Sharing Real-Time Visual Traffic Information via Vehicular Clouds

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Abstract: Today millions of people are using different navigation applications, lots of transportation businesses are using navigation applications to travel on highways so they can have surety of route. We are taking this service to next level which will provide collaborative traffic management, notify the user about current situation of the route, and suggest any alternate way to continue travelling if there is major problem on the route. This paper describes how users collaborate to share traffic images by using their mobile device camera with the use of firebase technology. We've presented the architecture of a collaborative traffic image–sharing system called 'collaborative traffic navigation', which allows driver who is synchronize with firebase cloud system to report and share real time traffic information called traffic post. Traffic post is then filtered, condensed and analyzed into a firebase cloud. Then according to GIS and Geo spatial and firebase synchronize data more pertinent and reliable information about the road situation and can complement predictions like estimated time of arrival, thereby supporting users' route decision making. As proof of concept, this paper presents the system design and a prototype implementation running on the Android smartphone platform, along with its evaluation.

Keywords —Social vehicle navigation, Traffic digest, Vehicular social network, smart route decision, Cellular area, Traffic images .

I. INTRODUCTION

Advancement in technology is making system smarter with use of Firebase, global positioning systems (GPSs), Geo spatial, GIS, and high definition Mobile cameras. Ongoing attempts to alleviate traffic congestion via smart System use crowd sourced traffic data collected from Firebase technology traffic speed and identify traffic conditions. When provided to navigation systems, this information is used to generate and present a list of recommended routes for trip planning. Such crowdsourcing services can be classified into two types: push-based and pull-based.

The majority of today's systems anonymously pull GPS location information from mobile phone users or navigation systems to generate a live traffic map The push-based approach depends on social participation, where drivers purposely report traffic information with a richer context (e.g. the location, the degree of traffic congestion, and the types of traffic incidents) onto a cloud to be redistributed and shared with other drivers.

Conventional ways of reporting traffic conditions have mainly been through the police, transportation officials, drivers on phones, and traffic reporting companies. Nowadays, real-time traffic updates on traffic congestion are becoming widely available and easily accessible via online maps, mobile phones, and GPS-equipped devices. Drivers route planning can be heavily influenced by such traffic information, which consequently leads them to less congested routes. Such planning is done by selecting a route from a recommended list of alternative routes calculated based on factors like shortest distance or estimated time of arrival (ETA), taking real-time traffic data into account.

This paper highlights the use of geo-tagged traffic images, called Traffic post, provided by the vehicular cloud to assist drivers in route planning and route decisions. We use a cloud service called Firebase. Drivers who are planning a route can opt into the service and request images showing the traffic conditions on routes and suggest alternative route. Other drivers whose vehicles are subscribed to the same service collaborate and share their real time traffic images by uploading traffic post concerning the current traffic conditions or any unexpected events. The Firebase cloud computes a Traffic Digest that organizes the traffic reports into a user-friendly format to show to the driver and aid the individual in route choice decision-making.

In the near future, rapid development in autonomous or semi-autonomous cars mounted with wide-angle cameras will make such information sharing more pervasive and desirable at the same time. Moreover, hands-free driving experiences will allow drivers to have the time to leisurely participate in sharing traffic information and to engage in more careful route planning.

II. RELATED WORK

A. Collaborative Sharing

Drivers can specify their interest in a service, in which other drivers subscribed to the same service can collaborate by sharing necessary information with regard to the request. Described images where images taken from mobile cameras and upload to cloud. Uploaded image is surveillance service in which several vehicles are selected to take photo images of an urban landscape. However, the authors mainly focused on the security and privacy of the data exchange between entities [3]. Unlike traditional navigation systems, Waze [1] is a navigation app that collects traffic data from users to provide traffic reports to a central server, where such information is shared with other drivers to provide real-time traffic and road information, such as the volume of traffic, any road hazards, or accidents affecting traffic. Other navigation apps, such as Inrix Traffic [4], have included user-generated traffic reports, and after Google's acquisition of Waze, Google Maps added similar features in its mapping business. Moreover, recent research [5]&[7] discussed the potential for traffic information sharing, and we are starting to see greater integration of these techniques.

