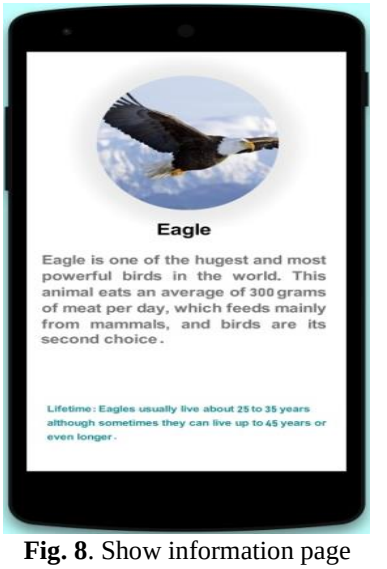

Fig. 8. Show information page

3. SIMULATION RESULTS

All simulations were conducted in Matlab. The proposed system can be used in mobile devices such as mobile phones. In this system, as shown in Figure 9, the user enters their gender, age category and first four routes. The system compares the information with the existing gender, age and first four routes, and then determining which item it is equal to, it multiplies its probability by the probability of each of the available items and calculates its maximum. In this case, the most probable route is suggested to the user.

Next, it is checked whether the suggested route and the user's chosen route are the same or no. If yes, it can be concluded that the recommender system has made a good offer.

Since the database contains 120 samples, which is small, test samples containing 30 samples can also be used as training samples. This way the system can modify itself simultaneously. For this purpose, the route taken by the user is checked and added to the database by the system, and its probability will change automatically. If the sub-route is not included in the training samples, it will be added to the database along with its probability. This is very common in systems with a small number of training samples.

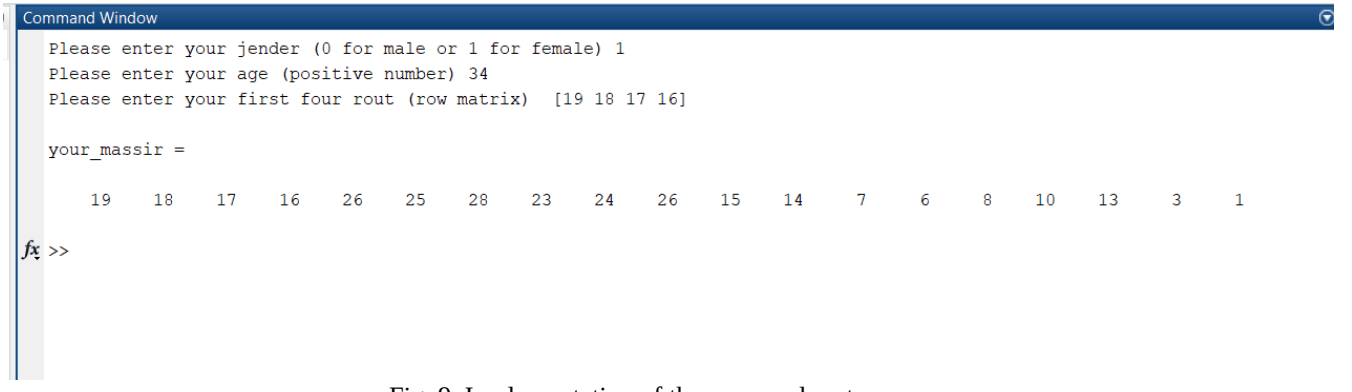

Fig. 9. Implementation of the proposed system

Table 4. Simulation results

First four routes	Number of selections of four routes	Number of correct suggestions	Correct suggestions (%)
1/2/5/7	8	6	75
1/2/5/6	6	5	83/33
1/3/4/5	2	2	100
1/2/4/13	0	0	-
1/3/13/12	2	2	100
1/3/13/10	3	2	66/66
19/18/17/16	5	4	80
19/18/17/11	1	1	100
19/18/12/13	0	0	-
19/20/21/29	2	2	100
19/20/22/23	1	1	100
19/20/22/24	0	0	-
19/18/12/10	0	0	-
Total	30	25	83/33

As shown in Table 4, the proposed system made recommendations to 25 users according to the route taken by the user. Adding test samples to the dataset increases the efficiency of the recommender system. The correct offers were 83.33% of the whole.

4. CONCLUSION

Tourism is one of the fastest drivers of economic development in the world, which plays an important role in achieving the goals of sustainable development. Given that the most important concerns about sustainability are threats to the survival of humanity and the ecosystems on which humans depend, a change in the consumption and productive behaviors of individuals and society is inevitable.

In this article, a zoo tourism application was designed, which contains features such as route suggestion for visitors, providing images of different animals in the zoo, providing a variety of visual and audio services to users along with images, textual information and so on.

The proposed design consists of two main parts: 1- Designing a location-based recommender system and 2- Basic design of mobile tourism app for zoos. In the recommender system, Bayesian classification is used to suggest a route to the user.

The input of the program is gender, age category and the first four routes taken by the user which are compared by the system with the available information, and it determines the recommended route calculating the probability of the routes. The experiment shows that in this system, 25 users were given a suggestion according

to the route taken by the user. Test samples have also been added to the dataset to improve system performance. The correct offers in this system formed 83.33% of the whole.

Conflict of interest

The authors declare that they have no conflict of interest.

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