University of Stuttgart
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Enhancing Driving Experience with Geovisual Recommendations

Thesis Proposal

submitted by

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Abstract

Navigation systems are designed to assist drivers to find the shortest path between two or multiple locations. The trend of research in recent years has shown, that navigating from one point to another should no longer be the sole focus of navigation applications. Multiple different systems have emerged that recommend different route possibilities to start the journey, however, dynamic adaptation and visual enrichment of routes with recommendations during the journey have largely been explored. In the past, the small size of infotainment screens inside cars has limited the design space of location recommendations during navigation to simplistic icons. However, the recent increase in screen size of infotainment systems and the availability of a variety of geospatial information, opens up new possibilities to enhance the journey experience in navigation applications. In this master's thesis, we focus on enhancing that experience by increasing user stimulation and engagement with the navigation application through novel design methods. This will include the exploration of geovisual recommendations inside the navigation application based on user preferences and driving context. To determine the requirements user experience research will be conducted, followed by design methods, navigation system development and evaluation with end-users.

1 Introduction

During the technological surge in the last decade, digitization has become increasingly intertwined with our daily lives and has therefore been carried over to multiple different platforms. An example is the automotive industry, which has profited from the improvements in digitization to a large extent. Multiple different systems have emerged to aid drivers like parking assistants, companion applications, or voice controls. However, the most important application inside cars remains to be navigation, since driving from one point to another is the main task of drivers. Navigation Systems have evolved in multiple different fields over recent years, but one aspect they are still lacking is recommendations. Existing research that focuses on recommendations for navigation mostly focuses on the introduction of scenic factors into routing. They subsequently compute a recommended alternative to the main route. While this approach succeeds in enhancing the driving experience through the route itself, it doesn't consider to provide location-based recommendations to the users during the trip. These can have a lot of different useful applications in a mobility environment, for example, they could be recommendations for:

- Scenic spots for taking great photos.
- Historic monuments or tourist attractions.
- Shops or Restaurants.
- Hot spots in cities.
- Any interesting places in the vicinity of the user.

Since these are location-based recommendations, the navigation application provides seamless integration capabilities. In the past, however, the screen space of navigation applications in cars has been severely limited due to small infotainment screens. Points of interest like gas stations or restaurants have been presented in navigation applications as a simplistic icon-based map marker representation. This also limited user engagement and therefore the possible journey experience that location-based recommendations in the navigation application could provide. The increasing integration of digital services and even car functionality into the infotainment system in recent years has resulted in an expansion in screen sizes. This extra space provides the capabilities to introduce novel design methods into navigation applications. Additionally the large variety of geospatial information allows for

This master's thesis aims to enhance the journey experience of drivers and riders by exploring possibilities to display location-based recommendations inside the navigation application. At the start of the project, user experience research will be conducted to determine the requirements of drivers and riders of this system. Subsequently, a prototype system will be developed that satisfies these requirements.

Optionally, a personalization system can be introduced to adjust the recommendations to the individual preferences of the driver. Finally, we will perform user testing in a mobility environment to determine the system's effectiveness.

The rest of the proposal is organized as follows. The next section examines the related work. Section 3 gives more details on the key novelties and contributions. Section 4 will give more details on the Approach while Section 5 will describe its intended outcomes. The goals, preliminary outline and schedule are presented in Sections 6, 7 and 8, respectively.

2 Related work

Multiple research trends in the last decade have identified a need for systems that assist users in decision-making processes in a mobility environment [1]. These are usually realized in the form of location-based recommendation services which focus on providing point-of-interest recommendations to users. Points of interest could for example be scenic spots, restaurants or tourist attractions, etc. Many systems try to enhance the in-car experience with location-based services [2]. Research in this domain focuses on different scenic routing or trip planning, approaches which will be examined in the following sections.

2.1 Scenic routes

Existing research primarily focuses on the integration of „scenic routes“ into navigation routing. These are supposed to provide a personalized experience by including user preferences in routing from the starting to the endpoint.

