Mobile Information Technologies for Tourism Domain

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Abstract. The paper analyses a number of advanced mobile information technologies in the sphere of tourism. A large volume of information has been processed to determine the main areas of development and improvement of tourism mobile information technologies. Mobile information technologies are built both for tourists and for travel agencies. In this paper, information technologies for individual tourists are laid stress on. These are tourist program guides, augmented reality tourist information systems, gamification traveling systems, tourist location based systems and others. The paper offers description of the available mobile software for trip planning and information support of tourists during a trip. It consists of two chapters: the current studies and existing mobile program algorithmic tools. According to the research outcomes, the authors propose to build a new information system for tourists Mobile Tourist Information Assistant. A set of functional features of this system as an integrated information system relying on mobile applications is proposed. The main principle of the system is EVERYTHING, HERE AND NOW.

Key words: mobile IT, mobile application, information technology, mobile information system, tourism, e-tourism, travel planning, travel information support.

INTRODUCTION

The modern information society is rapidly approaching a new peak of mobile information technology evolution. The use of smartphones and tablets for mobile access to the Internet resources has increased to the level where the number of accesses to them has exceeded the amount of traffic from stationary specialized access tools [1]. According to eMarketer's research, the total number of mobile Internet users in 2013 reached 134 million, and by 2019 this figure will have become twice as large as the number of desktop computer users [2].

The tourist industry is an area which needs the use of mobile information technology for full-scale operation and development. Mobile Information Technologies significantly affect both the behavior of tourists and the whole industry in general [3].

Traditional software products focused on stationary PCs remain important means of information marketing tools and information technology support for tourism businesses. However, tourists are increasingly using their mobile devices (smartphones, tablets) for planning their next trip, studying tourism destinations, booking hotel rooms, etc. [4].

The implementation of the EVERYTHING, HERE AND NOW principle in the tourist information resources is becoming increasingly popular among both tourists and people engaged in tourism.

THE ANALYSIS OF RECENT RESEARCHES AND PUBLICATIONS

Tourist's questions to be answered using up-to-date IT

The tourist industry clearly demonstrates a huge potential for application of mobile information technology.

However, there is still insufficient understanding of the range of methods and tools which can be used by tourists on the move for trip planning and support.

The number of issues to be dealt with during a trip is often underestimated, but they could be successfully tackled with mobile IT.

A tourist trip is naturally divided into several stages, and each of them requires adoption of certain decisions to address a number of specific problems (see Table 1).

Table 1. Information support of decision-making processes at different stages of a tourist trip

STAGES OF THE TRIP										
TRIP PLANNING										
				TRIP IMPLEMENTATION						
							AFTER TRIP ENDS			

NEEDS OF THE TOURIST									
Choosing tourist destination		transport decision	budget counting	information collection		booking accomodation	tour guide	food	experience exchange	the analisis of the results of the trip
trip in one city	trip arround tourist route			general information	detailed information					photo/video archive

A good pre-planned trip will require less effort in the future to overcome different kinds of problems. The main question to be answered before a tourist trip is **"Where?"** A Facebook survey showed that 52% of users claim that photos of their friends travelling significantly affected their decisions on where to go [1].

An equally important question which a tourist faces is **"When?"**, because each tourist destination has certain features and characteristics which should be considered at the planning stage of the trip. The season and the profile of the tourist group must also be considered. Many tourists face these questions when they are actually on their trips, and this entails making operational decisions under extreme conditions often with strict time limits.

One of the first and probably the most important problems encountered by tourists staying in an unfamiliar place is **"What to do?"** Tourism is a specific form of human activity which includes a number of opportunities and choices, such as visits to sites of interest, relaxation, searching and buying souvenirs, etc. Usually, tourists need to make decisions very quickly on a wide range of issues regardless of the type of holiday [5].

Typically these decisions must take into account the time needed to get to the right place and tourists' preferences with regards to tourist attractions. Therefore, the question **"Where?"** arises naturally. Tourists often visit an impressive number of tourist attractions so the travel route has to be optimized. Along with the previous question, the question **"How?"** must also be answered. When visiting certain countries, tourists should be informed about behavior, local customs and rules to avoid unpleasant situations and possible rejection by the local population [5].

