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DEVELOPMENT OF INFORMATION SYSTEM FOR PLANNING PERSONALIZED TOURIST ROUTES

The object of research is processes of information and technological planning of tourist trips. The article analyzes the processes of information technology planning of tourist trips and develops an information system for personalized planning of tourist routes using graph theory. The paper describes in detail a new approach to the formation of optimal routes based on graph models and the analysis of personal preferences of users.

The developed information system uses graph theory to represent and optimize tourist routes, taking into account various criteria such as distance, travel time, and individual user preferences. Algorithms for calculating optimal routes are designed to improve the quality of recommendations and provide a high level of personalization.

The functionality of the information system for planning tourist routes is based on the use of a number of innovative approaches and technologies that make the system more efficient, accurate and attractive to users. This takes into account the need to use modern route optimization algorithms. Algorithms have been developed to optimize tourist routes based on various criteria, such as cost, time, personal preferences, and environmental aspects. The introduction of intelligent analytical tools for predicting tourist trends helps to determine the popularity of places and other factors that influence the choice of routes. For the audio support of the excursion route, an algorithm for generating multimedia information content that is relevant to an individual personalized excursion route and its duration is used. The authors formulate the requirements and analyze the functionality of the information system for personalized planning of tourist routes, since a personalized approach and the use of graph models facilitate route planning that takes into account various aspects, including user-friendliness, accuracy of recommendations, system flexibility and security.

The developed information system can open up new opportunities for individual and intelligent planning of tourist routes, providing users with a unique tourist experience.

Keywords: *information system, tourism industry, graph theory, personalized planning, optimal routes, unique tourist experience.*

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1. Introduction

The use of information technology in tourism in today's information society has a very positive impact on the quality and convenience of travel. Information systems provide convenient tools for navigation, mapping, and route planning. Users can quickly find not only tourist attractions, but also restaurants, hotels, transportation, etc. Information systems provide users with instant access to a large amount of information about tourist attractions, events, cultural activities, restaurants, hotels, and other important travel details. Thanks to information systems, users can easily book hotels, transportation tickets, excursions, and use travel management functions to make changes to their plans. Information systems equipped with language translation functions facilitate communication between users in places where language barriers may arise, and provide the ability to get recommendations for restaurants, shops, and other places from other users, making it easier for tourists to make choices. Information systems can serve as a means to obtain safety information and provide alerts in case of emergencies, as well as provide contacts for local emergency services. In general, mobile information technologies facilitate and enrich the tourist experience, making it more convenient, interactive and rich.

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Information systems for various purposes are used in the tourism industry. According to the functional content, they can be divided into the following classes:

– Travel planners are information systems aimed at providing users with tools and resources for efficient and convenient travel planning. These systems typically provide a wide range of services and features to meet the diverse needs of tourists [1].

– Itinerary planners are information systems aimed at creating optimal and customized itineraries for travel and excursions. These systems allow users to easily plan their itineraries, taking into account various factors such as defined points of interest, distances, available modes of transportation, and other parameters [2].

– Travel information and reference systems are comprehensive information platforms designed to provide users with a wide range of information about travel resources, services, and other aspects of travel. These systems aim to facilitate the selection, planning and implementation of travel for users [3].

– Offline tourist information systems are information platforms that operate offline, i.e. without an Internet connection. These systems are designed to provide users with access to tourism information even in the absence of a network connection [4].

– Comparison and booking services are tools that allow users to compare and book travel services, such as hotels, airline tickets, vehicles, and other services, even without access to the Internet [5].

– Guide apps are interactive programs that help tourists get acquainted with different locations and receive information about attractions, history, culture, clothing purchases, etc. [6].

– Dynamic maps are interactive geographic mapping tools that allow tourists to interact with maps and receive dynamic information about different locations [7].

– Vehicle location tracking systems – used in the travel industry to determine the exact position of vehicles in real time [8].

– Offline geographical digital maps – in the tourism industry, they are an important tool for travelers and tourism businesses, the main advantage of which is that users can use digital maps without an Internet connection, which is especially useful in regions with limited or no connectivity [9].

– Augmented reality systems – in the tourism industry, they introduce interactive and innovative opportunities for travelers, providing the ability to solve problems, add interactive elements, and obtain additional information about objects [10].

