Bewared Android Mobile Awareness Platform about Natural Disasters

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Abstract: Latest developments in crowd-sourcing and inter-user information sharing has led to the idea of sharing crucial information about a near disaster. Having this information can decrease the number of casualties. If people are aware of a near disaster, they can more easily avoid it, which in term, can minimize the damage it makes. The fastest way to get informed, in these situations, is by having peer information and on-time alert. Users of the social networks, have shown, over the years, that they can share information fast in time of a crisis. This type of information sharing is commonly known as crowd-sourcing. In this paper, we propose an android awareness platform called Bewared, which, in term, allows users of the social networks to collaborate, share information and pinpoint a natural disaster with its location. The types of natural disasters, used in this research, are: earthquakes, fires, floods, fire and their level of validity. The application uses some of the existing platforms and social media networks. In our case, Bewared is supported by Facebook due to its option (application interface) to geographically locate each user of the network, by using their mobile device its real time interaction possibilities.

1 INTRODUCTION

Each person (internet user) is equally responsible for the environment, interaction with other people and the way of living. According to latest research finding in [1], the chances of facing a catastrophe or a disaster are increasing. Since we are witnesses of several natural disasters [1], that happened in the near environment without previous awareness, it was the motivation to explore and develop an application to help users stay informed of disasters by other users who can share this information. Since people nowadays are constantly linked on social networks and share information about anything, the idea of this research is to use this massive information to alert users of danger and thus avoid it. Crowd-sourcing can be used as a method to obtain data from different users and reconstruct the object. In our case, we can use crowd-sourced information from different users to increase the liability of the information. This means that if more users report the similar information (at a near geo-location), the information is considered more reliable. With the number of users continually increasing over time, the crowd-sourcing is being more specific and the data that is being generated is more detailed and quantitative [2].

As explained in [3], generating big data of knowledge in a group can increase the validity of the information passed and confirm it as a fact. This is why we need more users to confirm the information and help others. In terms of popularity and number of users and social media ranking, Facebook is the most popular social media network worldwide. A wide selection of social networks also heavily relies on user-generated content: image-heavy Tumblr, Instagram and Pinterest. However, these networks are home-based and content-oriented. Data can be automatically extracted from social media sites via Application Programming. API's are generally used for recording an event sent by an individual or bundle of users, accumulating within collections for later analysis. The data that will be kept in the database using API's can be manually selected and saved in variables as properties.

After the information is obtained from the network, it can be analysed and alert other users of the network. There can be levels of different alerts or alert types to indicate the level of danger the user is in. Furthermore, the data collected can help the system produce more accurate and more reliable conclusions about the disasters. Since our data acquisition uses the Facebook platform, the data also will have the location of the users who agreed to the terms of use of Facebook. Also, for Facebook users to be able to use the Bewared application, they would have to agree that their data will be used in additional calculations and data generation for the purposes of the Bewared. The main research in this paper is the Bewared application, which uses crowd-sourced data from Facebook users to alert about near disasters. This information is verified by crisis management agencies that marks information as verified of not. The reliability of the crisis information is increased with the number of users that are reporting it. The paper is organized in sections, where Section 2 presents state of the art solutions and existing services that provide access to crisis data. Section 3 of this paper presents the data gathering from Facebook and crowdsourcing of the Bewared application, whereas, Section 4 presents the architecture of the Bewared verification system. Section 5 presents a case study of the system with 15 users and Section 6 concludes the paper.

2 RELATED WORK

There are a numerous of different platforms that help, support and improve the process of Prevention, Preparedness, Response and Recovery (PPRR). Some platforms isolate and focus on particular disasters, whereas, others are more general and tend to alert all sorts of anomalies and possible harmful situations. Some small number of these are open source platforms, whereas, most of them are commercial applications.

As an example, the Gov.uk platform, presented in [4], is a specific website for England and Wales, where one can specify any postcode of any place in one of these countries and obtain an information about a flood or get a flood warning.

Another example is the Palantir platform, presented in [5], which is a global website that tries to prepare the individuals for unexpected harmful circumstances is mainly used for risk management. This platform is developed and used mainly to support and integrate massive volumes of data for crisis response operations on a moment's notice. This data includes publicly available data, damage assessments, satellite imagery, weather reports, geospatial information on key infrastructure and relief resources, as well as, reports from news agencies and governments. Furthermore, this data is available for researchers and users to analyze and use via API (Application Programming Interface) in JSON format, [5]. An example of such information is shown in Figure 1.


```
{
  "disaster": "earthquake",
  "property": 4.5,
  "happening_now": true,
  "keen": {
    "timestamp": "2015-05-27T22:44:50.722Z"
  }
}
```


Figure 1: Data collected using API.

