A System of Collecting, Retrieving and Displaying Emergency Information: an Android Client with Web Application

Jing Leng

Abstract—Sharing emergency or disaster information in a timely manner is very important to people's life. With more and more people carrying a smartphone on daily basis, an emergency and disaster information sharing system accessible to smartphone users is necessary and could be very useful. This project is to construct a disaster and emergency information website that allows smartphone users to upload and search information about incidents such as car accidents on road or incoming severe weather conditions at anytime and from anywhere. The system comprises of five components: a MySQL database, web services, an iPhone client, an Android client and a web application. The first three components have been developed by my colleague Tengda Wang [6]. The Android phone users can input emergency information to the server database through the Android client, or search for interested disaster information that has been stored in the database already. The Android client will display the retrieved data from the database on the Google map as pins. Clicking each pin, the corresponding detailed information about a particular disaster situation will show on the screen. The web application provides a web view of summarized information for all users who have a device with internet access. The resulting emergency information sharing system could be very useful in providing precautions to ordinary people on travel, or for officials of government emergency management agencies to analyze and use the emergency information collected by this system.

Key words—Emergency Management, Android phone, Android SDK, web application, Google maps Javascript API

I. INTRODUCTION

Emergency management is a very important topic not only for government agencies that handle emergency and disaster issues but also for ordinary people. Everyday, or even every second, there are hundreds or thousands of emergency situations happening around the world such as the big earthquake hitting Japan in March and the recent E.coli outbreak in Europe. Suppose you are planning for a travel, you must be eager to know if there is any unusual situation happening in your planned travelling destinations. A comprehensive emergency information website could be very helpful for you in this case.

According to Wiki emergency definition [1], an emergency is a situation that poses an immediate risk to health, life, property or environment. Based on this definition, there are generally four types of emergency situations: (1). risks of life loss, including medical emergencies or natural disasters such as stokes, heart attacks, floods, tornadoes, and etc. (2). dangers to health, such as broken limbs in a sports activity. (3). risks of property loss, such as fire in an evacuated house. (4). dangers to the environment, such as oil spill in the Mexico gulf. Every government has designated agencies, called emergency services, to handle those emergency situations. They are responsible for identifying and collecting emergency information, analyzing the emergency situation, announcing and planning for the incidences to the general public with the goal of minimizing the effects of the disaster or emergency already happened. In order to fulfill these tasks, a good emergency management system is indispensable for the government emergency agencies.

Collecting emergency information is the very first step towards effective and efficient emergency management. There are two aspects that are critical for emergency information collection. One is time, and the other is the source of the emergency information. In order for government emergency services to act quickly and make correct plans after an emergency situation happens, the emergency information has to be collected in very short period of time and also important is the accuracy of the emergency information collected. The most direct and accurate information regarding an emergency situation should come from the witnesses and bystanders. How can they report what they saw about an emergency situation in a timely manner? Probably, a smart phone is the best way for them to do the job. Firstly, the smart phone is very popular today, and many people carry one on daily basis. Secondly, the smart phone usually has a built-in camera that can take pictures or videos, and it has internet access so that people can use it to upload emergency information in the form of text, picture or even video to an online system easily.

This project is to develop an emergency information sharing website with the capability of collecting important and timely information about any incidents from smartphone users. In the rest of this section, the problem statement of the project is clarified as well as its scope, assumptions and approaches applied.
A. Problem Statement

1) This project is meant to construct a very general emergency and disaster information website. There are many websites already existing that provide emergency or disaster information to the public, but they are not general enough. Most of the time, you can find only one particular type of emergency information such as earthquake, bad weather or car accidents on a single such website. Often People want to know anything endangering life that happened in a certain area when, for example, planning for a trip to an unfamiliar place. Therefore, the project will collect and store the emergency and disaster information classified into the following four general types: dangers to life, health, property and environment [2].

2) Easy understanding of the emergency situation is an important measurement to the quality of an emergency information website. After collecting the emergency and disaster information, the next question is how to present that information to the query users most effectively and impressively. Showing an on-site video about a disaster is probably the most straightforward and intuitive way in terms of impressing a user. Therefore, the project will include videos and pictures as part of the emergency and disaster situation. In addition, visual display of the emergency situation on the Google map is a desired feature of the project.

3) User friendly interface and easy access are a must for this project. People on travel are probably the most in need of emergency information. How can they easily access the emergency management system? The answer is to use a smart phone because the smart phones are very popular nowadays and most importantly they have easy internet access. Therefore, a primary task of this project is to provide smart phone users convenient interface to access the emergency management system. Since iPhone and Android phone are the most popular smart phones in the current market, a user friendly iPhone client and Android phone client are at least required for the project.

