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A Survey on Smart Navigation System

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Abstract: Street by street navigation system has proven to be an exciting technology that has grown over the years. The Google maps API is one of the best navigation system which is used by millions of users today. Google uses many strategies to obtain the data necessary for turn by turn navigation. It uses GPS satellites, and the distances of the road for each road segments are amazingly accurate. But this already efficient system could be made more efficient. One of the major shortcoming as observed and reported by the Google maps users is that, the maps sometimes show a longer route to the desired destination when an alternative shorter route is available. The problem here is that even when the shorter route is taken, the maps tends to make the same mistake next time (i.e., does not show the shortest path to the destination). The proposed solution resolves the issue (i.e.,) when the better path is taken, the system understands that the chosen path is better than it's suggested one and rectifies its mistake next time. The proposed solution makes use of data structures and Artificial intelligence in order to update the shortest route. Moreover, certain road segments displayed on the maps may be erroneous and the existing systems may require manual editing to update the segment. The solution also provides a way to automatically update those segments without any human involvement. The road segments updation is done by combining the concepts of machine learning and artificial intelligence. The solution turns out to be an add-on to the existing navigation systems that makes it more efficient. Therefore it hardly requires any architectural changes in the existing system.

Keywords: *Google API, Machine Learning, GPS, Navigation.*

I. INTRODUCTION

The GPS based navigation system, particularly Google maps, are extensively used today and is extremely popular. The navigation system had a huge impact in the society that we cannot even imagine travelling to new place without Google maps.

To satisfy the user with its directions, Google does a huge amount of work. Exploring more into how Google map works, there is a need to understand how all the road data is collected. There are two main types of Google maps implementation:

1. Ground Truth
2. Map marker sourced

In the first type Google uses various ways to collect the road data. These methods include having dedicated vehicles that provides road data, connecting to various third parties and collecting local map information, combining the obtained results with satellite image, using GPS information to figure out road segments, having sensors, specialized cameras to identify street signs & road paths.

Google also makes use of an API named 'ATLAS' which can be used to correct some inaccuracies that may have been caused using above mentioned approaches. There is some manual work involved in correcting the directions or pathways that are obtained using above mentioned procedures. The ground truth techniques are applied in developed countries like U.S, U.K etc. In countries like India, Google uses map marker based implementation where user make their own direction & pathways & provide information to Google using markers. As the data here is directly provided by end user, the Google maps are most accurate & successful in India.

An important consideration in both these techniques is that while suggesting a route to the user, Google always prefers fastest route rather than the shortest route. The fastest route to the destination is obtained by considering the traffic in all suggested routes.

Google maintains a huge amount of historical data and collects real-time data from various users using Google maps at a point of time & maps the real time data with historical data to find out real time traffic in a particular route.

The fastest route is then suggested to the user. Despite analyzing huge amount of data & applying best algorithm to determine, fastest route, it is possible that the user may find a better route that being suggested. This is the problem that prevails in maps. This is because, there's no artificial intelligence can match human intelligence. The proposed system makes use of human's intelligence & corrects or updates a better route once found. The solution also determines correct inclination of roads which may be wrongly shown by Google maps.

II. LITERATURE SURVEY

In the recent years, many professionals indulged in uncovering the technology needed to further improve our modern day navigation.

An Liu et al [1] proposed Efficient Path Query Processing Through Cloud-Based Mapping Services. To calculate the shortest path from an origin to a destination, an LBS provider usually needs to know the map data of the underlying road network, which can be rather costly especially if such data need to be kept continuously and up to date. They propose two optimization techniques in this paper, namely, path sharing and path caching, to reduce the number of external requests and the user query response time. However, this impressive research paper exhibited more on the estimation shortest path but cannot always be determined to be correct because of the changing road topology as well as the real-time traffic.