The government of Virginia developed and still maintains the VIPER platform (The Virginia Interoperability Picture for Emergency Response) [6]. This platform contains weather reports, flood gages, traffic incidents, wildfires and many other hazards, which is accompanied with the location it covers.

The following sites represent crowd-sourced incident maps, created and maintained mainly by peer users:

Hotosm in [7] creates collaborative maps for humanitarian help, that unlike the previous platforms, in case of a major disaster, this platform helps to gather volunteers. The application creates a map of incidents and maps paths for the volunteers to reach and help victims. It organizes the paths by reaching the victims that require more immediate help. The platform follows the Reach and Rescue protocol. It receives information from victims in a JSON format and creates the routes and maps to reach them.

Climatecolab.org is an organization that works on a #CrowdCriMa platform, where all the unheard voices can be heard.

Case scenario for #CrowdCriMa:

Step 1: A victim or an activist sends SMS to a particular mobile number connected with #CrowdCriMa platform.

Step 2: #CrowdCriMa collects the SMS and store it / directly publish it and forward it to the authority. Or

Step 3: The admin of #CrowdCriMa platform checks SMS and publish it via different social media channels.

Step 4: Once published, SMS will be auto forwarded to particular pre-added email id (e.g. for fire service or for flood and et cetera).

All of the presented thus far have the same general concept, which is, to prevent casualties and save lives by communicating and sharing information. All of the platforms use peer information sharing, which some of the platforms use official reports from agencies.

3 FACEBOOK AND CROWD-SOURCING

It is commonly known fact that people commute on a regular basis every day, and this includes going to work, school, university etc. Each person is connected to friends and acquaintances and communicates using the social networks. Most of the world's population uses Android as a platform for their smartphones as a cheaper version, compared to the iOS. Since the rapid growth of users and bringing the social networks closer in their lives, users tend to share all sorts of information. On one hand, the Twitter social platform is created for short bursts of mostly textual information that has made this platform mainly a deck of personal opinions that the users share with the followers. Facebook, on the other hand, is a social network platform that contains all sorts of information, such as pictures, opinions, activities and so on. However, the main reason why Facebook is chosen as an information sharing platform, for the research, due to the level of sharing and the real time information delivery. Also, Facebook has dedicated an additional section in their platform for disaster information sharing with an API to connect.

Social networks are useful for big data generation, since users are zealous to participate and share information to other users. This behavior further depicts the reason for using Facebook and social networks all-together. Users of the online social networking also share common interests, pages, and by using hashtags, indicate specific subjects of interest. Since most of the social media is based on crowd-sourcing, they present a valuable source of information. On Figure 2 is shown a screen-shot image that displays the interface of the users of the Facebook application, with which, each user has to agree with its Terms of service and Privacy policy.

When developing an application using this Facebook interface, the API requires a token of request per application, which the request has to include the list of parameters that the application will take from the API. In our case, we request user_location and user_action_news. With the user_location is used to pinpoint the news on the map, where the other parameter is the news (disaster) that is announced by the user. The detection of users that are near is done using the Facebook Graph API Explorer, [9].

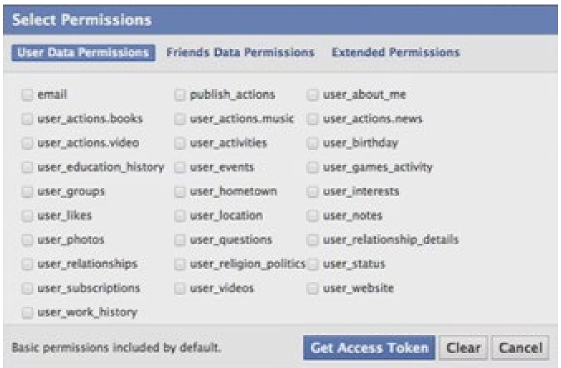

Figure 2: Facebook's API to allow access to user's data.