Tourists often analyze their progress and the details of their trips and then share experiences with friends, family and relatives when the trip is over. According to the survey, 41% of Facebook users in the UK posted a summary of their trip, 24% of users shared their experiences through social networks and blogs even during the trip and 49% posted their records after returning home [1].

At first glance, quite simple and sometimes trivial questions that arise when planning and implementing a tourist trip after more rigorous analysis can transform into an extensive complex of interrelated problems. This in turn translates them into the category of semi-structured tasks requiring the use of a wide range of special mathematical methods and algorithmic tools to find a solution.

Classes of mobile applications in the sphere of tourism

As a result of the rapid technological development of smartphones, tablets, and other mobile devices, the market for mobile software applications has increased dramatically. Mobile information technology in its functional guidance and complexity of implementation in the field of tourism has reached a new higher level of development. The modern tourist cannot feel comfortable without the support of intelligent information technologies at all stages of a trip. In fact, a large number of new original methods of acquisition, use and distribution of tourist experience have been formed [6].

According to the situation and context, users have different information needs that can be satisfied by using mobile information technology and appropriate computer tools. As a result, mobile software applications developed to cater for a certain stage of a tourist trip must be endowed with specific properties and ensure quality performance of certain functions in order to meet all the tourist's needs [7].

According to the functional content of mobile software applications for the tourism industry they can be divided into the following classes:

- *Trip Planners* – software that the tourist can use to plan the main aspects of the trip (e.g., hotel booking, transport, etc.).
- *Route Planner* – systems which provide for quality planning of travel routes.
- *Tourist information* – the systems providing the user with comprehensive information on various travel destinations. Such systems are commonly used at the planning stage of trips, when a potential tourist collects and analyses data about places to visit during the trip. This information can be presented to the user in the form of text, audio and video files and images.
- *Offline information tourism systems* – travel systems that require a large amount of available memory on a mobile device, since all information is stored in it. They feature a limited volume of information and less detailed data.
- *Service tools of comparison and booking of services* – systems which are used to compare the prices of certain type of services and allow booking hotel rooms, flights, etc.
- *Tourist program guides* – systems which replace human guides by providing information on target destinations on a route. Relevant information in the system can be supplied in the form of static images, text, audio and video formats. In some cases, the system provides recommendations to the user on the routes of viewing of particular places of interest.
- *Dynamic maps* – maps which contain labels with information about each individual object depicted in a dynamic view. The user is able to choose what information is of interest.
- *Systems for tracking the location of transport means* – systems which provide the user with information about the location of a certain type of public transportation such as taxi, bus or train.
- *Geographical digital offline maps* - similar to offline information systems in that they require a large amount of available memory, and they usually require additional downloading of various maps in the context of individual countries and regions.
- *Augmented Reality systems* – tools which provide additional information about the place where the user is located and the objects in view. To do this the user must have a mobile device with a webcam and GPS interface, as augmented reality systems are based on the principles of video and image processing, machine vision algorithms and information about current locations.
- *Location-based systems* – systems which need information about the current geographical location of the

user and, accordingly, the mobile device to ensure good quality functioning.

- *Knowledge-sharing systems* - allow users to share their experiences on the trip. This applies to the trip itself and also to reviews after it is finished.
- *Gamification traveling system* – a system which forms tasks which need to be completed during the trip, or while exploring a specific tourist attraction. Such tasks usually cannot be solved if the tourist is not in the territory of a tourist attraction. In case of solving a task the system provides information about the current location. This information is presented in an interesting and entertaining form.

Current researches of mobile information technologies in the sphere of tourism

The tourism industry is one of the most topical spheres for research today. This is particularly true about an innovative class of systems for mobile information technologies. Scientists are working to develop new tools and methods of submission and processing of tourist information and systems to generate personalized recommendations. Powerful centers of development of advanced mobile information technologies for the tourism industry are The Digital Tourism Think Tank, International Federation of IT and Travel & Tourism, Bournemouth University (United Kingdom), University of Lugano (Switzerland), etc.

Tourist program guides. Travel systems called program guides have become very popular with mobile users. Modern tourists require personalized access to comprehensive travel information in any place they stay and at any time. Mobile application guides have been created to take into account such requirements [8].