András Király et al [2] deals with Redesign of the Supply of Mobile Mechanics based on a novel Genetic Optimization Algorithm using Google Maps API. If a mobile mechanic has to travel for material, productive time is lost. This paper presents a novel method to reduce activities regarding material handling with extending of serving locations. The design of the supply system can be considered as a complex combinatorial optimization problem, where the goal is to find a route plan with minimal route cost, which services all the demands from the central warehouses while satisfying the

capacity and other constraints. They made use of a multi-chromosome technique for solving the multiple-Traveling Salesman Problem (mTSP). The new operators based on a problem-specific representation proved to be more effective in terms of flexibility, complexity and transparency, and also in efficiency than the previous methods. The proposed optimization algorithm was implemented in MATLAB and integrated with Google Maps to provide a complete framework for distance calculation, definition of the initial routes, and visualization. In contrast, they didn't quite implement historic data and only considered the platform of a 2D scenario.

Alexander Vu et al [3] proposed Eco-Routing Navigation System Based on Multisource Historical and Real-Time Traffic Information. Due to increased public awareness on global climate change and other energy and environmental problems, they focused on how to reduce the energy consumption and environmental impact of roadway travel. In advanced traveler information systems, recent efforts have been made in developing a new navigation concept called "eco-routing," which finds a route that requires the least amount of fuel and/or produces the least amount of emissions. This paper presents an eco-routing navigation system that determines the most eco-friendly route between a trip origin and a destination. It consists of the following four components:

1) A Dynamic Roadway Network database, which is a digital map of a roadway network that integrates historical and real-time traffic information from multiple data sources through an embedded data fusion algorithm;

2) An energy/emissions operational parameter set, which is a compilation of energy/emission factors for a variety of vehicle types under various roadway characteristics and traffic conditions;

3) A routing engine, which contains shortest path algorithms used for optimal route calculation;

4) User interfaces that receive origin–destination inputs from users and display route maps to the users.

But this paper had a lot of errors in the field of insufficient data as well as state of traffic. They were unable to rectify random errors that popped up and were specifically focused on reducing the emissions generated.

Bruce Wallace et al [4] discussed on Measurement of Driving Routes and Correlation to Optimal Navigation Paths. Here, they explored the potential for sensor systems to instrument the performance of a high cognition task (driving) as a means to detect cognitive change/decline. Clinical measurement of cognitive function is a sample at a point in time and impacted by variability in how the subject feels and their environment at that point and may not reflect the progression of cognitive illness. Their cognition for navigation is measured using GPS tracking data and analyzed to determine a number of attributes of cognitive ability such as navigation decisions for trip stops, route and road path choice. These are then correlated with the attributes for a Google maps routing. The measurement of efficiency for the overall trip and specific navigation choices provides a baseline for a patient's cognitive performance. However, they focused mainly on behavior and instincts of the driver and the clinical conditions of the "patient". The system proves to be dynamic but requires further supervision.

Junsong Zhang et al [5] introduced Generating Multi-Destination Maps. In this research, they showed that multi-destination maps are a kind of navigation maps aimed to guide visitors to multiple destinations within a region, which can be of great help to urban visitors. However, they have not been developed in the current online map service. To address this issue, the novel layout model designed especially for generating multi-destination maps, which considers the global and local layout of a multi-destination map. Their intension was:

(1) To produce multi-destination maps within a single, consistent visual frame.

(2) A novel layout model is designed especially for multi-destination maps. This novel model is a two-level layout optimization method, which automatically and efficiently generates multi-destination maps.

Although this paper showed immense amounts of promise, it led to the requirement of powerful devices to support its services which was time consuming as well as infeasible, with large datasets.

Mengke Cheng et al [6] discussed on The Optimization Research on Map Marker Coverage. They made use of existing online map and determined whether from the positioning accuracy, reaction speed, and operating convenience aspects, it is an advanced system. But for the abundant makers, due to the positions of the searched makers are so close, there is a problem of overlapping coverage between markers and markers at a certain zoom level, which requires the maker clustering algorithm to optimize the geographic information display. Through their aided optimization of interaction design in the process of marker clustering, it can help to enhance the study of geographic data mining and analysis. Clustering algorithms involved:

- Grid-based
- Distance-based
- Partitioning
- Online
- Thermal-based

Despite their way of showing markers in an eye pleasuring manner, they only made efforts to approximate them into clusters from a wide range which shows inaccurate data leading to multiple random locations generated within a sector.

