Citizens-centric mobile application for traffic accidents reporting

Marko M. Dabović*, Valentina Janev**
* School of Electrical Engineering, Belgrade, Serbia
** The Mihajlo Pupin Institute, Belgrade, Serbia
marko.dabovic@outlook.com, valentina.janev@institutepupin.com

Abstract—Nowadays modern mobile phones have a lot of sensors that can be helpful in various situations, for instance, to facilitate the collaboration between citizens and public services. This paper explores the use of smart phones for producing rich information about traffic accidents in real time. The goal is to examine the Linked Data approach for building a mobile application to be used by citizens for collecting evidence about an exceptional situation (a traffic accident) and for notifying emergency organizations (e.g. the nearest police station) and the wider community. The benefits expected from using the Linked Data in this scenario are related to interlinking data from different sources, semantically enriching the data and sharing the data in a standardized format. This paper presents preliminary results from the design and implementation of a mobile application for Android-based devices.

I. INTRODUCTION

Nowadays modern mobile phones and social networks (Twitter, Facebook, LinkedIn) are commonly used for raising awareness about events e.g. music, scientific, political, and/or opportunities (e.g. shopping, employment). In the last five years, government agencies worldwide [1] have recognized the potential of social networks in the emergency management process, and in particular, for situation awareness and notification in crisis situation. A good example is given by the tsunami disaster in Japan in 2011. During this event, the authorities realized that a big amount of updated information was broadcasted in Twitter and revealed the public usefulness and effectiveness of social networks [2]. When an emergency occurs, citizens can be a helpful support for the operation centers involved in the response activities [3].

The research presented in this paper is motivated by the need to improve awareness about traffic accidents by utilizing modern technologies. We created a mobile application (named TraffAccs) that can be utilized for real time information exchange on traffic accidents, via the Internet. The goal is to support the first, and perhaps the most important, phase when the witnesses need to collect information about the situation and notify the law enforcement agency and the wider community. The guiding idea was the need to create a software solution that will allow users (witnesses) to very easily create information about traffic accident and share the evidence via channels dedicated for that purpose without extensive knowledge of police or other procedures. These data, later can be used for both interlinking with other semantic data, as well as for a variety of analysis carried out by state institutions and or insurance companies.

II. PROBLEM STATEMENT

A. Scenario analysis

Citizens directly involved both as victims or witnesses and thus being aware of updated information useful for managing a critical situation (e.g. traffic accident) can play an important role in first response activities.

For example, let’s suppose that a person A is a witness of a traffic accident with victims and great material damage, which implies that congestion on this part of the road is inevitable. Person A could easily share information about the traffic accident so that others can know what, when and where it happened. Further on, let’s suppose that a person B, which is close to the location under consideration, receives information about the event and will be able to choose alternative travel route, to avoid the expected / predicted congestion. Implementation of services that replace the currently missing links between data producers (witnesses) and data consumers (public authorities and citizens) is of high importance for the society.

B. Requirements

Nowadays, 112 is the common emergency telephone number that can be dialed free of charge from most mobile telephones and is also operational in all European Union countries. 112 calls are connected to an emergency response center (ERC), and ERC staff makes alarm connections to a number of authorities and stakeholders needed for resolving the situation.

Putting in place a community participation service which will help to collect data on traffic accidents and to store the data in one place requires, on one side, (1) an effort to develop the citizen-centric participatory sensing tools, and on the others, (2) an effort to adapt the information systems used by ERCs to the channels that people are already used to (e.g. Twitter or Facebook).

C. Research Focus

This paper deals with the requirements from point (1). A precondition for the revival of such community participation service is design and implementation of a very simple application where user can input details of the traffic accident (e.g. short text about the event, the early assessment of injured and material damage). According to our analysis, there is a small number of notification services of this type.

Aimed at innovating the current traffic accident EM practices, our research focus was on using the Linked Data paradigm, databases and semantic technologies, open
source tools, and cloud platforms such as the Dydra platform for prototyping the solution.

III. TRAFFACCS IMPLEMENTATION

A. Design

Drawing on a wealth of sensors in smartphones, we created an application for smartphone devices that is based on the Android operating system. The TraffAcc application is aimed at recording data on traffic accident in a very fast and efficient way, as is presented in Figure 1.

After starting the application, the user needs to login to his/her Twitter account (step 1). After that, the user takes a picture of the incident itself using the smart phone camera (step 2) and enters details of the accident (type of accident, e.g. with death, with injuries, with material damage, step 3). The exact date and time of the accident is created automatically when the user takes the photo. By pressing the ‘submit’ button (step 4), the data will be stored on server in RDF triple form. The application will inform the user about the uploading of information in the central data store.