Existing research suggests to rely on geotagged images from photo-sharing platforms and volunteered geographic information to estimate the scenic quality of roadways [3]. As an example, GPSView [4] is a System by ZHENG et al. that tries to diverge from the shortest path by considering a scenic factor to let drivers and riders enjoy sightseeing on the drive. They relied on the public's attention to geotagged images to determine their interestingness and therefore the scenic capabilities of the road.

Runge et al. [5] argue that spatial relationships shouldn't be the only deciding factor in scenic routing. They improved the experience by including the view itself into the decision-making process. Their system called „Autobahn“ uses Google Street View images to classify route segments into visual characteristics and takes these characteristics of the route to match the preferences of the users during routing.

2.2 Trip planners

These applications offer trip planning capabilities with recommendations to users. As an existing application that integrates location recommendations into a route, Roadtrippers [6] offers a selection of highlighted places before planning the trip from one point to another. These highlighted places are suggested to the user if they are under a threshold chosen by the user in proximity to the road. The route will subsequently be calculated by considering all the additional stops that the user selected by essentially taking this series of points and routing with the shortest path from each point to the next.

3 Key novelty and contributions

The research of this master thesis focuses on the exploration of novel design methods to incorporate location-based recommendations into the user interface of the navigation application. Regarding location-based recommendations, this system doesn't offer alternative routes to improve the driving experience, it rather offers geovisual recommendations and therefore a possibility to add additional stops during the trip. Additionally, it includes a means to visualize different kinds of location-based driver context information and present it to the user in the navigation application in a seamless manner. This will include conducting user experience research to investigate the need of the users for visual feedback from location-based notifications. Therefore a system will be developed that meets the evaluated requirements. Lastly, user testing will be conducted to analyze the benefits of the proposed approach.

This work will be centered around following major questions:

- What kind of location-relevant content would modern drivers/riders like to be recommended to them?
- How the relevant location-based recommendations can be visually represented in the user interface of the navigation application to enhance the journey experience?
- How can the geovisual recommendations be dynamically adapted to the driving context?

In addition, we might also explore possibilities to personalize the recommendations to the interest of the user. For example by using the personal photo collection as a basis for determining user interests.

The results of this master thesis can be beneficial for the following use-cases:

- Researching possibilities for drivers/riders to add additional stops to their route to enjoy sightseeing, dining, or other activities in the area.

- Making drivers/riders aware not just of the main road they are driving on but also of their surroundings by providing points of interest as images.
- Introducing marketing possibilities for companies for highlighting their retailing stores inside the application.
- Inspiration for future development of products for users in a mobility environment, especially concerning the navigation application itself.

4 Approach

The primary focus of this research is to explore novel design methods regarding location-based recommendations inside the navigation application. This will involve three main parts: user experience research, prototype system development and user testing/evaluation. The details of these parts will be discussed in the following sections.

4.1 User Experience Research

Since the system will be developed for specific users, the development will be inspired by the user-centered design process [7]. At the beginning of the Project, user experience research will be conducted to determine the requirements of the users for such a system. This research will be conducted in the form of one-on-one interviews with the target user group. The design of the Study will be part of the research, therefore the exact specifications will be given during the execution. However, it will include interview questions on these main topics:

1. Demographic Information.
2. Identifying experience with existing navigation applications.
3. Determining relevant content to recommend.
4. Researching possibilities to visualize recommendations.
5. Specification of the adaptation of the system to the driving context.

4.2 Proposed Systems

Subsequently, a prototype system will be developed as prototypes and evaluated based on user testing. The proposed system could be something like the following but will vary based on the results of the user experience research:

1. **Recommendation-based image map markers** This system could provide enhanced map markers that are pointing to the location of recommendations. This method utilizes the location visualization capabilities of the navigation

application to highlight certain locations on the map itself. These could contain images that can indicate the surroundings or the context of the recommendation. Offering intermediate stops to specific marked locations could be possible. (Example applications: Traffic condition visualization, recommendations for points of interest.)