– Location-based systems are systems based on information about the current location of the tourist, play a key role in providing a personalized and efficient tourist experience, use GPS, Wi-Fi, Bluetooth or NFC technologies to accurately determine the location of the tourist in real time, provide interactive maps, navigation directions and optimal routes for tourists based on their current location [11].

– Travel experience sharing systems provide a platform for tourists to share their experiences, impressions and feedback about the places they have visited, help tourists make informed decisions and choose the best travel options based on the real-life experience of other travelers [12].

– Game-based tourism systems are systems that use game elements to create a unique and exciting tourist experience, provide tourists with interactive games and tasks related to specific places and attractions [13].

Thus, *the object of research* is processes of information and technological planning of tourist trips. *The subject of research is* tools for personalized information and technological planning of tourist trips. *The aim of this research* is to develop an information system for the formation of personalized tourist routes, i.e., the creation of individual travel itineraries that take into account the unique interests, preferences, and needs of a particular tourist.

2. Materials and Methods

This should be based on the collection and analysis of personal information about the tourist, including interests, places visited, and cultural events. Unique preferences and travel styles, such as nature, history, architecture, shopping, gastronomy, etc. are taken into account. Information technologies are used to determine the location of the tourist and include related interesting objects in the route. The analysis of information about the tourist and his/her previous travel impressions becomes the basis for developing a system of recommendations that allow creating personalized tours and activities that meet the specific interests of the tourist. The development of an information system for planning tourist routes involves the introduction and development of a number of innovative approaches and technologies that make the system more efficient, accurate and attractive to users. This takes into account the need to use modern route optimization algorithms. Developing and applying new algorithms to optimize tourist routes, taking into account various criteria such as cost, time, personal preferences, and environmental aspects.

The introduction of intelligent analytical tools for forecasting travel trends helps to determine the popularity of places and other factors that influence the choice of routes. The proposed information system uses algorithms that take into account contextual factors such as weather, season, events, and personal preferences to provide more individualized recommendations and applies geospatial analysis to understand the impact of territories and locations on the tourist experience. The peculiarity of the proposed approach is that it takes into account all aspects of complex tourist routes.

This approach requires the formation of requirements for an information system for route planning that take into account various aspects, including user-friendliness, accuracy of recommendations, system flexibility, and security. General requirements can be summarized as follows:

1. *User interface*. An intuitive interface that provides convenient use by users with different levels of technical training.

2. *Mobility*. Support for mobile devices to access the system anywhere and anytime.

3. *Personalization of recommendations*. Analyzing preferences and taking into account individual preferences of users. Providing individually adapted and relevant recommendations.

4. *Use of geoinformation technologies*. Ability to determine the current location of the user. Use of interactive maps and navigation features.

5. *Technologies of analytical processing and route optimization*. The use of algorithms to find optimal routes based on various criteria.

6. *Analysis of tourist trends*. Ability to analyze and take into account current tourist trends.

7. *Security and confidentiality*. Ensuring the security of users' personal information.

8. *Multimodality*. The ability to take into account different types of transport when forming a route.

9. *Flexibility and extensibility*. Providing customization options to adapt the system to different user needs. Expandability and easy ability to add new features and modules.

10. *Integration with external systems*. Ability to integrate with other travel services, booking systems, etc.

11. *Multiplatform*. Development of a multi-platform information system that provides convenient access to personalized routes on various devices.

These requirements help to ensure the efficiency and usability of the information system for creating tourist routes for a wide range of users.

Personalized travel itineraries help to create individual and unique journeys that meet the unique needs and expectations of each tourist (Fig. 1).

To formalize the representation of a tourist journey, graph theory is used, which allows mathematical modelling of the interactions and connections between different elements of the journey. The basic concepts of graph theory, such as graphs, vertices and edges, are used to represent and analyze travel routes.

Route planning in graph theory can be expressed using the concepts of graphs and their properties. Various mathematical models are used for this purpose, but the basic one is to represent routes as graphs. Here are some of the key elements:

A graph G consists of a set of vertices X and a set of edges E, where the edges connect pairs of vertices. Formally, $G=(X,E)$.

The nodes of a graph represent different objects or locations, such as cities, landmarks, hotels, restaurants, shops, etc.

Edges represent connections or routes between nodes. They can have weights that represent distances, times, or other parameters.