B. Implementation

For the purpose of testing the application, we used the Dydra database, a powerful graph database in the cloud, https://dydra.com/, i.e. hosted on Amazon Web Services, http://aws.amazon.com/. The Android application - TraffAccs was developed with the Punya framework, http://punya.mit.edu/project.

Both tools (Punya as well as Dydra) are results of experts from MIT CSAIL (Computer Science and Artificial Intelligence Laboratory, http://www.csail.mit.edu/) with the aim to help researchers in the field of semantic technologies develop Android Linked Data applications in a quick and easy way.

Dydra back-end infrastructure is based on core messaging technologies such as AMQP, http://www.rabbitmq.com/ and Redis, http://redis.io/. Currently, Dydra is offered as a commercial database via the company Datagraph, Inc. The proprietary distributed SPARQL query engine, called SPOCQ, is built in Lisp and compiles SPARQL queries to native x86 machine code. The distributed RDF storage system is built in C, relying on Raptor, http://librdf.org/raptor/ at the interfaces.

Punya framework is derivative of the MIT’s App Inventor platform for developing Android applications. Based on block-based programming approach, the application development in Punya is very fast, and thus helps researchers to focus on solving the problem. Part of source code behind the block-based coding is presented in Figure 2.

IV. TRAFFACCS VALIDATION

Our research on the state-of-the-art applications for emergency notification has showed that there aren't many applications in the domain that utilize graph databases and Linked Data technologies.

A. Linked Data Approach

The term Linked Data here refers to a set of best practices for publishing and connecting structured data on the Web. These best practices have been adopted by an increasing number of data providers over the past three years, leading to the creation of a global data space that contains many billions of assertions - the Linked Open Data (LOD) cloud, http://lod-cloud.net/. The cloud has been enlarged from 12 datasets in 2007 to 1,139 in January 2017.

Our research on the state-of-the-art applications for emergency notification has showed that there aren't many applications in the domain that utilize graph databases and Linked Data technologies.

Linked Data enables datasets to be linked together through references to common concepts. HTTP URIs are used to identify any entity or concept (people, locations, products, events etc. in the LOD cloud), so that data consumers are provided with more information when accessing data, including relationships, i.e. links to other related URIs. The standard for the representation of the information that describes those entities and concepts, and is returned by dereferencing the URIs, is RDF, see https://www.w3.org/RDF/.

Figure 1. TraffAccs GUI on the mobile device
B. TraffAcc Messages in RDF Format

Currently the TraffAcc prototype supports the data collection process only (see Data Producer icon in the Figure 3). In case of a traffic accident the user describes the accident in the Text Box on the TraffAcc GUI (see object TypeOfAccident in Figure 4) and specifies a link to the image stored on the Twitter server (object Image). The DateTime and the Location object are created automatically. The RDF triples stored on the cloud server comprise the alert message that should trigger additional actions by public authorities.

The Emergency Data Exchange Language (EDXL) is a suite of XML-based messaging standards that facilitate emergency information sharing between government entities and the full range of emergency-related organizations. Implementation of EDXL standards aims to improve the speed and quality of coordinated response activities by allowing the exchange of information in real time. Alignment of the TraffAcc messaging format to the EDXL is part of the future work.

C. Enriching TraffAcc Messages with Open Data

Once available is the RDF format the message could be semantically enriched by linking the data with related entities from Open Data resources such as:

- Road network data from Open Street Map, https://www.openstreetmap.org,
- Satellite images from Copernicus emergency management service, see http://www.copernicus.eu/main/emergency-management, and others.
D. Discussion

Although in this very early phase, the solution has advantages over the classical traffic accident notification channels because it provides means to collect a lot of information in a very simple and efficient way (plenty of precise and accurate information that are important for the accident situation). These advantages include; 1) increased mobility, 2) increased speed of filling of data into the system [6], 3) increased situational awareness.

Presenting the message in Linked Data format opens possibilities for standardizing the ways of sharing information across Europe and building smart cities apps [7]. Currently, in the domain of emergency services implementation, EU member states are quite independent, meaning that each stakeholder has deployed its own system of command, control, and communication. As a direct result of this situation, ERC systems and information data models and formats are invariably incompatible with each other, meaning that cooperation between emergency forces becomes almost impossible in many regions [8].