The response from the Facebook API request includes Facebook login, sharing and sending dialogs, triggering application events and Graph API. When someone connects with an app using Facebook Login, the app will be able to obtain an access token which provides temporary, secure access to Facebook APIs and the application has the right to own the user's credentials or other information on Facebook behalf. Sharing and sending dialogs is crucial part of the process since it is the main target of this application, which is, to share the required information at the right time.

3.1 Google Maps(Marker)

Google maps is a desktop web mapping service developed by Google. It offers satellite imagery, street maps, 360° panoramic views of streets (Street View), real-time traffic conditions (Google Traffic) and route planning for traveling by foot, car or public transportation. In our case, we use Map Android API on which a custom map is created and used by all users of the application. This will allow users to mark all the dangerous areas or places, which in term can serve as a warning information to other users. In our case, the warning is done using three symbols for flood, fire or earthquake, placed on the map.

3.2 Geo Crowd-Sourcing

In its basic form, crowd-sourcing is a method that uses mobile devices from users to gather massive amount of information, typically named CrowdInfo. This information can be geo-located and can help to determine where to build the next shopping center or obtain an information about the events that are taking place near the user. On the other hand, it can be used by companies to place their products according to user's needs. These types of companies collect massive amount of data from active users, who report the events taking place and reports to the crowd-source database.

Recently, crowd-sourcing is mostly associated with Social Networks, such as, Facebook and Twitter, [10]. These networks generate images, text, Semantic text using hashtags, geo-location and mood markers. All of this information can be used to create the crowd-sourcing picture, where by combining the data, applications can generate new data (e.g. disasters, global events, traffic congestions and health hazards), shown in Figure 3.

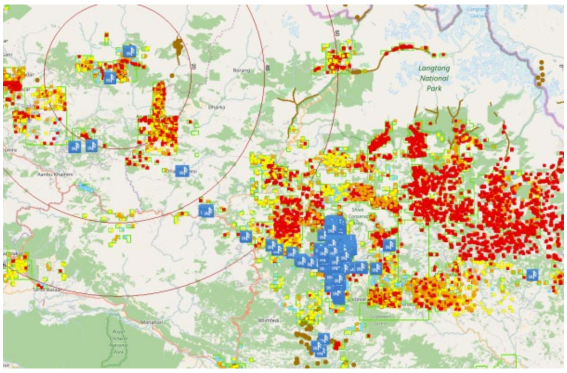

Figure 3: Report of earthquake using CrowdSource.

On Figure 3, it is shown how an earthquake is reported using crowdsourcing. Since many people are using mobile devices, the red markers are where reports are done by many users close together.

4 ARCHITECTURE OF THE OUR AWARENESS PLATFORM

Based on the architecture given in [7], we are proposing our own awareness platform. The architecture of the system is shown in Figure 4, where our system uses two external sources to gather information. These two sources are interfaced by a third part of the application, which is the interfacing API. The first part of the architecture is the crowd-source, where this module connects to Facebook via API and exchanges information about crisis detected from users. This part uses Data Acquisition Package to retrieve information from the crowd. The information that the crowd shares is maintained and acquired by users' permission (shown on the right in Figure 4). The part of the crowd that is willing to participate in this crisis system, voluntarily allows Facebook and Twitter to share their information.

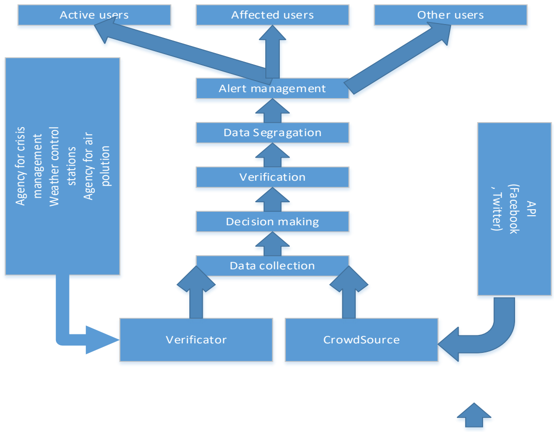

Figure 4: Architecture of our awareness platform.

