Analyzing and tracking the data of the millions sized gatherings for the Arba'in visit and proposing alternative ways to relieve congestion using spatial analysis algorithms

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Abstract

The city of Karbala is one of the most important holy places for visitors and pilgrims from the Islamic faith, especially through the Arabian visit, when crowds of millions gather to commemorate the martyrdom of Imam Hussein. Offering services and medical treatments during this time is very important, especially when the crowds head to their destination (the holy shrine of Imam Hussein (a.s)). In recent years, the Arba'in visit has witnessed an obvious growth in the number of participants. The biggest challenge is the health risks, and the preventive measures for both organizers and visitors. Researchers identified various challenges and factors to facilitating the Arba'in visit. The purpose of this research is to deal with the religious and cultural events that occur during the Arba'in visit in Iraq by providing optimal and alternatives routes, and strategic resting points along the way from all cites to Karbala. This research depends on data analysis and artificial intelligence methods to determine the best routes and determine locations of the rest points accurately and effectively. These aims will be accomplished by analysing population distribution and potential paths. For the purpose of providing the best rest points on the proposed roads and decreasing the crowds within these stations, the rest stations are divided into two categories: main stations and sub-stations. The main stations contain services such as: rest places, accommodation, health and awareness services, in addition to providing food and drink; whereas the sub-stations comprise only rest places, sleep, food and drink. The research suggests that the main stations must be distributed at a distance of 5 km from each other, but the sub-stations must be situated at a distance of 1 km. This research presents an improved approach to route optimization and visualization, utilizing

GMap.NET library with a C# environment. The research integrates dynamic rest points generations at specified intervals, adding the capability to save real coordinates of these points and export the final maps as images, whereby the system improves usability and functionality for navigation and geographic information system (GIS) applications providing a user-friendly interface to detect the best routes between any two points. The methodology comprises fetching routes from Mapbox API, automatically adding main and sub points, and incorporating user-interactive elements for managing markers and adding or removing points according to population distribution and saving map views.

Keyword: Routes, Dynamic Break Point, Karbala, Crowds of Millions.

Introduction:

The advent of geographic information systems (GIS) has been progressing quickly especially for navigation and route optimization. Today, most people depend on real mapping solutions, and there is a growing need for customizable and interactive map features. This research determines the best route for the visitor to be used in the Arba'in visit in Karbala with dynamic breakpoints at regular intervals that allows the visitor to save the current map view as an image. The proposed system holds on GMap.NET, a powerful mapping tool for .NET applications, and integrates with the Mapbox API for fetching optimized routes (Smith, 2020) (Doe, 2019) (GMap, 2023) (Mapbox, 2023).

Literature Review:

Moheeb k. Alrawe and Mimoon m. Qasim in 2018, worked on the simulation of the movement of crowds of visitors in the Holy City of Karbala, Iraq. They state the difficulties and significance of finding solutions for crowds during important occasions, such as pilgrimages. The research emphasizes using simulation principles and the AnyLogic 7.0 Professional software to state a solution for how crowd are spread out for functional needs, service arrangements and space usage, in the city centre of Karbala (Alrawe, 2018).

Rizwan, K. Mahmood et al (2019) wrote about creating a database model and a mobile app to monitor Hajj pilgrims and assist them in their pilgrimage. Its target is to improve the organization and supervision of pilgrims during the pilgrimage, in Makkah. The suggested work incorporates geo-fencing technology to improve services and guarantee the execution of ceremonies in the most efficient way possible. The model concentrates on real time monitoring, assistance and tracking of ceremonies through geo-fencing. Important features include direction based on location, managing emergencies, and providing healthcare assistance (Rizwan, 2019).

Hanaa Ali Aldahawi (2021), authored a piece of research which spoke of the significance of relying deeply on the utilization of data analysis to monitor crowd movements, safety measures and operational efficiency during the Hajj and Umrah pilgrimages, in Saudi Arabia. The increase in the number of participants in gatherings, crowd management, conflict resolution and advanced data analysis systems were necessities. Through developing the models and structures, big data applications struggle in improving safety protocols for the increasing streams and enhancing the overall experience for pilgrims. The field of data analytics provides a range of tools and frameworks to imagine and predict results and prove the success of Hajj and Umrah events. The benefit of data from sources such as sensors, smart gadgets and social media platforms facilitates precision healthcare solutions, traffic management strategies, hospitality services optimization will be efficient for crowd arrangement, during the pilgrimages (During, 2021).