V. CONCLUSION

Smart technologies revolutionize the way the cities locate, mitigate, and prevent safety issues. The current prototype demonstrates the use of the TraffAccs application in the data collection process only. The presented results have a dual role, on the one hand, to introduce a citizen-centric application for reporting traffic accidents, and on the other, to demonstrate a wide range of possibilities of the Punya frameworks for building cloud services.

Although in this very early phase it is obvious that the solution has advantages over the classical traffic accident notification channels because it provides means to collect a lot of information in a very simple and efficient way (plenty of precise and accurate information important for the accident situation). However the adoption of the application should be analyzed in the wider national and EU context.

As part of our future work, the collected information will be interlink with other databases, such as GPS data of closest police stations or nearest health centers, as well as other data that will be available via the national Open Data portal, see https://data.gov.rs/sr/. Interlinking databases would lead to the maximum utilization of the knowledge of the data in real time in various ways, some of which have already been presented in the context of the work itself.

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REFERENCES

TABLE I.
COMPONENTS USED TO BUILD THE TRAFFACCS APPLICATION

<table>
<thead>
<tr>
<th>Palette</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonvisible components</td>
<td></td>
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<tr>
<td>Camera</td>
<td>Media component takes a picture using the device’s camera. After the picture is taken, the name of the file on the phone containing the picture is available as an argument to the AfterPicture event.</td>
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<tr>
<td>Location sensor</td>
<td>Sensor component providing location information, including longitude, latitude, altitude (if supported by the device), and address. This can also perform geocoding, converting an address (not necessarily the current one) to a latitude (with the LatitudeFromAddress method) and a longitude (with the LongitudeFromAddress method). Location sensor should be enabled (property Enabled set to True), and the device should allow location sensing through wireless networks or GPS satellites (if outdoors). Location information might not be available immediately when an app starts. The user will have to wait a short time for a location provider to be found and used or wait for the OnLocationChanged event.</td>
</tr>
<tr>
<td>LinkedData</td>
<td>Linked Data component.</td>
</tr>
<tr>
<td>Twitter</td>
<td>Social component that enables communication with Twitter. Once a user has logged into their Twitter account (and the authorization has been confirmed as successful by the IsAuthorized event), many more operations are available:</td>
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<tr>
<td></td>
<td>• Searching Twitter for tweets or labels (SearchTwitter)</td>
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<td></td>
<td>• Sending a Tweet (Tweet)</td>
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<tr>
<td></td>
<td>• Sending a Tweet with an Image (TweetWithImage)</td>
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<tr>
<td></td>
<td>• Directing a message to a specific user (DirectMessage)</td>
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<tr>
<td></td>
<td>• Receiving the most recent messages directed to the logged-in user (RequestDirectMessages)</td>
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<tr>
<td></td>
<td>• Following a specific user (Follow)</td>
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<tr>
<td></td>
<td>• Ceasing to follow a specific user (StopFollowing)</td>
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<tr>
<td></td>
<td>• Getting a list of users following the logged-in user (RequestFollowers)</td>
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<tr>
<td></td>
<td>• Getting the most recent messages of users followed by the logged-in user (RequestFriendTimeline)</td>
</tr>
<tr>
<td></td>
<td>• Getting the most recent mentions of the logged-in user (RequestMentions)</td>
</tr>
<tr>
<td>Visible components – User Interface (UI)</td>
<td></td>
</tr>
<tr>
<td>Button</td>
<td>Buttons are components that users touch to perform some action in the app. Buttons detect when users tap them. Many aspects of a button’s appearance can be changed. You can use the Enabled property to choose whether a button can be tapped. In TraffAccs the following buttons are used: Twitter, Camera, Submit, and Location.</td>
</tr>
<tr>
<td>TextBox</td>
<td>Users enter text in a text box component. The initial or user-entered text value in a text box component is in the Text property. If Text is blank, you can use the Hint property to provide the user with a suggestion of what to type. The Hint appears as faint text in the box. In TraffAccs, TextBox is used for inserting details.</td>
</tr>
<tr>
<td>Label</td>
<td>Labels are components used to show text. A label displays text specified by the Text property. Other properties, all of which can be set in the Designer or Blocks Editor, control the appearance and placement of the text. In TraffAccs are labels for presenting date and time, location and caption.</td>
</tr>
<tr>
<td>LinkedData-Form</td>
<td>A form for grouping data properties. LinkedDataForm is subject, grouped data are predicates, and their data are objects in RDF triple. In TraffAccs, LinkedDataForm is used (see Figure 4).</td>
</tr>
</tbody>
</table>