ON-BOARD SMARTPHONE APPLICATION PLATFORM FOR REAL-TIME SHARING OF TRAFFIC INFORMATION

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Summary
Real time traffic information is available on a very limited number of roads and highways where cameras or traffic sensors are implemented. Since majority drivers and travelers have smartphones which can record multimedia (image, video) and use sensors (accelerometer, gyroscope, etc.) it is possible to use those devices for sharing real time traffic events. In this paper, a system for recording and sharing traffic multimedia content over the Internet in a real-time is proposed. It consists of on-board smartphone application and data server platform and it works in three modes: 1. proactive – image/video is recorded within time interval; 2. reactive – event triggers image/video recording; 3. user – users can manually select what to record and when to deliver. Proposed system is tested in a real-world environment and is available for usage.

1. INTRODUCTION

The development of intelligent transport systems is driven by the rapid development of technology and the growing need for efficient transportation. The increased need for mobility in the past few decades has led to significant changes in the transport infrastructure. However, vehicles increasingly overwhelm cities, leading to daily crowds, congestion, unpredictable traffic situations and traffic accidents. Inefficiency of traffic causes significant time losses, reduces vehicle and pedestrian safety, causes large pollution and high loss of energy. Intelligent transport system represents an upgrade to the classic transportation system, and the main goal is achieving safe, reliable and efficient transportation of passengers and goods. The basis of intelligent transportation system is an efficient exchange of information between vehicles for making useful and usable telemetry applications for work in large-scale changing environments. There are numerous applications that can be used for various purposes, such as improving safety (accident avoidance, incident notification), improving driving (congestion monitoring, parking space allocation) and commercial services (business, entertainment) [1]. For the majority of applications, it is crucial to deliver the right information at the right time and in the right place in order to make informed decisions. Intelligent transport systems cover all types of transportation, road, rail, air, sea, and river.

Nowadays, smartphones are ubiquitous and majority have unlimited Internet access and built-in many sensors, therefore they can be useful for various purposes. Since majority travelers have smartphones which can record multimedia (image, video) and use sensors (accelerometer, gyroscope, etc.) it is possible to use those devices during driving for purposes like recording road ahead or detecting events using sensors and for informing interested users (driver and travelers) about real time traffic events. Proper smartphone usage can be a great assistance while driving. Drivers can be informed about conditions of the traffic road or possible upcoming driving situations. Collecting and sharing information about traffic can help drivers to avoid unfavorable conditions such as traffic jams or even traffic accidents. Drivers would be timely informed so they could adjust driving to the presented conditions.

In this paper, our main focus is road transportation that is consisted of different types of vehicles like cars, trucks, busses, motorcycles, bikes and also pedestrians. In the past decade, many researchers have been working on a development of VANETs (vehicular ad-hoc networks) which is a subgroup of mobile ad-hoc networks and it is recognized as important element for intelligent transportation system development. Our current work in the field of VANET is available in [2], [3], [4], [5], and [6]. Every vehicle is equipped with wireless devices and acts as node that communicates with other vehicles (nodes) to
exchange useful traffic information. However, implementation of such network in the real world have not started yet and it is a challenging task since vehicles are constantly moving and making network topology very dynamic. Buildings, traffic signalization and other obstacles are disrupting wireless communication. However, traffic information that are not urgent can be shared over the Internet using smartphones that are present in almost every vehicle. According to WG6 described in [7] three technical solutions for the access to in-vehicle data and resources are proposed. These comprised the following technical architectures: Data Server Platform, In-vehicle Interface and On-board Application Platform. Therefore, we developed on-board smartphone application that records videos or images of the road ahead in three modes. Records are synchronized over the Internet and displayed in data server platform. It consists of map with marker for every record. Record filtering and directions are provided.

Section 2 presents an architecture of the developed system. In Section 3 an on-board smartphone application is described. Section 4 describes used BaaS and developed data server platform. Section 5 concludes paper and specifies possible system extensions.

2. SYSTEM ARCHITECTURE

Designed system is defined as iMANET (Internet-based mobile ad-hoc network) [8]. iMANET is type of wireless ad-hoc network where mobile nodes are connected over the Internet. Implementation is based on set of mobile phones connected in ad-hoc network using BaaS (backend as a service). Mobile phones are not connected directly to each other but over BaaS they communicate for resource exchange. BaaS is used for user authorization and authentication, sending and receiving multimedia and other data resources with additional information. Resources are publicly available, and therefore can be accessed from any platform with an Internet connection. On-board smartphone application is used on smartphones in vehicles and data server platform is available online for all types of users.

On-board smartphone application consists of few screens for user navigation through application and background services. There are three types of services inside application. First service tracks user location using in-build GPS module and shares information with other services. There are services for proactive and reactive modes which depending on the calculations and other sensors take pictures or video records. Final service is used for synchronization of user records with online database. It periodically or depending on internet connection synchronizes records. System architecture is visible on Fig. 1.