Edge Weights indicate distances, cost, time, or other parameters that influence the choice of a route. If a route has a weight (e. g., cost, distance, time), then each edge is assigned a weight. Let's denote the weight of an edge e as $w(e)$.

A path in a graph is a sequence of edges that connects vertices. If P is a path, then $P=(x_1, x_2,..., x_n)$, where x_i – vertices; (x_i, x_{i+1}) are the edges of the graph.

Directed Edges – the order of the vertices in the edges is important (e. g. for determining the direction of travel), if the edges have a direction, the graph is directed. The weights of the edges can also indicate the direction or cost of travel.

Clustering and subgraphs. The travel route is divided into clusters or subgraphs, representing different stages or aspects of the journey.

Weighted Graphs. Applying weights to vertices to reflect the importance or attractiveness of specific locations.

It is advisable to use the classic Travelling Salesman Problem (TSP) if it is necessary to find the shortest path (P) that passes through all the vertices of the graph only once and returns to the starting vertex.

Mathematically, the route can be represented as a sequence of vertices $(x_1, x_2,..., x_n)$, and the cost of the path is the sum of the weights of the edges:

$$P=\sum_{i=1}^{n-1} w\left(\left(x_i, x_{i+1}\right)\right)+w\left(\left(x_{in}, x_1\right)\right). \quad (1)$$

Graph theory allows to take into account complex interactions and dependencies between the elements of a tourist trip. This approach is used to solve the problem of the optimal route, analyse the interaction of different locations, and develop algorithms for automated planning and recommendation of tourist routes.

The methods used in the development of the information system are aimed at ensuring automated dynamic individual formation of various types of multimedia content intended for mobile information support of the user as one of the basic functions of an intelligent information system, taking into account his/her individual requests, wishes, speed of movement and the total duration of the tour.

Consider a simple example of a tourist trip that can be represented by a graph. Suppose the three points (graph vertices) – x_1, x_2, x_3 and several routes (graph edges) between them. Each route will have a weight that represents the distance or time of travel.

Planning a tourist's route for an individual tour is defined by a list of target points: $\underline{x}=[x_1,\ldots,x_n]$.

Fig. 2 shows the vertices of the graph with the initial x_1 and final x_{10} points of the route and the intermediate points $(x_2,x_3,x_4,x_5,x_6,x_7,x_8,x_9)$. In this graph (Fig. 2):

– Point x_1 connected to point x_2 by a distance 2 km.
– Point x_2 connected to point x_3 by a distance 3 km.
– Point x_1 connected to point x_3 by a distance 5 km.