The second part of the system is the data verification (shown on the left on Figure 4), where data is collected from certified agencies such as Agency for crisis management, weather control stations and air pollution. This data is certified and is used to verify data from the crowd-source. The data from these two parts is collected into a Data Collection Unit, used to store and backup data. This unit sends the data to the Decision Making Unit that uses algorithms that evaluates and classifies data from Crowd-source and Verificatior. This algorithm extracts data from Facebook and Twitter statuses by using key words, location and sentence structure. It determines a crisis based on at least three sources. These three sources have to use similar crisis key words (or word structure), and it has to be done in a certain amount of time and to be close to each other (geo-location). This determines the type of the crisis and the location. Based on the number of sources and how close (by geo-location) they are, it determines the percentage of accuracy of the information of a crisis. Accompanied with the data for that location and type of crisis from the Verificatior, the data is sent to the Verification Unit. This unit simply uses basic algorithms to verify if the information for a crisis is reported by the Verificator. The simple algorithm just checks if some of the stations for crisis actually have reported the determined crisis in the area.

The next part is the Data Segregation, where the crisis detected and validated in the previous step is sent, along with the amount of certainty of detection. The segregator classifies and divides the crisis into geo-location groups and sends the data to the Alert Management part. This part of the system is what connects the second part of the architecture with the third part and delivers alerts to end users. The end users are in the third part and they are divided into three groups: Active Users, Affected Users and Other. Active Users and Affected Users are users that have been registered with our system and these users have registered to receive information about near crisis. The Other Users are the non-registered Crowd-source users, that our system sends global information about crisis in the area. However, these users receive the information only if they explicitly check for crisis (they do not receive push notifications since they are not in immediate danger).

The Active and Affected users, as mentioned above, are registered with the system and they receive immediate information about crisis in their area. Affected users are users that are closest to or in the crisis (according to the decisions made by our system). They receive immediate information about possible crisis, along with the amount of certainty. Our system gets information about registered users via GPS and their location, so it is possible for users to not have their GPS coordinates updated, thus they might get false alarm. That is why our system lets the users choose the frequency of GPS acquisition and the size of the radius that they consider as radius of immediate danger.

5 CASE STUDY

Since Skopje, the capital of Macedonia, is not prone to disasters, our case study uses simulated messages passed between the three parts of the system. The messages sent are shown in Figure 5, where we can see what our system receives from the Crowdsource (Social networks) and from the Verification agencies. In this section, messages shown on Figure 5 are addressed from left to right, so the first message is in the upper left corner and so on. Only the crucial messages are shown in Figure 5. We receive the type of disaster (Flood, Fire or Earthquake), the notification type (1 for CrowdSource and 2 for Verificator), when it happened (timestamp) and where it happened (Latitude or Longitude). As we can see, if the Verification Agency sends us Earthquake, then it additionally sends the size of the Earthquake.

If our system receives several notifications from the same type happening in a 1 km radius, then it creates a single pin on the map by taking the middle point of all those in the radius. This is shown in Figure 6 on the map where messages 2,3 and 5 from Figure 5 are fused in a one alert shown in the middle of the map with yellow triangle for fire.

There are 4 different colors representing different types of alert notifications. The green color means that only one person reported the disaster and that it is not verified. The yellow means that three or more Social Network users reported the disaster but it is still not verified. Orange means that it has been reported by the verification agency but no one from the Crowdsource (Social Networks) reported it. And last, if it is used red as an alert color, then it means that both parts reported the disaster.

Our application was tested by 15 users, who were positioned around the city with their smartphones on different locations throughout Skopje. The users were positioned selectively so that 5 users would be affected, 8 users would be active and 2 users were registered as other type of users. Active and affected users registered to get immediate alert, so when active users entered the radius (1 km), the Alert Management system sent notification about the type of disaster and level of certainty.


```
{
disaster_type: "flood",
notification_type:1,
timestamp:"2017-01-20T10:10:08.002Z",
whereLAT:42.005430,
whereLON:21.414884
}
{
disaster_type: "fire",
notification_type:1,
timestamp:"2017-01-20T15:10:08.002Z"
whereLAT:42.005430
whereLON:21.414884
}
{
disaster_type: "fire",
notification_type:1,
timestamp:"2017-01-20T15:12:33.902Z"
whereLAT:42.004697
whereLON:21.416643
}
{
disaster_type: "earthquake",
notification_type:2,
value: 2.7R,
timestamp:"2017-01-20T15:17:20.114Z",
whereLAT:42.007826,
whereLON:21.391195
}
{
disaster_type: "fire",
notification_type:1,
timestamp:"2017-01-20T15:30:11.527Z",
whereLAT:42.005079,
whereLON:21.415613
}
{
disaster_type: "fire",
notification_type:2,
timestamp:"2017-01-20T17:01:15.973Z",
whereLAT:41.992482
whereLON:21.427844
}
```


Figure 5: Messages sent to our system from Verificator and Crowdsource.