Data server platform is divided in two main parts. First part manages server and all records. It has in build authorization and authentication modules for users, files module for saving records of any type and dynamic resources for saving additional information about records. Table 1 shows properties and descriptions for records in a database. Second part is client side Javascript application that displays results on map. It uses Javascript SDK and additional libraries for displaying a record on Google map.
### Table 1. Properties of record entity

<table>
<thead>
<tr>
<th>Properties</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>Universally unique identifier for the record</td>
</tr>
<tr>
<td>fileType</td>
<td>Enum which defines type of record (VIDEO, PHOTO)</td>
</tr>
<tr>
<td>fileName</td>
<td>File system record name</td>
</tr>
<tr>
<td>fileExtension</td>
<td>Record file extension, .jpg for images and .mp4 for video records</td>
</tr>
<tr>
<td>localURI</td>
<td>Absolute route for record</td>
</tr>
<tr>
<td>latitude</td>
<td>Latitude for record location</td>
</tr>
<tr>
<td>longitude</td>
<td>Longitude for record location</td>
</tr>
<tr>
<td>accuracy</td>
<td>Accuracy of GPS module for taken location</td>
</tr>
<tr>
<td>linkToFile</td>
<td>Online URL for record</td>
</tr>
<tr>
<td>dateCreated</td>
<td>Date and time for record</td>
</tr>
<tr>
<td>sync</td>
<td>Flag to determine if the file is synchronized with online service</td>
</tr>
<tr>
<td>recordType</td>
<td>Enum that indicates in which mode record is saved (PROACTIVE, REACTIVE, USER)</td>
</tr>
</tbody>
</table>

### 3. ON-BOARD SMARTPHONE APPLICATION

On-board smartphone application is developed for Android operating system which is the most used operating system in the world. Mobile application can be used with proper mobile positioning inside vehicles. It must be places on a front windshield window of a vehicle using a mobile holder attached to the window. Back device camera needs to have a clear sight of the road ahead for recording multimedia files. Application can be used in three different modes as shown on Fig. 2.

In the user mode, users can take pictures or videos and it can be started by touching one of the top buttons with camera or video camera. After user selects one of the buttons in-build camera application is started. Location is acquired and saved along with recorded resource.

![Traffic Application](image)

**Fig. 2.** On-board smartphone application GUI.

Proactive mode saves records for provided time interval and it is started by touching **START SERVICE** button under proactive mode section. User need to select what to record, picture or video, enter interval number and select desired interval units (sec, min, hour). If video is selected under section for user needs to enter length of recording.

Reactive mode takes records based on two events. If sudden stopping event is selected device will use accelerometer to determine g-force created by vehicle movement. Any g-force measurements higher than specified inside application will trigger recording. Traffic jam service records vehicle speed for desired time period. Approximate speed lower then 20km/h will trigger recording.

All records can be viewed inside application. Record screen shows preview, location, time, event type and synchronization status (Fig. 3). User can delete records, open record location on map and manually synchronize records. Inside settings user can choose automatic synchronization options and default proactive and reactive settings. Automatic synchronization can be allowed only over WiFi and for specified record types.

After desired service is started persistent notification is displayed with option for stopping service at any time. Records are taken in background so application does not need to be in foreground to work. In top left corner of the screen
record preview is shown inside system window which can be displayed on top of any application.

Fig. 3. Records application GUI.

On first application use users need to create account or login with existing credentials. For registration user needs to enter email and password. Activation email with activation link is sent.

Activation link needs to be open with Traffic Application to complete account creation. After login user info and access token will be saved for communication with BaaS.

4. DATA SERVER PLATFORM

Data server platform is divided into two components. First component is BaaS with configuration for resources and files with permissions. Second component is web application that displays map with markers.

BaaS provides API endpoints for user authorization and authentication, files and resource administration. BaaS dashboard provides control for users and resources via GUI. Users in role administrator have access to dashboard and all resources and permissions. Registered users will be in user role and have permission to upload new resources. User resources are saved using combination of two different functionalities of BaaS. Application uploads files (image or video) on specific endpoint using http post method. When file is successfully uploaded dynamic resource needs to be created with file URL. It is custom created object saved in JSON format that contain all info about uploaded file. Client web application query dynamic resources when displaying markers on map. Registered users have permissions for creating

Fig. 4. Client web application
files and dynamic resources. Read access is public for files and dynamic resources.

Client web application, shown on Fig. 4 displays map with markers. Markers are displayed with two different icons that define record type (video or image). Clicking on marker opens info window with record preview and time when it’s recorded. Click on record preview will open full size resource in new tab. Panel in top right corner contains options for directions and filtering. User can enter start and destination point and by clicking Search driving route will be displayed on map. Filtering allows user to display event by time and type. Selected time can be 2, 12, 24 and 48 hours. For type image or video can be selected. Clicking on Filter will show only markers for selected filter.

Client web application uses Google map with markers and direction, BaaS Javascript SDK for fetching and querying dynamic resources and additional Javascript libraries for common use. Application can be used without public server because browser compiles client-side code. It can be published as static web page while loading time and all server-side options are managed by BaaS. Resources can be displayed in any application with Internet access and this is the only proposed solution. Application executes http get request for fetching dynamic resources with desired filter parameters formatted as query language similar to SQL. BaaS compiles query and returns results inside response of the request.

5. CONCLUSION

Intelligent transportation systems are advancing rapidly and the main goal is to provide benefits for drivers, passengers and other traffic participants. However, the full potential is still not used since vehicles are missing on board units so users cannot access and exploit useful information. Therefore, in this paper we proposed a system based on smartphones that has ability to collect, record and share multimedia traffic data. It is consisted of two components: on-board smartphone application and data server platform.

Developed on-board smartphone application has ability to record traffic conditions in three different modes and two types and share useful information with other interested traffic participants. It provides simple user interface that can be used without much interaction which makes application safe for usage while driving. Application works in background so other navigation applications can also be used. Upgrades and improvements can be done by implementing new modes, events detection, advanced synchronization and sharing options.

Data server platform displays markers with icons and provides directions and filtering. Users can easily find relevant records by entering route and click selecting displayed markers. Client web application can be upgraded by extending filtering and route options.

6. REFERENCES