B. Real-Time information via cloud

Formerly known as Google Cloud Messaging (GCM), Firebase Cloud Messaging (FCM) is a cross-platform solution for messages and notifications for Android, iOS, and web applications, which currently can be used at no cost. Firebase Cloud Messaging and the FCM SDK, for developers Firebase Notifications (Notifications) provides an option for seeking a flexible notification platform. With Firebase Analytics With notifications targeted to user segments, you can contact exactly the right user audience for updates on available upgrades, new features, or other news.

Firebase system allows the reliable data storage and synchronization. Firebase system analyzes the relevant user for sending the push notifications. Mal coding effort to get started and a graphical console for sending messages.

C. Route Planning

Route choice behavior is associated with the decision-making process of route selection in transportation, and much research conducted to understand this complex behavior [8,9]. For route selection previously Studies did not consider traffic images as part of the criteria. Thus, there has been limited work on route selection behavior. However, there are patent proposals [10,11] and studies in the literature [12,13] that apply or identify the usage of traffic photos in route planning. Users have a receiver that displays the images so they can view the route ahead and choices the route. Adam et al. [11] proposed a navigation device that displays a route on map with locations where visual traffic information exists. Visual traffic information comes from cameras, and viewing still images allows the driver to assess traffic conditions.

The Highways Agency in the United Kingdom is making images from traffic cameras available to licensed organizations to provide traffic information to the public to enable better route planning [12]. Speirs and Whitehead [13] providing public access to traffic camera images presented a research survey to evaluate the influence. Their results showed that combined with other sources of traffic information (e.g. speed/delay information), provided an additional secondary level of detail by traffic images. And they support drivers for better decisions on their route choice.

D. Vehicular social network

Vehicular Social Networks (VSN) was framework was introduced [16], which is an integration of social and vehicular networks. The goal of this framework is to construct a periodic virtual social community for user who are traveling on the same roadways. As an application of VSN, the authors presented RoadSpeak, a voice chatting system over VSN, which is used to facilitate communications between commuters so they can share common interests. SVN is application of VSN, which was first introduced in [6, 14]. Desktop web version of SVN was developed, and the latest version of the prototype was upgraded from Open Street Map (OSM) [15] to the Google Maps [17] platform, which currently incorporates all media file types (i.e. voice, images, and video clips). Another SVN algorithm differs in that the previous version was based on time and space, whereas the current version is based on time, space, and causal relationship. Fourth SVN model is described. Finally, extensive simulations were conducted to evaluate the digest and system performance along with a user study that investigated the real behavior of sharing traffic information.

III. SOCIAL VEHICLE NEVIGATION

In the proposed system we have introduced a cloud based collaborative traffic management system. All users' data is synchronized to the cloud. As soon as any user create an event that describe problem in the route or any situation that will take longer time to travel, system automatically determines all other vehicles that are travelling to that route and in the range of 10km. To achieve that the vehicular cloud (VC) is used, where a mobile cloud is formed from a group of participating vehicles that collaborate to share its resources, i.e. sensed data from the local environment; each vehicle can opt into the VC and utilize its services.

Figure 1 depicts example scenario to illustrate the SVN architecture. John commutes to work and prefer to consider safety first when deciding between route 66 and route 22. However, the information to access the safety of the roads is not available in current navigators. Therefore, John registers with a vehicular cloud service that allows him to benefit from social feedback shared by other drivers in the VC ahead. Lucy, driving on Route 66, experiences traffic congestion due to an accident ahead and shares this information by posting an image traffic post(TP1) to the cloud via firebase push message service. Similarly Sam post a description traffic post (TP2) noting that the bridge of Route 22 is slippery, but luckily there is little traffic. Other drivers in the VC along Route 66 have previously posted traffic posts (TP3-TP5) concerning the traffic accident at the same location in front of Lucy. The system recognizes that TP1 and TP3-TP5 refer to the same traffic accent, so it discards the older traffic posts while retaining TP1, which is most up to date. The system the aggregates TP1 and TP2 into traffic digest and send it to querying navigator. John acknowledges both routes' conditions based on a traffic digest and plan is route accordingly, where is decides to take Route 66, despite the slow traffic because he prefers a safe, albeit slow journey By using vehicular cloud services, shared real-time sensed data about the environment becomes a possibility.