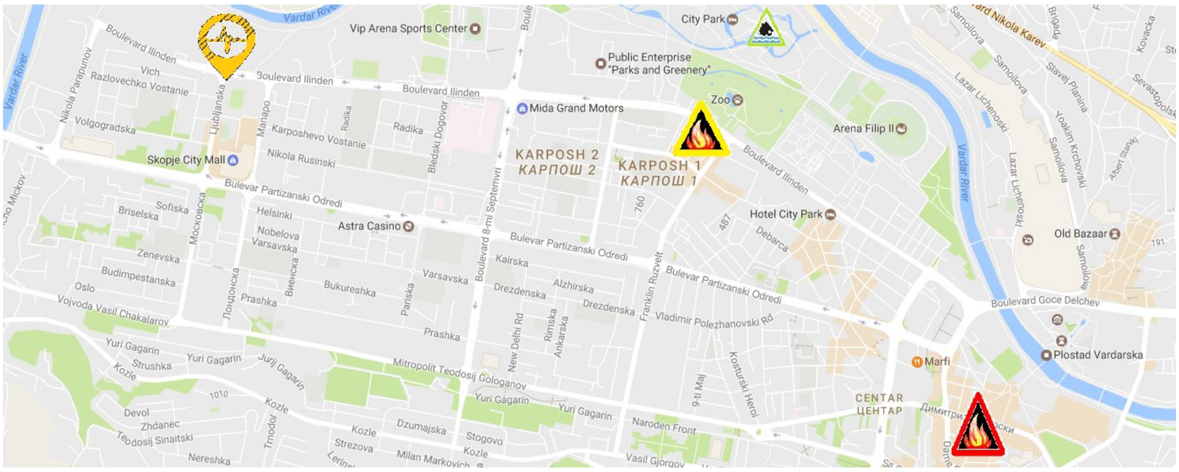

Figure 6: The results that our system sends back to users.

6 CONCLUSION AND FUTURE WORK

This application, can be beneficial to users to get real time alerts about near disasters. Also, this application can be used as a disaster information kit, where users will get information about disasters in the near area. This can be beneficial, in case of fire or flood, for users that are in traffic, to know where the disaster is and to avoid those streets. However, this application mainly relies on the information shared by crowd-sourced users and that information is verified by crisis agencies. For future work, we plan on upgrading the application with information about traffic jam and car accidents to alert drivers which streets are closed (by the authorities) and which streets to avoid (due to accidents).

REFERENCES

[1] A global display of terrorism and other suspicious events. Accessed on: Sep. 18, 2016, [Online]. Available: http://www.globalincidentmap.com/

[2] Th. Buecheler , J. Henrik Sieg , R. M. Füchslin1 and R. Pfeifer, "Crowdsourcing, Open Innovation and Collective Intelligence in the Scientific Method," A Research Agenda and Operational Framework, Proc. of the Alife XII Conference, Odense, Denmark, 2010.

[3] Ch. Eaton, D. Deroos, T. Deutsch, G. Lapis, P. Zikopolous, "Understanding Big Data," USA, The McGraw-Hill companies, 2012, [E-Book].

[4] Flood information service. Accessed on: Sep. 19, 2016, [Online]. Available: https://flood-warning-information.service.gov.uk/

[5] Disaster Preparedness and crisis response. Accessed on: Sep. 19, 2016, [Online]. Available: https://www.palantir.com/disaster-preparedness/

[6] Virginia Deploys Web-Based Emergency Management System. Accessed on: Sep. 19, 2016, [Online]. Available: https://cop.vdem.virginia.gov/dev/viper30/

[7] Humanitarian Open Street Map Team (HOT). Accessed on: Sep. 19, 2016, [Online]. Available: https://hotosm.org/about

[8] A. Broughton, T. Higgins, B. Hicks and A. Cox, "Workplaces and Social Networking," The Implications for Employment Relations, The Institute for Employment Studies, 2010.

[9] The Graph API. Accessed on: Sep. 19, 2016, [Online]. Available: https://developers.facebook.com/docs/graph-api/using-graph-api

[10] W. Tung, G. Jordann, "Crowdsourcing Service Design for Social Enterprise Insight Innovation," IEEE International Congress on Big Data, 2015, pp 367 - 373.