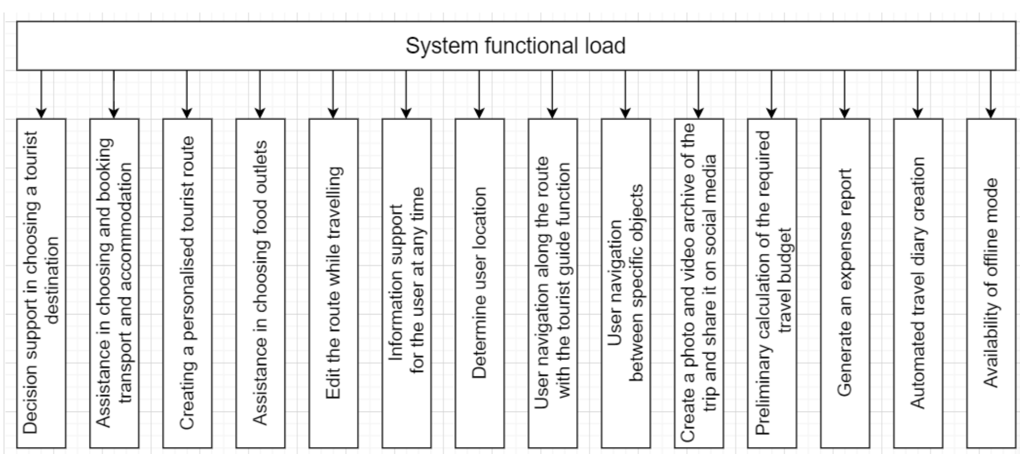

Fig. 1. Functional load of the system

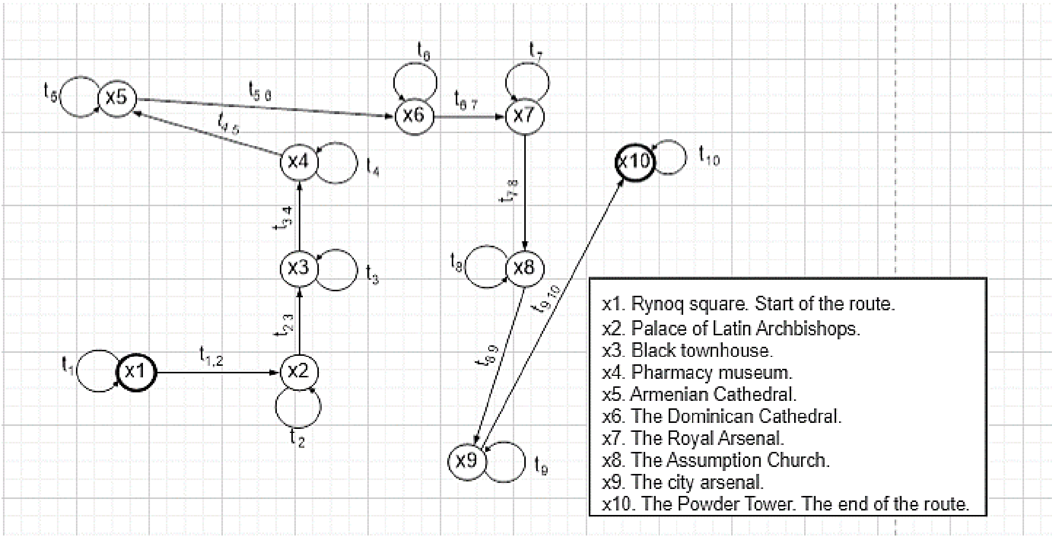

Fig. 2. Graphical representation of a tourist route in the central historical part of Lviv

Let's calculate the distance between the points using graph theory. For example, if a tourist wants to travel from point x_1 to point x_3, it is possible to calculate the distance along one of the possible routes. Let's say the route $x_1->x_2->x_3$.

Distance $(x_1->x_2)=2$ km. Distance $(x_2->x_3)=3$ km.

So, the total distance for this route is 5 km (2 km+3 km).

The route shown in this example is an illustration of preliminary calculations for planning optimal routes and analysis options that can be implemented taking into account the diverse semantic loads on the corresponding graph edges. In our case, the duration of travel and stops (t_1, t_2, ... t_n) near objects are used as input parameters for the automated generation of multimedia content, which is created taking into account the interests and personal preferences of the tourist. The multimedia content contains audio and text fragments with specific time characteristics. This makes it possible to form an audio track for multimedia tour support, taking into account the time of movement and the time of stops.

Further research will focus on the construction of semantically consistent fragments of multimedia support, taking into account the individual interests of users and the relevant time constraints on the components of the tourist route.

Graph theory allows to calculate optimal routes, analyze options and solve various problems in planning tourist routes using mathematical methods.

The information system is developed in the Android operating system environment and is being tested on examples of personalized sightseeing routes in the central part of Lviv, which is a UNESCO-protected architectural monument.

In order to present the information content of a tourist route that takes into account various factors, it is advisable to use a function that combines different aspects and takes into account the importance of each of them. The article presents one of the options for calculating the assessment of the attractiveness of the route for the user, one of the elements of which is the time that should be spent on visiting the object.

3. Results and Discussion

At the same time, for the audio support of the excursion route, it is advisable to develop an algorithm for the formation of multimedia information content, which should be relevant to the individual personalized excursion route and its duration.

It should be noted that the information content depends on the importance of the excursion objects, the state of the matrix of time values of transitions and stops, the user's tourist preferences, the level of his/her knowledge and the information available in the database about these objects. This factor affects the attractiveness of the route.