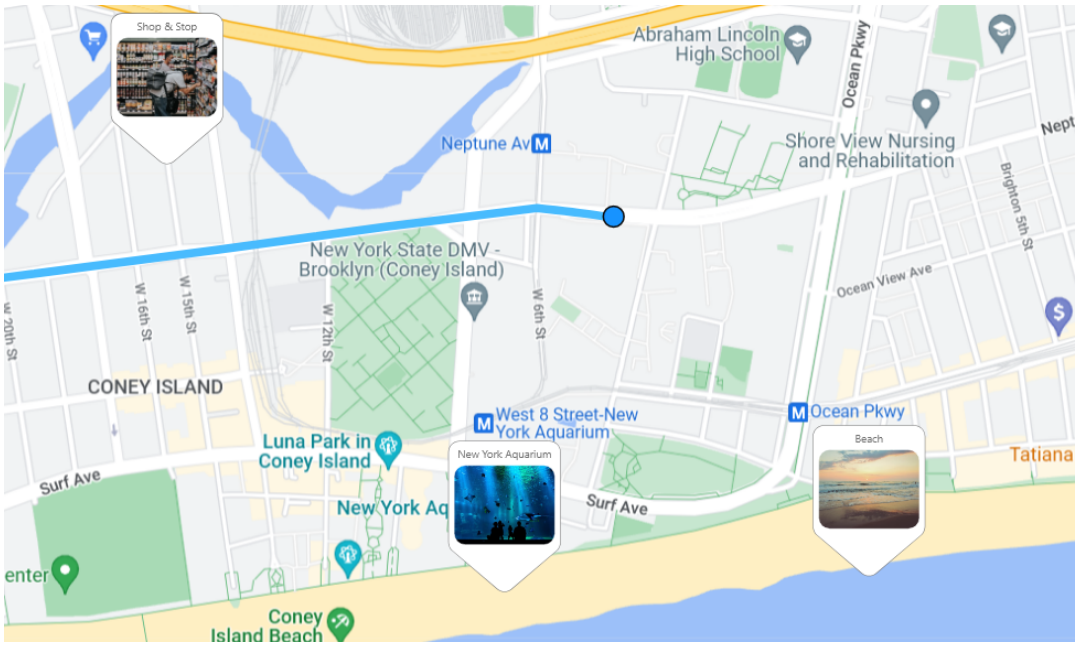

Figure 1: Possible visualization of image map markers.

2. **Recommendation-based image clouds.** This system could create an image cloud based on location-based recommendations, that scales recommendations based on their importance. The importance could be derived from a personalization system. This method takes up screen space but can display a large number of recommendations and their information. It would need investigation as to how it can be seamlessly integrated into an existing application. (Example applications: location transition, location recommendations, etc.)

3. **(Optional) Theme transitioning.** A system that visualizes information by transitioning from the existing theme of the map into a theme that fits the application or context. The information can then be expanded to get additional information. This method does not take up extra screen space, however, it can only convey little information. Regardless it can be useful in different circumstances. The users themselves can decide if the extra information is important or unimportant to them. (Example applications: visualizing weather conditions, context status information, location transition, etc.)

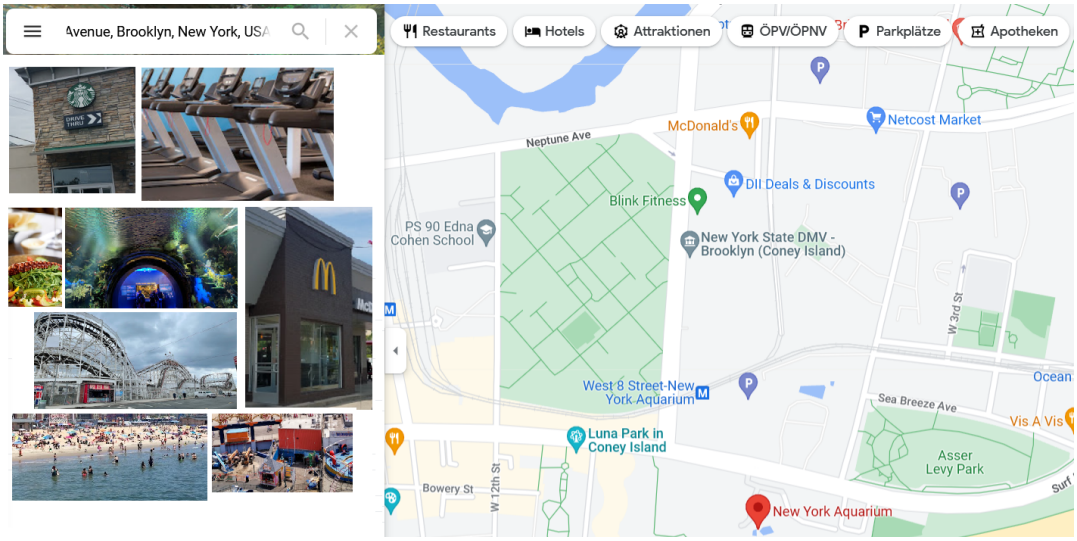

Figure 2: Possible visualization of image clouds.