Hisham H. Yusef et al (2023), gives a full review of crowd detection, monitoring, and management in various events like sports, music festivals, religious gatherings, and political campaigns. He points to the importance of organizing and controlling the movement of large crowds to prevent disasters such as pushing that lead to fatalities and injuries. This study is concerned with addressing the challenges of crowd identification, monitoring, behaviour analysis, and counting by utilizing recent technologies and methodologies for crowd management (Al-Ashmoery, 2023).

Foziah Gazzawe and Marwan Albaharin's (2024) research points to issues with traffic overcrowding during the Hajj by utilizing of AI and advanced communication technologies. It employs smart cameras and real-time data analytics to predict, manage, and operate the lighting for traffic congestion. The work could improve road safety, emergency response efficiency, and air quality. It could also boost local businesses and tourism revenues, enhancing economic growth. The work shows the importance of AI in traffic management strategies (Gazzawe, 2024).

Methodology

The proposed work creates a route between cities by determining the best route and then applying a dynamic breakpoint. Initially, routes are fetched from the Mapbox API, and breakpoints are generated at specified intervals (5 km for main breakpoints and 1 km for intermediate breakpoints). The flow-chart of the work can be seen in figure (1). The system ensures non-overlapping breakpoints by prioritizn breakpoints. Subsequently, a feature to save the current map view as an image is integrated, allowing users to capture and store map information for offline use. The system is implemented in C# using the GMap.NET library for map rendering and interaction.

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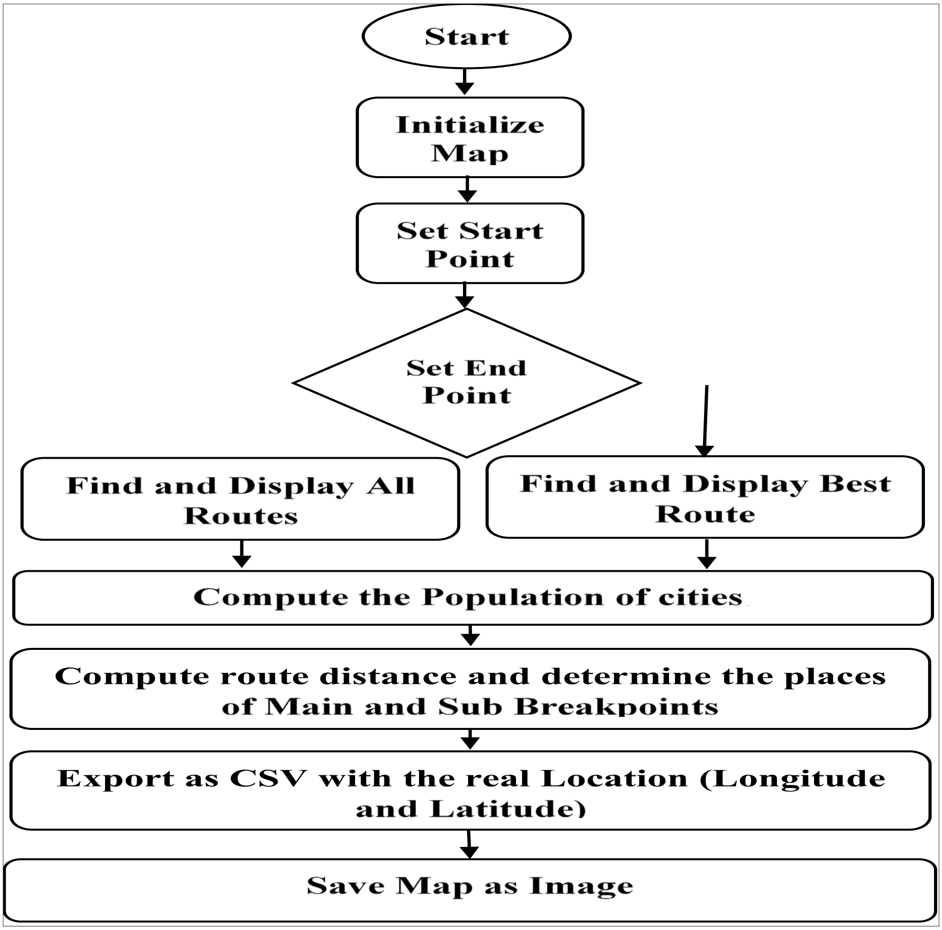
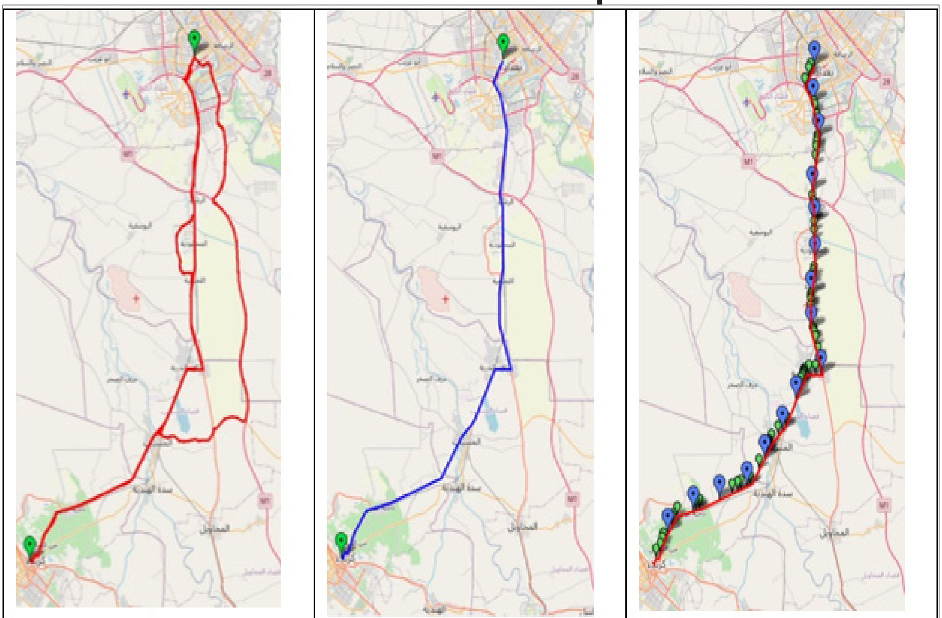
Figure (1): Flow-chart of the proposed work



