A REAL-TIME TOUR ROUTE DEVELOPMENT MECHANISM FOR TOURIST ZONES OF QASHQADARYO REGION

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Abstract. This article proposes a real-time tour route development mechanism for tourist zones of Qashqadaryo region. The mechanism combines tourist profiles, geographic information systems, GPS-based positioning, weather and road conditions, visitor load, object availability and service quality indicators. Unlike static tour packages, the proposed approach dynamically filters, scores and reorders tourist objects according to the current context and the personal constraints of the traveler. The paper presents a functional architecture, a mathematical scoring model, an algorithmic workflow and a scenario-based analytical evaluation. The results show that real-time route generation can improve route relevance, reduce wasted travel time and support more balanced use of historical, pilgrimage and ecotourism resources.

Keywords: Qashqadaryo tourism, real-time routing, smart tourism, GIS, GPS, dynamic optimization, tourist profile, eco-tourism, pilgrimage tourism.

Introduction

Digital tourism has become an important instrument for presenting regional tourism potential, regulating tourist flows and improving the quality of services. Modern tourists usually expect not only a list of attractions, but also a flexible route that considers time, distance, weather, transport accessibility, personal interests and the actual availability of objects. Therefore, real-time route development is becoming one of the key components of smart tourism systems.

Qashqadaryo region has a rich tourism structure that includes historical cities, architectural monuments, pilgrimage sites, mountain landscapes, recreation zones and ecological routes. In practice, tourists may want to combine several types of travel in one day: historical sightseeing in Shahrisabz, nature-oriented travel in mountain areas, pilgrimage visits and local service points. Such diversity requires an adaptive mechanism that can select and sequence tourist objects according to changing conditions. The aim of this article is to develop a real-time tour route mechanism for tourist zones of Qashqadaryo region. The proposed mechanism treats tourist objects as nodes of a dynamic graph and evaluates each object according to cultural value, visitor interest, accessibility, service quality, crowding and risk. The route is then generated as a constrained optimization problem, where the system searches for the most useful sequence of objects within the available time and travel limitations.

Related work and research gap

Tour route optimization is related to several research areas: geographic information systems, shortest path algorithms, vehicle routing, multi-criteria decision making and recommender systems. Classical routing algorithms can find the shortest or fastest path between two points, but tourism routing requires more complex logic because the most valuable route is not always the shortest one. The route must also reflect tourist motivation, object attractiveness, seasonal restrictions and the quality of local services. Many existing tour routes are offered as fixed packages. A fixed route is convenient for travel agencies, but it does not fully reflect real-time changes. A tourist object may be closed, traffic may increase, weather may reduce safety on mountain roads or the tourist may change interests during the trip. In such situations a static route becomes less effective.

The research gap addressed in this paper is the lack of a compact and practical mechanism that combines real-time data streams, tourist preferences and regional tourism objects into one route generation model. The proposed mechanism is designed as a software-oriented framework that can later be implemented as a web or mobile application for Qashqadaryo tourism management.

Proposed real-time route development mechanism

The proposed mechanism consists of five interacting blocks: tourist profile collection, real-time data acquisition, tourism object database, filtering and scoring module, and dynamic route optimization engine. The tourist profile includes interest type, available time, preferred transport mode, budget level, physical capability and language needs. Real-time data may include weather, road status, traffic speed, visitor density, event schedules and object availability.

The tourism object database stores information about each attraction: name, category, geographic coordinates, average visit duration, opening hours, seasonal limitations, service infrastructure, safety indicator and historical, cultural or natural value. This database must be regularly updated because tourism objects and services change over time. The filtering stage removes objects that do not satisfy the user constraints. For example, closed objects, unsafe routes, inaccessible mountain points or objects located outside the allowed time window are excluded. The scoring stage ranks the remaining objects. The optimization engine builds the final route and recalculates it when significant changes occur during the trip.

Figure 1. Real-time tour route development mechanism.

Mathematical model and algorithm

Tourist zones and service points are represented as a dynamic graph G = (V, E), where V is the set of tourist objects, transport nodes and service points, and E is the set of road segments between them. Each edge has a dynamic cost that changes according to time, traffic, road condition and weather.

$$Cij(t) = w1*Tij(t) + w2*Dij + w3*Wij(t) + w4*Lj(t) - w5*Pj(u) + w6*Rij(t) \quad (1)$$

Here, Cij(t) is the dynamic cost between objects i and j; Tij(t) is real-time travel time; Dij is distance; Wij(t) is the influence of weather and road conditions; Lj(t) is visitor load at object j; Pj(u) is the personal preference score of user u for object j; and Rij(t) is the route risk indicator.

The overall selection score of a tourist object is calculated as follows:

$$Sj(t,u) = a1*Hj + a2*Ij(u) + a3*Aj(t) + a4*Qj - a5*Lj(t) - a6*Rj(t) \quad (2)$$

In Eq. (2), Hj denotes historical, cultural or natural importance; Ij(u) represents matching with tourist interests; Aj(t) indicates current availability; Qj is service quality; Lj(t) is crowding; and Rj(t) is risk level. The optimal route is selected by maximizing the total object score while minimizing movement cost:

$$R* = \text{arg maxR} [\text{Sum } Sj(t,u) - \text{lambda*Sum } Cij(t)], \text{ R in Omega}(u,Tmax) \quad (3)$$

The algorithm consists of the following steps: 1) receive tourist goals and constraints; 2) collect real-time data; 3) filter objects that are closed, unsafe or outside the time window; 4) calculate object scores and edge costs; 5) generate candidate routes; 6) select the best route; 7) monitor changes during the trip; and 8) rebuild the route if conditions change significantly.