To present the information content of a tourist route that takes into account various factors, it is advisable to use a function that combines different aspects and takes into account the importance of each of them. Here is one of the options for calculating the assessment of the attractiveness of a route for a user:

$$V=k_{objects}\cdot W_{objects}+k_{time}\cdot W_{time}+k_{stops}\cdot W_{stops}+$$
$$+k_{preferences}\cdot W_{preferences}+k_{database}\cdot W_{database}, \quad (2)$$

where V – a general assessment of the route attractiveness for the user; $W_{objects}$ – a specific assessment of the significance of an object, which is assigned to it in a particular information system; $k_{objects}$ – the coefficient of importance of sightseeing objects, determines the importance or influence of the objects' importance on the overall route assessment, serves to scale or take into account the importance of objects in the overall route assessment; W_{time} – a matrix of time transitions, which presents the time parameters of transitions between different points of the route and is determined based on the time factors that affect the attractiveness of the route; k_{time} – a coefficient of significance of the time parameter, which reflects the importance of taking into account the «time» parameter; W_{stops} – the importance of stops, which takes into account the number and quality of stops near sightseeing objects; k_{stops} – a coefficient that takes into account the importance of stops (points) on the route; $W_{preferences}$ – the importance of the user's tourist preferences, which are determined from the user's profile, including interest in history, architecture, nature, shopping, etc.; $k_{preferences}$ – a coefficient that takes into account the importance of the user's personal preferences in the context of the tourist route; $W_{database}$ – the importance of information in the database, takes into account the availability and amount of information in the database about each tourist attraction; $k_{database}$ – the coefficient of importance of the information contained in the database for the formation and optimisation of the tourist route.

Each of these elements can be a numerical value or a function that takes into account different factors. By setting them according to the importance of each aspect for the user, it is possible to get a score that takes into account many different factors.

The significance factor ($k_{objects}$) reflects the importance or priority of sightseeing objects for the user and is determined based on the user's profile.

The element «Importance of tourist objects» ($W_{objects}$) is an assessment of the importance of a tourist object, which is assigned taking into account their historical or cultural significance. Let's say some parameters affect the importance of objects. For example, each sightseeing object can have a characteristic of importance to the user on a scale from 1 to 10. The importance of objects can be calculated as the average value of these importance values. For example, if there are n sightseeing objects with an importance of I_i for each object, where i is the ordinal number of the object, then the significance of the objects can be represented as:

$$W_{objects} = \frac{1}{n}\sum_{i=1}^{n} I_i. \tag{3}$$

The importance of tourist objects is distributed evenly among all sightseeing objects, and the weight of objects is calculated as the average value of their importance.

The weighting factor $k_{objects}$ determines the importance or priority of the objects' weight in the context of forming a tourist route. It is determined based on various criteria that are important for evaluating route objects, including the popularity of the object, the rating set by users, user interest, seasonality, and additional attributes. The popularity of an object is determined by the frequency of visits or selection of the object by other users. The rating is set based on the ratings given by users and their feedback on the object. User interest is considered to be information about the interest of a particular user and is determined based on the analysis of objects that have been selected during previous visits or marked as favorites. It is important to take into account possible changes in the popularity of objects depending on the season. Additional attributes are attributes that are important in determining the importance of an object, including accessibility, architectural or historical significance, etc. Further research will be aimed at developing a methodology for determining the significance of tourist attractions.

The element «time parameters of transitions between different points of the route» (W_{time}) is determined on the basis of various time factors that may affect the attractiveness of the route and represents an assessment that reflects the importance of the «time» parameter. For example, this may include the time required to complete the route, the availability of specific time windows for visiting sightseeing sites, the time of day that may affect the convenience of travel, etc. Let's consider one of the options for taking this factor into account. For example, for each object, there is a quantitative indicator of the time parameter in the range from 1 to 10 (where 10 is the shortest time or the best). Let T_i be the time score for object i.

The importance of the time factor can be assessed by taking into account the duration of movement between each pair of sightseeing objects and the duration of stops. Let T_i be the time of movement between object i and object i+1, and S_i be the time of stopping at object i. Then the importance of time can be defined as follows:

$$W_{time} = \frac{1}{n}\sum_{i=1}^{n-1} T_i + \sum_{i=1}^{n} S_i, \tag{4}$$

where n is the number of sightseeing objects, and the formula assumes that the importance of time is distributed evenly between all stages of the trip and stops, and the importance of the time parameter is calculated as the average value of time estimates for all objects.