4) Multi-platform capability is also desirable for the system. The emergency information input from any one of the smart phone clients should be able to be retrieved and displayed correctly for other clients. For instance, the video regarding a disaster situation uploaded by an iPhone user should play on the Android client flawlessly and vice versa. As different components of the system are developed using different programming languages such as C# and Java script, the use of a protocol that can be understood by multiple languages is necessary. Soap seems to be a good choice because it is an XML based protocol over HTTP that can be used for communication between Android or iPhone clients and the C# web services.

B. Scope

The whole project comprises of five components: a MYSQL database, web services, an Android client, an iPhone client and a web application. The MYSQL database is on the server side to store all the disaster and emergency information. The web services are actually web methods providing access to the database such as creating, deleting and updating emergency information database records. The smart phone users can input or retrieve emergency information from the server database through the Android client or iPhone client that connects to the server database with the help of web services. The web application provides a web view of summarized information regarding emergency situations for all other users who have computers with internet access. Fig 1 shows the relationship between all the components of the system. The MYSQL database, web services and iPhone client have been developed by my co-worker [6], while I'm developing the Android client and the web application.

C. Assumptions

Any person that has a proper device with internet access should be able to use this emergency information system. The Android phone and iPhone users can use their individual client to have full access to the emergency information website that includes searching, uploading and updating emergency/disaster situations. Other smart phone users and ordinary desktop computer users can only search for emergency information from the server database through the web application.

D. Approaches

The procedure of the project development is as follows:

1. Use Android SDK to design the Android client application for emergency information searching and uploading by Android phone users.
2. Develop the web application using ASP.NET for PC or other smart phone users to search for emergency and disaster information.

II. LITERATURE REVIEW

In order to develop an effective and efficient emergency information website, it is very important to do a literature survey and obtain an overview of the most widely used emergency information systems already existing. In addition, a careful study of the Android system and all aspects of the web application will provide us a better understanding of the technology background and thus facilitate the design and implementation of the system.

A. Emergency Systems

Emergency systems are not strange at all, and they are actually here and there in every person’s daily life. For example,
National Severe Weather Warning Service (NSWWS) is a weather monitoring emergency system operated by National Oceanic and Atmospheric Administration (NOAA) in the United States[3]. NSWWS is basically a web application to inform the general public of severe weather that could be dangerous to people’s life. Figure 2 shows the online web page of NSWWS. On the national geographic map, different regions are using different colors representing different warning about the local weather condition, such as white color meaning no warning issued and green color representing flood warning. The web application allows the user to click on each colorful weather warning sign on the map to see the detailed information page of that warning. The system is updating 24 hours a day to provide people the most current weather warnings and it is particular useful for people on travel or planning for a travel.

![Fig. 2 NSWWS Weather Warning Color Map](image)

With mobile devices getting very popular nowadays, more and more mobile emergency management systems are available. Collision Watch is one such system that can notify the mobile phone owner’s emergency responders in case of car accidents[4]. Of course the mobile phone has to be a smart phone with many advanced features such as GPS. When the mobile phone user is on the road and the Collision Watch is turned on, the application running in the background of the mobile phone will continuously monitor the device’s GPS, accelerometer, and movement patterns. When Collision Watch detects some important indicators suggesting that the car is experiencing a crash, the application will send out notifications to the mobile phone’s primary contacts. Not only this, the future versions of Collision Watch could take over your phone’s function such as the alarms to warn you before the crash or send emergency services information such as your vehicle’s exact location, the estimated crashing speed and impact after the crash.

CiviGuard is another mobile application service that helps the government to deliver emergency information to civilians[5]. Once a natural disaster or emergency situation happens, the government command centers will first use all technologies available to indentify the crisis zones. The CiviGuard can then figure out which cell phone towers are in the crisis zones and thus compile a list of registered users affected to whom an emergency message will be sent. Those users will receive critical information provided by the command centers such as route plans, directions and other emergency warnings that could help survive the disaster. The California-based CiviGuard plans to make their service available to all kinds of smart phone devices such as iPhone, iPad, Android, BlackBerry and Windows Phone.

![Fig.3. Architecture of Android](image)

B. Background for Android

Android is a mobile device platform originally developed by Android, Inc and Google. It started the first release in Nov. 2007, and now it becomes the top-selling smart phone platform with more than one-third of the market share[7]. The Android SDK is an open source package that provides the tools and APIs necessary for developing applications based on the Android platform using Java programming language. Figure 3 (taken from Reference [8]) shows the architecture of the Android system. Five layers of components from lower to upper are described below:

1. **Linux Kernel**

Android is built on Linux Kernel version 2.6. However, it doesn't provide a native X Windows system, and some of the standard GNU libraries are not supported. The reason is that Google has made some architecture changes during the development of the Android system. The Android Linux kernel layer includes hardware drivers such as camera driver, WiFi driver and display driver to communicate with the mobile device hardware directly and provides support for the rest of the software system.