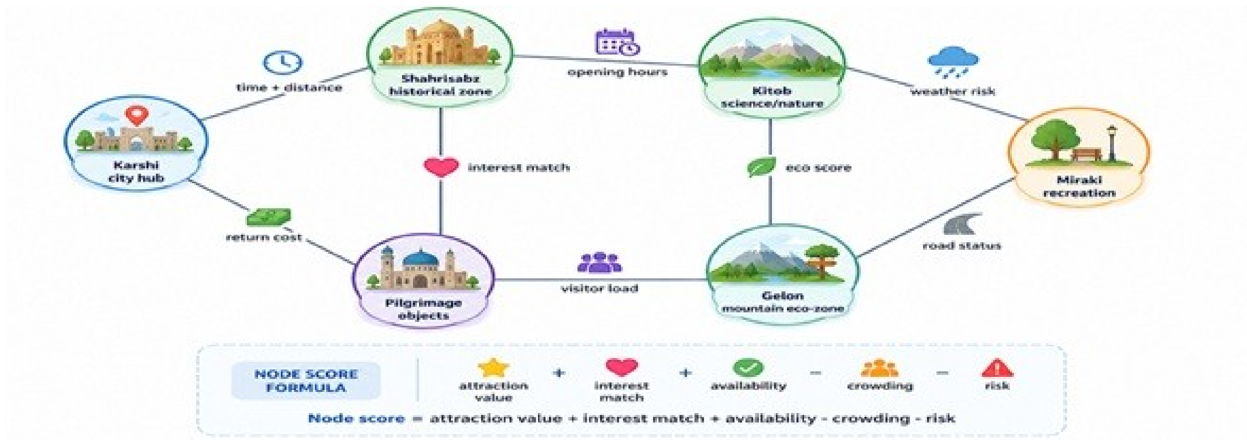

Figure 2. Scenario graph of tourist objects and route factors.

Functional modules and data structure

When the mechanism is implemented as a software system, correct organization of the data layer is essential. The platform should maintain object cards, route rules, real-time API data, user profiles, transport parameters and analytics logs. Table 1 summarizes the main functional modules of the proposed mechanism.

Table 1. Functional modules of the real-time tour route development mechanism.

Module	Input data	Main function	Expected output
Tourist profile module	Interest, time, budget, mobility	Defines individual route constraints	Personalized route parameters
Real-time data module	GPS, weather, traffic, object load	Updates the current context	Dynamic route factors

Tourism object database	Coordinates, category, service, value	Stores regional tourism knowledge	Candidate attraction list
Filtering and scoring module	Object data and constraints	Removes unsuitable objects and ranks others	Prioritized object set
Optimization engine	Scores, costs, time limit	Generates and updates the route	Recommended route sequence
Analytics module	Logs and tourist feedback	Evaluates use and improves future routes	Management indicators

Scenario-based analytical evaluation

At the initial research stage, the mechanism can be evaluated through scenarios. Three typical tourist demands are considered: a historical-cultural route, a pilgrimage route and an ecotourism route. In each scenario, the proposed system is compared with a static route package. The evaluation is analytical and shows the expected methodological effect rather than final large-scale empirical proof.

Table 2. Scenario-based comparison of static and real-time route generation approaches

Route type	**Method**	**Relevance**	**Time efficiency**	**Adaptability**
Historical-cultural	Static package	0.72	0.68	Low
Historical-cultural	Proposed mechanism	0.88	0.82	High
Pilgrimage	Static package	0.69	0.65	Low
Pilgrimage	Proposed mechanism	0.84	0.80	High
Ecotourism	Static package	0.66	0.61	Medium
Ecotouris	Propose	0.86	0.79	High

m	d mechanism			

The comparison indicates that real-time routing can improve tourist route relevance because it connects tourist preferences with the current state of the region. The improvement is especially important for ecotourism routes, where weather, road conditions and safety constraints may change rapidly. For historical and pilgrimage routes, the main benefit is the ability to avoid closed or overcrowded objects and to suggest nearby alternative attractions.

Scientific novelty and practical value

The scientific novelty of the article is the formulation of a real-time route development mechanism that combines tourist profile data, GIS-based object representation, dynamic cost functions and multi-criteria object scoring. The model does not consider tourist attractions as isolated points; instead, it treats them as elements of a context-sensitive regional tourism graph. The practical value of the proposed mechanism is connected with digital tourism management in Qashqadaryo region. The mechanism can be used in a mobile application, tourist information center, regional tourism portal or travel agency decision-support system. It can help tourists receive relevant routes and help local authorities distribute visitor flows more evenly among historical, pilgrimage and ecological zones.

Conclusion

This article developed a real-time tour route mechanism for the tourist zones of Qashqadaryo region. The mechanism integrates tourist profile parameters, GIS/GPS data, real-time contextual information and a tourism object database. It uses filtering, scoring and dynamic route optimization to generate routes that better match user interests and current conditions. The mathematical model represents tourist zones as a dynamic graph and evaluates both movement cost and object attractiveness. Scenario-based analytical evaluation shows that the proposed mechanism can improve relevance, time efficiency and adaptability compared with static tour packages. Future research should focus on creating a prototype mobile application, integrating real API services, collecting tourist feedback and experimentally testing the mechanism in real travel conditions.

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