The element k_{time} is a weighting factor that determines the importance or priority of the time value in the formation of a tourist route. The definition of k_{time} may depend on various factors. The estimated time that should be spent on visiting an object is determined, and if some objects require more time to visit, a higher value is set. For example, visiting some historical monuments may require more time than eating in a restaurant or looking for goods in a store. If there are restrictions on the time that a user can allocate to a particular tour, this element takes into account how well the route fits into a certain time period. The time-of-day priority determines which hours of the day or days of the week are preferred, and this element takes this aspect into account. The route is optimized for time, if the user has prioritized speed or time minimization, the time parameter also affects this. The importance of this element is determined by the combination of these factors that are important for the formation of a tourist route. The weighting factor k_{time} reflects how important time is to users in the context of their travel experience.

The element «Importance of stops» (W_{stops}) takes into account the number and quality of stops near sightseeing objects, such as the number of stops, the duration of stops, the availability of additional services that can be obtained during stops, etc.

Let's assume that the quality of each stop (S_i) ranges from 1 to 10, where 10 is the highest quality. Also, let n be the number of stops. Then the importance of the stops is defined as follows:

$$W_{stops} = \frac{1}{n}\sum_{i=1}^{n} S_i. \tag{5}$$

This assumes that the importance of the stops is distributed evenly among all stops and is calculated as the average value of their quality. The «Stop importance» element represents a score that reflects the importance of stops (points) on the route.

The element k_{stops} is a weighting factor that determines the importance or priority of the importance of stops (breaks) in the formation of a tourist route. This element is determined on the basis of various factors, including the number and quality of stops, the strategy of planning stops, the importance of stops for the user, the convenience of places to stop, the distance between stops, and the features of stops. The number and quality of stops is determined based on the importance of the facilities, which increases the weight of this element. The strategy for planning stops is based on the user's requests, which

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indicate certain objects near which they want to make a stop (for example, to visit only a certain category of places), which affects this indicator. The importance of the stops is determined by the user (for example, they include their favorite places) and is also taken into account in this indicator. Convenience of bus stops is determined by their location, including the ability to get to them as conveniently as possible. The distance between stops affects the weighting factor if it is important to avoid long distances between stops. If certain stops have special characteristics or facilities, this is also taken into account in the weighting factor. The weighting factor k_{stops} should reflect how important the stops are to users during their travel experience.

The element $W_{preferences}$ is a score that reflects the importance of the user's personal preferences in the context of the travel route. The element takes into account the user's personal preferences regarding specific aspects of the itinerary, such as types of attractions, travel style, favorite leisure activities, etc. This element is determined by the user's ratings, which take into account their personal preferences.

Let P_i be a preference score for an object, type of sightseeing or type of travel. Then this element is defined as:

$$W_{preferences} = \frac{1}{m}\sum_{i=1}^{m} P_i, \qquad (6)$$

where m is the number of preference aspects. This element assumes that the weight of preferences is distributed evenly among all aspects of preferences, and the weight of preferences is calculated as the average value of their ratings.

The element $k_{preferences}$ is a weighting factor that determines the importance or priority of the weight of user preferences in the formation of a tourist route. The $k_{preferences}$ element is determined based on a variety of factors, including categories and types of objects, personal preferences of the user, seasonal preferences, and unique user requirements. The categories and types of objects (e. g. museums, restaurants, parks) are determined based on the preferences of the user, who may be attracted to the relevant objects. The user's personal preferences are indicated by the user and are taken into account when determining the significance of this element. This element takes into account seasonal aspects, such as preferences for certain activities during certain times of the year. Unique user requirements or constraints related to user preferences affect the element «importance of preferences». The weighting factor $k_{preferences}$ takes into account how important users consider their personal preferences and individual priorities when creating a travel itinerary.

The «value of the database» element ($W_{database}$) takes into account the quality and availability of information that the user can obtain during the route. This may include the relevance of the data, its completeness and reliability. The weighting of the database can be assessed by assigning a numerical coefficient or rating that reflects the level of user satisfaction with the quality of the information. For example, if a user can easily find the information they need and it is always up-to-date and reliable, the value of the database may be high. For example, let D_i be the database quality score for aspect i, where i can represent relevance, completeness, reliability, etc. Then the weight of the database can be defined as follows:

$$W_{database} = \frac{1}{k}\sum_{i=1}^{k} D_i, \qquad (7)$$

where k is the number of database quality aspects.