Results

The program successfully draws a route between two cities (3 cases: Baghdad – Karbala, Hilla – Karbala and Diwaniyah- Karbala). These results can be seen in figure (2-4). For each case, the program calculates the available rote between cities. It concludes three route for each case and then a best route (least distance) is determined and shown in these figures. Dynamic break points were displaced in that route at distance (5km) between each one of it. These points are considered as main points and so sub-break points were applied between them (1km between them). The longitude and latitude of start and end points were listed in tables (1-3). Also, distance was calculated in these tables. The routes provide more interactive and user-friendly directions, making the system suitable for navigation and GIS applications.

Figure (2): Baghdad Karbala: (a) three routes (b) best route (c) best route with break point



a	b	c

Table 1: Baghdad Karbala Route and Distance

Route Name	Start Latitude	Start Longitude	End Latitude	End Longitude	Distance (m)
Route (1)	33.31503	44.36608	32.616035	44.024891	104531.602
Route (2)	33.31503	44.36608	32.616035	44.024891	119115.656
Route (3)	33.31503	44.36608	32.616035	44.024891	98832.0452

Figure (3): Hillah Karbala: (a) three routes (b) best route (c) best route with break point.

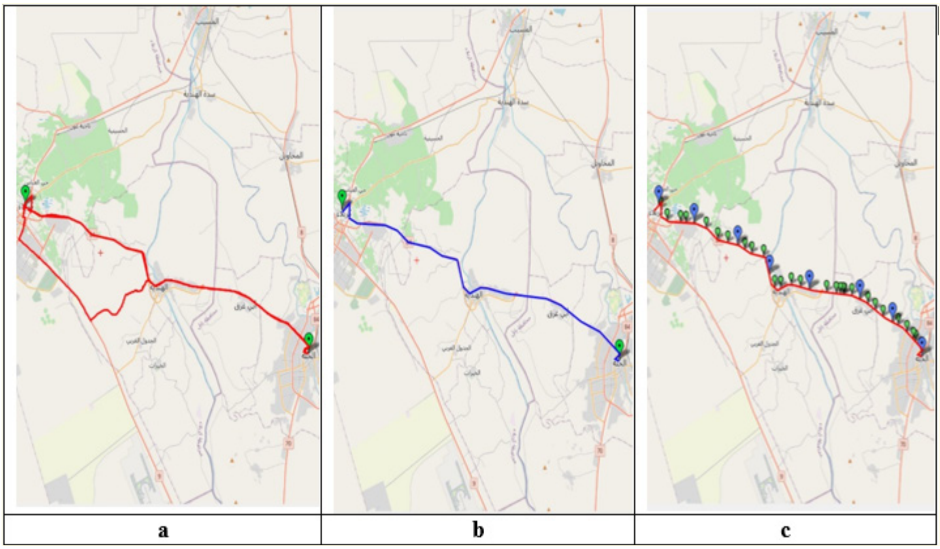
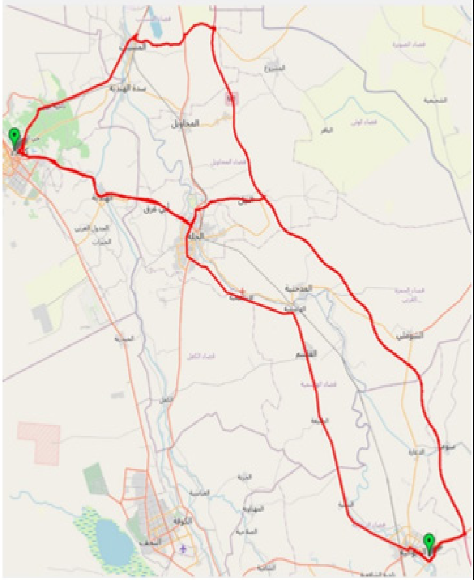