One of developments of this type is Latvia.Travel created by scientists who are members of The Digital Tourism Think Tank aimed at tourists who are traveling in Latvia taking into consideration the features of the country. The aim of the mobile application is to give the tourist access to good quality information during the trip. The developers claim that by using the application the user gets much more than expected. Functionally, Latvia.Travel can replace a website containing information about directions, tourist attractions, cafes, restaurants, hotels and events that may be of interest to tourists [9]. The application developer, Didzisom Spruds, confirms that a growing number of users are visiting the site Latvia.Travel using only a mobile device. This is yet another proof of the need to provide travelers with mobile software applications which can support them in their current locations [9].

A mobile information system with similar functionality is Innsbruck.mobile, a mobile travel guide for visitors of the city of Innsbruck. The system provides access to detailed information on tourist facilities, hotels and apartment rentals, current events in the places of tourist stays, places of dining and shopping, etc. At the same time, the system provides recommendations to tourists according to their wishes and preferences via short message service. Developers continue to work on algorithms to generate recommendations and information contents of the system [10].

Another modern mobile information tool is an application to the web site of the Saint Olav's Way (Norway). It contains consolidated information from the website and offers powerful functions for travelers, such as travel planning tools, information storage on a mobile device for off-line access, emergency calls with the transfer of location information, experience exchange (posting information on social media networks) [11].

An integral part of the tourism sector is entertainment. This in turn results in increasing dissemination of travel computer gaming systems. An example of such systems is Peter`s TrevelPlot Porto [12]. This is a computer audio-guide that provides additional interesting tourist information while asking a tourist to complete a specific task, such as "finding treasure". The "legend" the application is based on is the "great treasures" hidden in the city of Porto which must be found by a tourist faster than by his virtual rival. The task successfully completed, the system provides the user with information on tourist places of interest. The described "Legend" is divided into nine chapters and forty-two historical places of interest. Mobile application Peter`s TrevelPlot Porto has received numerous positive reviews from the users [12].

Tourist Augmented Reality systems. The technology of Augmented Reality (AR) is a mobile information technology that is rapidly gaining popularity. Augmented Reality as a technological concept was announced in 1960, but only now there have arisen real opportunities for the development and implementation of this technology. AR is an imaging technology based on information provided in the form of text, video and graphics that overlay the real images of the object taken with a mobile device camera. In other words, AR can complement the representation of surrounding reality through the additional information, thus contributing to a better understanding of surrounding objects [13].

The Augmented Reality technology is used in many spheres of human activity, and one of the most popular in this context is the tourism sector [14].

The overall structure of the tourism augmented reality systems can be represented as the combination of six classes (see Fig. 1). Class Servers is the main class of the system. It contains the functions of processing data received from a user to generate the required information and display this information on your mobile device. Class Smartphone is responsible for receiving data from the user and images from a webcam of his/her mobile device. BackendSystem class is a class that connects Smartphone and Servers classes. This class is responsible for setting the correct connection to the server and transferring the information from the device. Additional classes of the system are TouristLogin, which is responsible for signing in the user, and TouristRegister used to register a new user. These classes are important in case of generating personalized tourist information on the user's location and surrounding objects. The class Form is responsible for establishing communication between the user and the system [14].
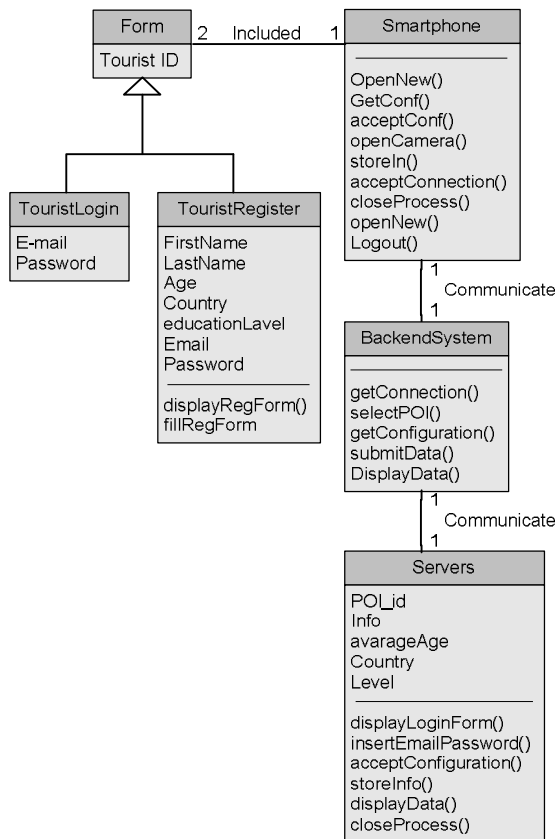
Fig. 1. General structure of augmented reality systems [14]