Ms. Bhagyashree Madan et al [7] stresses on Sentiment Analysis and Semantic Web to Create Smart Map. They made use of Semantic web as a core for their paper. In Semantic Web, information is given in well-defined and meaningful manner. Proposed system takes the advantages of Semantic web. In proposed approach, the approach is aimed at changing the way we map the world by providing a meaningful and personalized context that is augmented with the semantic web, smart search for an entity on a map is assisted through the semantic web. However, due to lack of further study, many bugs and glitches could be formed. There is also limited to search area (i.e., particular region) and replication of such data led to more errors.

Abhishek Shakwala et al [8] introduced Location Based Services and Integration of Google Maps in Android. They wished to show that the knowledge of mobile user's location can improve the class of services and applications that can be provided to the mobile device user. These classes of applications and services are termed as location based services.

Location Based Service (LBS) is a kind of service that helps in getting the geographical location of the user and more useful information near to the user location. This paper showed that location based information can be obtained in different terms such as position, vicinity, proximity, context, maps, routes, places etc. They also focused on LBS in detail and identify its key components of LBS for providing this service to the user on the Android platform. It also explains the use and implementation of Google Maps and its APIs in getting various location based information on Android**.** But in their efforts to show their innovations, they "reinvented-the-wheel" including only the users point of view and didn't quite exhibit their idea other than what already existed.

Shingo Kato et al [9] focused on Priority Control in Communication Networks for Accuracy-Freshness Tradeoff in Real-Time Road-Traffic Information Delivery. This paper majorly implicates how real-time road-traffic information is crucial for a driver.

However, real-time road-traffic information delivery has a fundamental problem: an accuracy-freshness tradeoff. This paper discusses on guaranteeing the freshness, the information needs to be delivered on the basis of the data received by a cloud or edge server before a predetermined deadline. However, only a limited amount of data is received due to bandwidth limitation and processing overhead in communication networks, which results in the poor accuracy of the delivered information. In order to do so, they showed that the way to improve the accuracy is to make the deadline less strict, which results in deteriorating the freshness of information. The proposed system solves this tradeoff. In this proposed system, "importance" is determined by how helpful the data are when the system needs to estimate missing spatial information from a limited amount of received data by using the machine learning technique. In this paper, simulation results verify that the proposed system ensures the accuracy of road-traffic information while satisfying the freshness requirement.

In their efforts to show their uniqueness, they were unable to implement the "real-time" traffic (which was their objective) because of the huge delays in sending data as well as the hindrances caused by maintaining high bandwidth.

Theodora S. Brisimi et al [10] deals with Sensing and Classifying Roadway Obstacles in Smart Cities: The Street Bump System. They developed an infrastructure-free approach for anomaly detection and identification base on data collected through a Smartphone application (Street Bump). Their approach was to effectively classify roadway obstacles into predefined categories using machine learning algorithms, as well as prioritizing actionable ones in need of immediate attention based on a proposed anomaly index. They explored some novel variants of classification algorithms that combine clustering with classification and introduce appropriate regularization in order to concentrate on a sparse set of most relevant features, which has the effect of reducing over fitting. Their anomaly index combines novel metrics of obstacle irregularity computed based on the data captured by the Street Bump Smartphone application. Although their system and research was phenomenal, their implementation was limited to only a certain region and required massive human specified data rather than historical data. They needed more manpower to generate obstacles outside the common routes, i.e., the obstacle can only be identified when multiple users used that particular route. Anything outside of user's reach still remain unknown.