Users can either post or receive other users' real-time sensed data about the traffic in more detail. Then, based on the user's perception of the traffic situation, the navigator can include the driver's preference in the route planning.

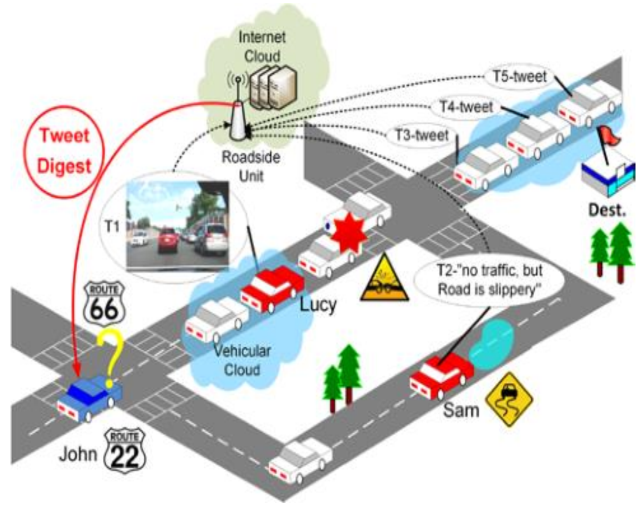

Fig.1. EXAMPLE SCENARIO

IV. CORE MODULE

A. Navigation Module

This module consists of real-time GPS data from mobile sensors. Given the source and destination, the routing algorithm is executed, and ETA is calculated to find of alternative routes based on the fastest route of shortest distance. Information regarding route plans and traffic volume for the routes flows to the upper module.

B. Social Collaborative Module

This module consist traffic reports in media files, such as text, or images or graphical information, which are tagged by location and placed on the road network map. Such traffic information is shared by participating drivers in the VC who subscribed to it. After the navigation module recommends alternative routes, all corresponding reports that coincide with the routes are selected and passed to the map presentation module. The reason for this is to filter out social traffic reports that are irrelevant to the route the route the driver is interested in.

C. Map Presentation Module

The role of the map presentation module is to summarize the information passed from lower modules. In route selection, user generally seeks only information pertinent to their routes of interest. People who receive too much information can easily become overwhelmed and may have difficulty processing the information. It would also be redundant to view similar traffic reports on the route, so the traffic digest summarizes the social traffic data set based on geo-tagged location.

V. ARCHITECTURE

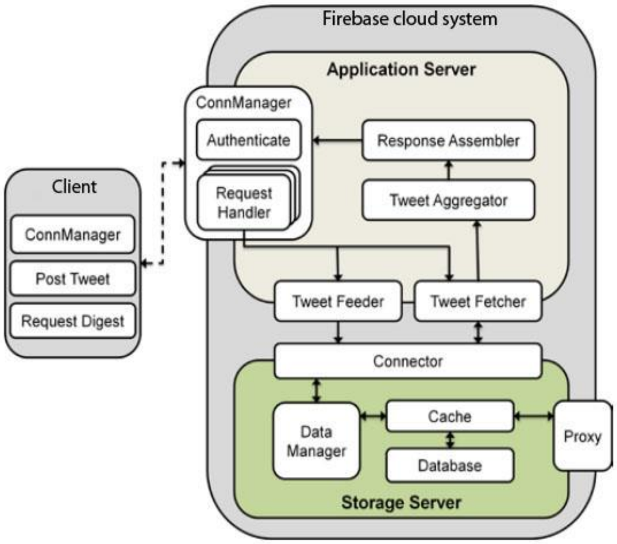

Fig. 2. ARCHITECTURE

System architecture contains mainly two parts.