One of the first Augmented Reality systems for tourist purposes is the system developed based on the information resources of the region of Tuscany (Italy), Tuscany +. The software application offers an interactive guide services in real-time mode to improve traveling conditions with regard to four branches of information contents, including sites of interest, accommodation, food and entertainment [15].

A well-known Augmented Reality system is the mobile software platform MobiAR devised in Android OSE. MobiAR gives offers tourist information about specific cities or objects. Tourists have the opportunity to use application MobiAR on their mobile devices. Using multimedia content, the system informs about the events that occurred in the user's location and provides access to necessary information when planning tour routes [16]. The system consists of subsystems of registration, user configuration, visualization of the map with marking of tourist sites and content generation for each tourist site. The developers have used cloud technology to implement communication between the mobile application and knowledge base [16].

Gaming systems with the feature of augmented reality are popular software in the sphere of mobile information technology in the sector of tourism gamification. They are good motivators of active and cognitive traveling.

An original case of computer augmented reality games is the mobile system TIMEWARP. The main purpose of TIMEWARP is defined as encouraging gamers to actively engage with the city [17]. The game is based on a fairy story *The Elves of Cologne*. The legend tells about elves that helped the city every night, and then suddenly disappeared. The developers of the application have suggested that elves remained in the city but got into time traps and find themselves in their time dimension. The main aim of TIMEWARP is to search elves in different eras using the time window tool, a user mobile device, and return them to real time [25].

Location-based services for tourism domain using GPS tools. Mobile tourist-oriented information technologies form a powerful sector of the market for mobile computer tools with GPS, which in turn generates a new class of technologies – location-based mobile services.

The representative of this class of systems is a mobile recommender system of public transportations PECITAS, established to meet the needs of visitors of Bolzano (Italy). The system provides the user with recommendations on the type and schedules of public transport, which tourists benefit from to move between two points in the city; the start point is the current location of the user. The system generates personalized recommendations based on the knowledge base and taking into account the specific preferences of a particular user. [26]

GPS technology is a convenient tool for the analysis of user behavior and of using the resulting information to provide better professional advice. One of the advanced developments of modern information technologies to get the information on user location is GimToP Toolkit (GTK). To understand the processes of the system, it should be noted that GPS-tracking is a common method of empirical research to obtain information on human behavior. The recorded GPS trajectories make it possible to analyze and to some extent explained the movements of individuals in space and time. GimToP Toolkit (GTK) is a combination of an original methodological approach and data processing technology with GPS. The system combines the data path with user polls obtained by using special mobile applications. Connecting to the server enables survey data processing and interaction with the applications. The system operation results in the information on tourists' behavior, depending on tourist destination and the purpose of the trip [20].

Mobile program algorithmic tools for the tourism industry

Taking on board that the demand for good quality IT tourist products is growing exponentially [27], IT companies have got actively involved into the development of powerful mobile software applications for tourists and travel agencies.

A popular tourist program and algorithmic application for planning a trip is RouteIt [18]. The database of the system contains information about over 1,000 tourist routes, which are divided into 8 categories (historical, corporate, educational, wildlife, shopping, adventure, festival and romantic) and 29 subcategories. The application is functionally focused on meeting the needs of customers who want a virtual tourism trip. The system supports a function of panoramic view of streets via Google Street View. The application supports information sharing by using social networks Facebook and Twitter. In addition, the system allows you to find other tourists that are traveling at the same time in the vicinity of the route chosen by the user [18].

A popular tourist destination mobile software tool to plan and support the implementation of the trip is the mobile travel application TripAdvisor, which contains information about the most popular tourist destinations, places of accommodation, food, entertainment, etc. The user can download information from the free city guides, which then can be used without connecting to the Internet. The system includes current location detection, tourist-guide and the planned route navigation [19].