TITLE	AUTHOR	TECHNIQUE	RESULT	ISSUE
Efficient Path Query Processing Through Cloud-Based Mapping Services	Detian Zhang, Yuan Liu, An Liu, Xudong Mao, Qing Li	Shortest Path method	Presented a system architecture, where LBS provider retrieves path information from cloud-based mapping services by issuing external requests with path sharing and path caching. (Path Efficiency: 78%)	Cannot always determine the correct because of the changing road topology as well as the real-time traffic
Redesign of the Supply of Mobile Mechanics based on a novel Genetic Optimization Algorithm using Google Maps API	András Király, János Abonyi,	multiple Traveling Salesman Problem (mTSP)	Presented an optimization of serving locations to reduce non-productive activities. A modified mTSP with additional constraints was introduced and solved by this method. (Accuracy: 82%)	Didn't implement historic data and only considered the platform of a 2D scenario
Eco-Routing Navigation System Based on Multisource Historical and Real-Time Traffic Information	Kanok Boriboonsomsin, Matthew J. Barth, Weihua Zhu, Alexander Vu	Routing that requires the least amount of fuel	Presented an eco-routing navigation system that finds the most eco-friendly route in terms of minimum fuel consumption or emissions between a trip origin and a destination.	Insufficient data, state of traffic not specified, unable to rectify random errors and specifically focused on reducing the emissions generated
Measurement of Driving Routes and Correlation to Optimal Navigation Paths	Bruce Wallace, Rafik Goubran, Frank Knoefel	High cognition; Clinical measurement	The work shows how Google Maps can be used to provide gold standard measure for as driven and optimal travel distances for the identified destinations. (Average Estimations)	Focused mainly on behavior and instincts of the driver and the clinical conditions of the "patient". Requires supervision

Generating Multi-Destination Maps	Junsong Zhang, Jiepeng Fan, Zhenshan Luo	Graph-cut based segmentation algorithm	Presented a multi-destination map generation, designed to address the problem that current online maps cannot show the overview and detailed views of a multi-destination map within a single, consistent visual frame. (Algorithm efficiency: 90%)	Requirement of powerful devices to support its services. Time consuming as well as infeasible, with large datasets
The Optimization Research on Map Marker Coverage	Mengke Cheng, Ligu Zhu,Wenqian Shang	Clustering algorithm	Optimization & improvement of the algorithm and the replacement of the heat map, making the map more intuitive, and facilitate the data mining and analysis (Accuracy: 60%)	Approximation into clusters from a wide map range. Shows inaccurate data leading to multiple random locations generated within a sector.
Sentiment Analysis and Semantic Web to Create Smart Map	Ms. Sandya M. Pardhi, Ms. Bhagyashree Madan	Geo Tagging	Focus of proposed system is to change the way of mapping. The design makes combination of user tweets with the help of Google maps location.	Possible bugs and glitches generated. Limited to search area (i.e., particular region) and replication of such data led to more errors.
Location Based Services and Integration of Google Maps in Android	Pankti Doshi, Pooja Jain,Abhishek Shakwala	Location Based Service	Developed LBS applications on android platform to help maximum population to get the benefits of this technology.	Exhibited only surrounding of user rather than the entire region on a whole and made use of the already existing features
Priority Control in Communication Networks for Accuracy-Freshness Tradeoff in Real-Time Road-Traffic Information Delivery	Shingo Kato, Ryoichi Shinkuma	Accuracy-freshness tradeoff (Traffic Analysis)	Proposed a data transfer control method to deliver highly accurate urban road-traffic information and freshness of data. (Good Evaluation Accuracy)	Unable to implement the "real-time" traffic because of the huge delays in sending dat. Hindrances caused by maintaining high bandwidth
Sensing and Classifying Roadway Obstacles in Smart Cities: The Street Bump System	Theodora S. Brisimi, Christos G. Cassandras, Chris Osgood, Ioannis CH. Paschalidis, and Yue Zhang	Machine learning algorithms	Demonstrate ubiquitous availability of wireless devices & development of approaches for solving problems in Smart Cities. Concentrated on the problem of detecting & classifying roadway obstacles. (Accuracy as high as 88%)	Required massive human specified data rather than historical data. More Manpower required generating obstacles outside common routes.

CONCLUSION AND FUTURE WORK

Smart Navigation System is very much a vital component for tackling the traffic situations by including optimal routes (fastest) as well as redesigning the mapping system for novices. Each paper has been discussed elaborately and categorized these papers based on their application areas. In this survey paper, we have analyzed 10 research papers from different application fields of Data Structures, Artificial Intelligence & Machine Learning.

In regards with the future, the navigation system constantly updates the route structure whenever a user finds a better path than the suggested, thereby updating the confidence level of the route to the cloud's database and the novice user can view the best path in his/her application. This work also involves finding proper road orientations and updating the same to the cloud using machine learning.

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