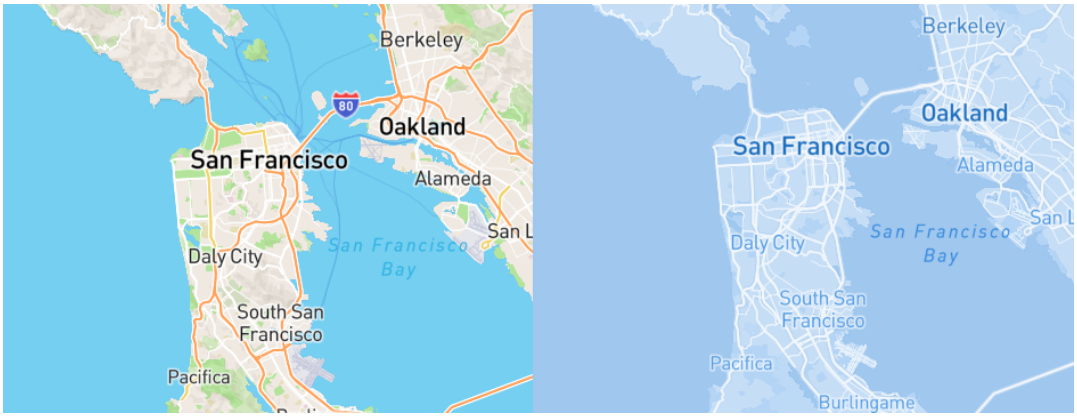

Figure 3: Possible theme transitioning to visualize context information (for example temperature).

4.3 User Testing

Finally, the developed systems will be tested with end-users. How this testing will be conducted is still subject to change and will be determined during the execution. Possibilities to test the system's effectiveness would be by utilizing usability scores like the „System Usability Scale“ (SUS) [1] or the „NASA Task Load Index“. [2] Additionally, the system could be tested and rated by the users in a simulation or a

[1] https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html
[2] https://digital.ahrq.gov/health-it-tools-and-resources/evaluation-resources/workflow-assessment-health-it-toolkit/all-workflow-tools/nasa-task-load-index

mobility environment.

5 Intended outcomes

The intended outcomes contain the following:

- The results of the user experience research.
- A prototype system that uses novel design methods to selectively visualize location-based recommendations inside the navigation application and adapts them based on the driving context. Additionally, it provides the means to add intermediate stops to the route to the recommendation's location.
- The results of user testing of the developed prototype system.

6 Mandatory and optional goals

Mandatory goals:

- Perform user experience research.
- Develop a prototype system that meets the requirements
  (specified in section 5).
- Adapt the recommendations/interface design to the driving context.
- User testing and evaluation.

Optional goals:

- Implement a personalization system to provide personalized recommendations.
- Add the ability to display location notifications/system status information (weather conditions, road conditions, traffic conditions, fuel status, etc).
- Explore possibilities outside of the navigation application.

7 Schedule

- Literature review: 1.6.2022 - 31.6.2022
- Research and development 1.6.2022 - 31.9.2022
  - User experience research preparation: 1.6.2022 - 16.6.2022
  - Conduct user experience research 16.6.2022. - 31.6.2022

  - Introduction to Mapbox API and Android Studio: 1.6.2022 - 31.6.2022
  - Implementation 1.7.2022 - 31.9.2022
- User Testing 1.10.2022. - 21.10.2022
- Research Documentation (Thesis Writing) 1.7.2022. - 31.10.2022
- Presentation Preparation 1.11.2022. - 14.11.2022
- Final Presentation 14.11.2022. - 31.11.2022

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