A mobile application standing out from the variety of trip planners is Minube, which was created to help tourists in choosing a tourist destination and planning a trip. It contains information on about 50,000 international tourist destinations. The information is divided into categories, taking into account the type of the trip. The application allows you to book a hotel and contains information about places to eat [20].

The application Trip Planner developed by Ukrainian programmers is a modern and popular in planning travel routes. The system allows users to create travel routes with a feature of navigation across the path and saving the route. During the formation of the tourist route the system takes into account the choice of appropriate transport solutions [21].

A powerful travel guide is the TourPal system, which provides the user with ample opportunity for travel planning and formation of separate tourist routes. The application provides information on tourist facilities, accommodation opportunities and places to eat. The location of these facilities is marked on the appropriate map. The audio-guide formed by professional tourist guides is a paid feature in this system [22].

The majority of mobile tourist guides and travel planners are created specifically for a special tourist destination. The mobile travel guide Malaysia Trip Planner is the official tourist application for tourists visiting Malaysia. It can be used at the stage of planning the trip and during its implementation. This application contains complete information about tourist sites of Malaysia, interesting events and festivals, places of accommodation and eating, etc. Among others, the application offers such functions as selection of information according to a specific user's preferences and knowledge sharing on social media networks [23]. Table 2 contains data on the comparative characteristics of tourism mobile information systems.

THE MAIN RESULTS OF THE RESEARCH
Mobile tourist information assistant

According to the analysis of the vast array of information sources, it can be stated that none of the currently existing mobile information systems for tourists meets the complex of all the needs and requirements of potential users. The authors of this paper propose to start developing a next generation system Mobile Tourist Information Assistant (MIAT) which will satisfy a wide range of information needs of all tourists in all stages of planning and implementation of a trip.

This system should provide the fulfillment of the following functions:

- helping the user in choosing a tourist destination,
- helping in selecting transportation (to a tourist destination and along the tourist route),
- creation of a tourist route based on a personalized statement,
- assistance in selecting places to eat and accommodation,
- changing the tourist route during a trip,
- providing information to the user before and during a trip:
  - general information about tourist destinations,
  - detailed information on every tourist site:
    - information on the type and specifics of a tourist site,
    - information about the location and opening hours,
    - tourist information in text, photo, audio and video formats,
- user locating,
- user navigation across the tourist route,
- hotel bookings, booking transportation (plane, train, bus), purchasing tickets to cinemas, theaters and museums online,
- creating photo and video archives of the trip with the option to attach additional information to each file (for example, location information, a description of a tourist sites, travel notes, etc.),

Table 2. Comparative characteristics of tourism mobile information systems

Mobile information tourist systems \\ Functions	Planning routes	Offline mode	Information on tourist sites	Information about accommodation opportunities	Booking accommodation	Information on places to eat	Information on events and parties	Information on transport	Popular ready-made tourist routes	Paid content	Free content	Connection with social nets	Dynamic maps	Locating and Navigation	Audio-guide	Users mark*
RouteIt	+	-	-	+	-	+	+	-	+	+	+	+	+	+	-	4.3
Malaysia Trip Planner	-	-	+	-	-	-	+	-	+	-	+	+	+	-	-	3.3
Minube	-	-	+	+	+	+	+	-	-	-	+	+	-	-	-	4.2
Планувальник подорожі	+	-	-	+	-	+	-	+	-	-	+	+	+	+	-	3.6
TourPal	+	+	+	+	-	+	+	+	-	+	+	-	+	+	+	3.7
TripAdvisor	+	+	+	+	-	+	+	-	-	-	+	-	+	+	+	4.1

*Users marks are taken from the GooglePlay service [24]

- automatically creating a trip diary, based on data obtained during the trip (photos, videos, notes, user movements),
- posting photos, videos and notes on social networks such as Facebook, Instagram, Vkontakte.

In order to prepare comprehensive proposals on providing personalized recommendations by the system, the user is required to fulfill the procedures of registration and answering a series of questions about his/her preferences, habits, professional activity, marital status, age, etc. It is necessary to obtain the most complete and adequate image of a potential tourist.