1) Firebase Cloud System
2) Client

Firebase mainly contains application server and storage server. Application server verify user and give permission to post the tweets. These tweets very firstly stored in the firebase cloud storage. Then these stored data broadcasted in the form of tweets i.e. notification to the users who are travelling in the same cellular area created by event generator. When a user posts a NaviTweet, it is important to gather as much information as possible, while also being able to reduce the cognitive burden on the user. We propose two models for posting: active mode and passive mode. To minimize the cognitive load, the entire procedure is completed within three commands, where each command is executed by either voice or gesture. Active mode is for users who are actively willing to post NaviTweets. A variable, f, is defined as a threshold where the client device detects potential traffic congestion and takes a picture when f is larger than a predefined value. This value is set by using parameters, such as the current speed, acceleration and deceleration rates, and position. Several car-following models for traffic in stop-and-go conditions can be used to determine a suitable threshold value. Then, the user is prompted to share the image. If agreeing to post the NaviTweet, the user is prompted to annotate it. If agreed to again, a list of recommended tags like e.g. congestion, accident, hazard, construction, and others, is presented for selection via voice command. On the other hand, passive mode is designed for users to post NaviTweets whenever they choose to. The only difference from active mode is that whenever the user wants to share a traffic image, the user can voice-activate the camera. Once the picture is taken, the annotating process is the same as active mode.

The Traffic Map Layer carries out the route calculation, and based on the routing algorithm, several recommended routes are provided. Users who opt in can ask the VC for the traffic digest on routes of interest. The client device will send to the server the corresponding road segments, and the user will be able to view the digest in a sequential series of events along the route to the destination.

The application server (AS) sits on top of the storage server (SS) in the Firebase cloud system, where it receives posts from the mobile client subscribed to the VC. The connection manager (ConnManager) authenticates each user and dispatches the job to the handler. Depending on the type of request, the handler updates or retrieves data from the SS. We propose a simple API for communication between the AS and the SS. The SS provides two basic methods to the AS: put () and get (). The AS is designed to handle two types of request: post () and download (). Upon receiving post request T, the AS simply calls put (T). On the other hand, when a client asks to download a Traffic Digest, it sends the route of interest to the AS. Upon receiving the digest download request, the AS performs a process of selection, digestion, and composition to satisfy the request. Details are covered in the next section.

The SS is the foundation of the Internet cloud, where it is dedicated to provide high-speed, lazy-consistent, and highly available storage services to small media files as well as their metadata. The tweets posted by the clients in the VC will be ultimately stored in the database in the SS. Also, both the metadata used by the Digestion process and the media files used in the Composition process are located in the Database subsystem.

VI. SYSTEM DESIGN

A. Design Consideration

We have referred SVN system and made some changes in architecture to improve efficiency and scalability. The problem domain includes unique features, such as short time event, increase in traffic communication in congested areas, cross-platform messaging solution, reliable delivery of messages, etc., which will provide challenges as well as advantages.

B. Network Performance

Network performance varies according to the commuting traffic volume, and it is expected that the aggregated network data traffic for uploading data is associated with pick rush hours. Network performance can be maintained by using firebase feature versatile message targeting as it helps to distribute messages to single device, to groups of device, or to devices subscribed to topics.

C. Time-driven Event

Atypical traffic event has a time-to-live (TTL) that can last anywhere from several minutes to several days. For instance, traffic jams rarely lasts for more than a few hours, but construction can last for several days or weeks. A TTL feature is based on the traffic event is incorporated into the design, where data can be safely deleted from the storage cache system after TTL expires. Such a feature reduces the requirement to sustain data durability, and means the system needs less storage space.