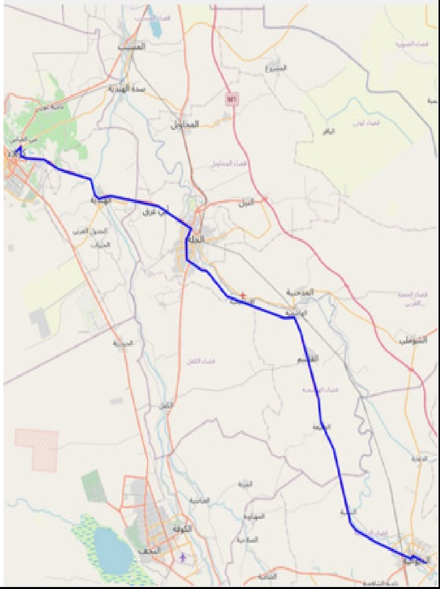
Table 2: Hillah Karbala Route and Distance

Route Name	Start Latitude	Start Longitude	End Latitude	End Longitude	Distance (m)
Route (1)	32.483905	44.432132	32.616203	44.031725	44902.746
Route (2)	32.483905	44.432132	32.616203	44.031725	51392.582
Route (3)	32.483905	44.432132	32.616203	44.031725	45638.539

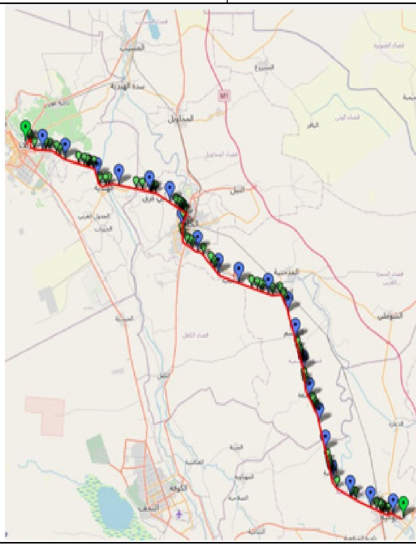
Figure (4): Nasiriyah Karbala: (a) three routes (b) best route (c) best route with break point.



a



b



c

Table 3: Nasiriyah Karbala Route and Distance

Route Name	Start Latitude	Start Longitude	End Latitude	End Longitude	Distance (m)
Route (1)	31.987828	44.923254	32.616451	44.031793	151272.359
Route (2)	31.987828	44.923254	32.616451	44.031793	178232
Route (3)	31.987828	44.923254	32.616451	44.031793	127796.7909

Discussion

The results of mapping routes show the availability of these route which can be selected from many cities to Karbala. These routes can be seen in figure (2a-4a). The best routes are shown in figure (2b-4b). Dynamic break points were displayed in figure (2c-4c). The longitude and latitude of the start point and end point with the distance between them were shown in table (1-3).

Conclusion

This paper presents a novel approach to enhancing route optimization and visualization using GMap.NET, showcasing the system's ability to dynamically generate breakpoints. The system enhances the practicality and usability of navigation tools. Future improvements could include real-time traffic updates, user-defined interval settings for breakpoints, and support for additional map providers. Future work will focus on extending the system's capabilities and exploring additional use cases in various domains.

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