This information is subsequently used at various stages of the system operation. Herewith, the system will require information about persons that the user is going to travel with, and data on the time limits of the trip, its maximum duration and approximate budget per person. The user will receive a list of recommended tourist destinations and their details, including, in addition to a general description, information about popular tourist destinations and tourist facilities, the estimated duration of the trip and its minimal budget [28, 29].

After the user selects a tourist destination, the system will offer a list of hotels and apartments which is generated in accordance with the wishes and needs of the user. Prospective tourists will be able to book a room at a selected accommodation facility online.

Another problem to be solved by a tourist with the help of MIAT is transportation. It is assumed that the system will provide the user with information about the cost of a transport solution, depending on the trip duration and accounting for the local estimated fuel prices. In addition, the system will provide opportunities of booking flight, trains and buses, and car rentals.

The user will be able to plan his/her trip in detail. MIAT will offer a list of recommended travel routes generated according to the results of the polls conducted at the beginning of the system operation. The user will be also able to create and modify the route according to his/her preferences at the stage of planning the trip and during its implementation. Any route can be stored on the mobile device and used offline.

While implementing a trip, the tourist will have access to any information about the tourist destination and its attractions. At this stage, according to the user's location, the system will generate recommendations, such as the nearest places to eat, or information about nearby tourist sites, etc.

All photos and videos taken with a mobile device while traveling will be automatically stored in the trip archive, enabling the user to provide additional information and description of the data files, as well as delete unnecessary one at any time. In addition, the user will have the option of making travel notes. The information gathered during the trip can be automatically saved in the user-editable travel diary.

The system provides for experience exchange, offering the option to post photos, videos and notes on social networks such as Facebook, Instagram and Vkontakte.

Table 3 presents the functions of the Mobile Tourist Information Assistant tool grouped according to the stage of the trip.

The basic principle that underlies MIAT is a quality implementation of the slogan EVERYTHING, HERE AND NOW. This intelligent mobile travel system should provide the user with information support in any part of the world and at any time.

So MIAT is a complex of system-integrated mobile program and algorithmic applications which will provide for the effective tourist's information support at all stages of planning and implementation of a tourist trip.

Table 3. Use of MIAT functionality according to the trip stage

	Stages of the trip		
	Trip planning	Trip implementation	Analysis of the results of the trip
MIAT functions	Help in choosing tourist destination	Locating the tourist	Access to saved photo and video archives
	Help in making transport decisions to a tourist destination	Help in selecting transportation along the planned route	Data sharing on social networks
		Help in renting a car	
	Transport tickets booking (plane, bus, train)	Editing the saved route	Forming the financial report on the trip
		Help in selecting places to eat	
	Planning a tourist route	Booking tickets to museums, theaters, cinemas	
	Accommodation selection and booking	Providing the user with detailed information on tourist sites	Option of evaluating every tourist route, tourist sites, accommodation and eating places on a ten-point scale
	Providing the user with general information on tourist destinations	Navigation along the route	
	Trip cost estimation	Creation of the trip diary and photo and video archive	
		Data sharing on social networks	

CONCLUSIONS

Despite the significant advances in mobile information technologies in tourism, the existing software has so far failed to fully meet the users' needs.

Most mobile tourist information systems still require direct access to the Internet, which is difficult to ensure in many cases. Systems on software tools that do not require direct Internet connection need a robust technical component for effective functioning.

Another drawback is that some of the mobile information systems rely on the information about the current location of the user, and the quality of their operation significantly varies depending on the hardware parameters and weather conditions.

At the same time, it should be emphasized that modern tourism mobile information technologies have a number of important positive qualities. They provide the user information support at all stages of the trip, which includes detailed information on tourist destinations, tourist attractions, places of accommodation and food, entertainment and upcoming events. Studies in the area of formation and provision of tourists with personalized recommendations are under way.

The analysis of the class of mobile information technologies in tourism has allowed distinguishing a number of current scientific and applied problems that should be dealt with in a short term, in particular:

• research of technologies to provide the user with personalized advice during the trip in an offline mode,

• development of mobile systems for planning family trips, taking into account the individual features of tourist groups,

• exploring the technology of smart planning of travel routes and their dynamic adaptation during the trip,

• significant expansion of mobile intelligent information services,

• full-scale implementation of EVERYTHING, HERE AND NOW principle in tourism mobile information technologies.

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