D. Scalability

Our system is designed as a scalable online service for commuters to share traffic information. The architecture should accommodate large number of users uploading and downloading data simultaneously. A distributed architecture of internet cloud (For example Firebase) can provide a natural solution to achieve scalability. A distributed architecture is favored due to the fact that most commutes occur between home and work within a reasonably stable and small geographic region, where a Firebase can handle the majority of requests in its locality.

E. Consistency vs. Availability

In distributed system architecture, it is essential to ensure distribution transparency and data consistency. In our system, data consistency can be tolerated for two reasons: drivers generally prefer to obtain up-to-date traffic information, and user-generated shared information can be inaccurate, leading to false negatives or false positives, e.g. false traffic alerts. Hence, emphasizing data consistency among the distributed storage servers is not necessary, and therefore, it is more desirable to provide drivers with timely and inconsistent traffic data rather than outdated and consistent data.

F. Vehicular Cloud Client

1. Posting TrafficPost

When a user post trafficPosts, it is important to gather as much information as possible, while also be able to reduce the cognitive burden on the user. In our system to minimize the cognitive load, the entire process is completed within three commands. A variable f, is defined as a threshold where the client device detects potential traffic congestion and take a picture when f is larger than predefined value, this value is set using parameters, such as current speed, acceleration and deceleration rates and position. Then the user is prompted to share the image. If agreeing to post the trafficPost, the user is prompted to annotate it. If agreed again, a list of recommended tags (e.g. congestion, accident, hazard, construction and others) is presented on screen user has to select one of these by touching the screen.

The most favorable placements, so the camera can take suitable pictures, is any areas above the vehicles dashboard. However, the middle area in the front windshield provides the most optimal view.

2. Requesting Traffic Digest

The navigation module carries out the route calculation, and based on the routing algorithm, several recommend routes are provided. Users who opt in can ask VC for the traffic digest on the interested route. The client device will send to the server the corresponding road segments, and the user will be able to view the digest in the sequential series of events of along the route to the destination.

G. Internet Cloud Design

Figure 2 presents the design of the system. The application server i.e. Firebase server sits on the top. Where it receives posts from (or send digest to) the mobile client subscribed to the VC. The connection manager authenticates each user and dispatches the job to handler. Depending on the type of request, the handler updates or retrieves data from real-time database server. Firebase has provided all functionalities to communicate to real-time database server.

VII. USER STUDY

The motivation for SVN implementation was to share traffic data that provides detailed information using images by developing a platform where users can easily to support drivers for route planning. The best user study approach is to deploy our application for studying the real behavior of tweet posting and the efficiency of the tweet digest. However, there are several limitations to such a user study. There is the lack of a decent number of traffic images that can be crowd sourced. Also, even if there were to be enough images, there needs to be drivers who take the corresponding route to make use of the images taken.

VIII. CONCLUSION

Users collaborate to share traffic images by using their mobile device camera with the use of firebase technology. This paper described a vehicular cloud service for route planning, where user captures the local traffic information from surrounded traffic in real time in contexts like text, images, and short videos. However, too much information can make route planning even more difficult when processing it all. As current navigation systems mainly rely on estimated time of arrival, there are limitations to taking other semantically rich information into account to support decision making and improve satisfaction in route selection. This paper introduced the use of traffic images provided through the firebase to assist drivers in route planning and route decisions. We proposed a social vehicular navigation system where driver-generated geo-tagged traffic reports can assist other drivers in route planning. The traffic reports are called NaviTweets, and summaries are called Traffic Digests, which are composed and sent to drivers on the relevant route. The paper presents the system design and the SVN prototype, along with performance and user-study evaluations.

IX. DISCUSSION AND FUTURE WORK

Several issues require further research security, privacy, malicious users, and last but not least, passenger safety must also be considered. Issues such as passenger safety and reducing cognitive load must be further examined through an analytical user study. Advancement in the proposed system is that different module could added such a that suppose user upload the accidental event on the system and describes the event as accidental event then automatically event notification will goes to nearest hospital. Along with this different modules like tracking systems, tour guide module can also be add in the system.

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