The element $k_{database}$ is a weighting factor that determines the importance or priority of the database weight in the formation of a tourist route. The definition of $k_{database}$ can take into account various aspects, such as the relevance and completeness of information, diversity of content, relevance of reviews and ratings, availability of additional information, updating and maintenance of the database. The presence of up-to-date and complete information about objects and events in the database, a variety of content such as descriptions, reviews, photos, etc., up-to-date reviews and ratings, additional information such as special offers, events or promotions has a positive impact on this element and can increase it. An important factor in determining the weight of this element is regular updates and maintenance of the database. The weighting factor $k_{database}$ takes into account the importance and quality of the information provided by the database when forming a tourist route.

Let's take a look at an example of calculating the route attractiveness score using the importance factors. Let's note that each factor has its own numerical value from 1 to 10, where 10 is the highest level of importance for the user. Using the expert evaluation method, let's determine the following scores for a particular route: $W_{objects}=9$, $W_{time}=8$, $W_{stops}=7$, $W_{preferences}=10$, $W_{database}=4$.

Let's assume that each of these factors can be evaluated with 10 points.

Now let's determine the weighting factors for each of them using the expert evaluation method: $k_{objects}=8$, $k_{time}=7$, $k_{stops}=6$, $k_{preferences}=9$, $k_{database}=5$.

Now let's plug these values into the formula:

$$Score=8\cdot 9+7\cdot 8+6\cdot 7+9\cdot 10+5\cdot 4=72+56+42+90+20=280.$$

Thus, the attractiveness score of this route for the user is 280 points. This allows to compare different routes and determine which one may be more attractive to a given user, taking into account their preferences and other criteria (Fig. 3).

Fig. 3. Choosing a possible option for building a tour route between points x_1 and x_n

The developed mobile tourist information system, unlike the existing ones, provides a personalized approach to the user in accordance with his/her preferences and provides recommendations for overcoming possible dangers during the trip and allows tourist users to plan and make a trip without the participation of travel organizations, which in turn saves time and money.

The information system is being tested to support tourist excursions in the central part of Lviv and is aimed at improving its operation as a tool and resource for efficient and convenient travel planning.

In the context of martial law, tourists are interested in planning safe travel, making thoughtful and balanced routes. This approach was taken into account when developing the information system.

Limitations relate to content creation:

1. For each tourist route, the content base requires relevant content, taking into account the language of communication.
2. When planning a new route, it is necessary to link it to tourist attractions.
3. Availability of 4G or 5G high-speed communication channels.

Further research will focus on building semantically consistent fragments of multimedia support, taking into account the individual interests of users and the relevant time constraints on the components of the tourist route.

4. Conclusions

The article analyzes the peculiarities of developing an information system for personalized information and technological planning of tourist trips, formulates requirements and analyzes its functionality.

The article presents a tourist information planning system for individual trips, which, unlike the existing ones, implements a personalized approach to the user in accordance with his/her preferences and provides recommendations on the route of travel.

The developed information system provides dynamic individual personalized formation of relevant content. The main focus of the study is on the software and algorithmic component that would ensure the synchronization of different types of content, its organization and integration into a single database/knowledge and would allow describing the dynamics of multimedia information fragments.

The functionality of the information system includes not only planning a tourist route and its audio accompaniment, but also providing recommendations on how to overcome possible dangers during the trip.

The use of the software product provides tourist users with the opportunity to travel without contacting managers of travel agencies and guides, which undoubtedly has economic advantages, in particular in conditions of limited resources and martial law.

The information system for planning tourist routes uses a number of innovative approaches and technologies that ensure its efficiency, accuracy, and attractiveness to users, and also helps to optimize routes. The study proposes algorithms for optimizing tourist routes that take into account such criteria as cost, time, personal preferences of the user, and environmental aspects of the territory through which the route passes.

The use of a personalized approach and graph models facilitates the planning of tourist routes that ensure the accuracy of the recommendations provided to the user and the convenience of obtaining information about tourist attractions.

A comparative analysis of the developed information system with analogous systems available on the market according to the following criteria:

– availability of a common interactive map;
– use of an interactive map of tourist attractions;
– possibility of forming tourist routes;
– professional verified content;
– availability of photo and video support;
– user positioning and navigation;
– possibility of offline use;
– personalization of content showed its advantages by at least one criterion.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

Financing

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Data availability

The manuscript has no associated data.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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