2. **Libraries**

Android provides a set of C/C++ libraries to support the development of Android applications. Some important ones are: Android system C library that is derived from the standard C system library and specially tuned for embedded devices; LibWebCore to provide a web browser engine for the mobile device; Media Framework to support various popular audio and video formats such as MPEG4, H.264 and MP3; SGL library for 2D graphics engine, and OpenGL/ES
for 3D hardware acceleration or 3D software optimization; SQLite is to provide a lightweight relational database capability.

3. Android Runtime
Android also provides a set of core libraries and Dalvik virtual machine to support the running of Android applications mostly written in Java. There is no Java Virtual Machine available for Android, and thus Java byte code cannot run directly. Instead, Java classes are compiled into Dalvik executables (.dex) which then run on the Dalvik virtual machine. The purpose of doing this is to optimize the process and thus minimize the memory and CPU demand.

4. Application Framework
Built on top of those libraries, Android provides some useful system services to ease the task of user applications development:

- The View System provides a view tool set including list, grid, text box, button, and even an embeddable web browser to be used in any applications.
- The Content Providers enable the applications to share data between each other.
- The Location Manager provides services to allow applications to obtain updated geographical location of the device with Android system.
- The Resource Manager provides access to application resources such as colors, media, drawables and raw asset files.
- The Telephony Manager provides the functionalities of monitoring the basic phone information such as network type and phone connection state.
- The Notification Manager provides APIs to notify the user of something happening in the background, such as displaying custom alerts in the status bar, turning on or flashing the LEDs of the device, and playing sound or vibrating to alert about an incoming phone call.
- The Activity Manager provides APIs to manage the overall activities going on in the Android device.

5. Application
Android is shipped with some core applications such as internet browser, calendar, maps, email client and contacts. These core applications are written in Java and make good use of those services APIs provided by the application framework layer. Users can develop their own applications with full access to the same framework APIs. In addition, the Android development platform is very open and it is designed to simplify the reuse of components. For example, any application can publish its capabilities for other applications to use. In a word, Android platform offers developers the ability to build rich and innovative applications in a easy way.

C. Background for web application
Internet, a world-wide fully interconnected TCP/IP networks, was officially introduced in 1982, with the standardization of the Internet Protocol Suite (TCP/IP)[9]. Since then, Internet is growing very fast and becoming a part of life for billions of people today.

With the introduction of Internet and the mass production of personal computers in 1990s, the so-called client-server distributed computing model is gaining popularity over other models such as peer-to-peer model. In the client-server model, the server device typically stores files and a database of information to share with all the clients. The clients are mostly PCs with network connections to the server device and they can request and receive information from the server database. The major advantage for this model is that the data storage is centralized on the server that generally has greater security than clients. Update to the data is much easier in comparison to the P2P model as well as other maintenance such as upgrade or even relocate a server.

In the early stages of client-server model, both the server and the client have one portion of the code to share the load of the application. That means there needed a client program installed on each client's PC. The client side code had to be also specific to the computer architecture as well as the operating system. What's more, any upgrade to the server-side code could require a corresponding upgrade to all the clients.

With the Internet gaining popularity outside of academic and technology society around 1995, here came the age of World Wide Web, or simply called the Web. If we think of internet a global system of interconnected computer networks, then the Web is a collection of interconnected documents in the form of Web pages seating on the Internet. The appearance of the Web is a huge revolution to the whole world looking back from today as all businesses and ordinary people are relying heavily on all kinds of Web applications for daily life nowadays.

The Web application can be viewed as a special type of client-server application, in which the Web browser serves as the client. They are developed by using a combination of server-side script such as PHP & ASP and the client-side script such as Javascript and HTML. With Web application technology, the developer doesn't need to build a client for a specific type of computer or operating system anymore because one client application can be run in any compatible web browser of any computer.

The most common Web application structure is of three-layered form, namely the layer of presentation, application and storage. Figure 4 shows the structure of a typical Web application [10]. The Web browser is normally serving as the presentation layer and it is seated in the client side. The other two layers are in the server side. The application layer uses technology tools such as JSP/Java, ASP.NET, PHP, Python and Ruby on Rails to provide the first layer the dynamic content to be shown in the Web browser. The third layer is the database carefully secured in the server side that contains all the source content such as news, customer data, and emergency information.
Comparing to the traditional client-server application, the Web application client, i.e. the Web browser, is kind of thin client. Using the Web browser as client provides the ability of easy updating and maintaining services without the hassle of distributing and installing client applications on potentially thousands of client computers. However, the major disadvantage of a thin client is the difficulty to provide interactive services to the client. It is no wonder that early Web applications were simply providing static Web pages to be shown in the browser.

The Android phone should be able to access the Internet, take photos, record and play videos, and use GPS features. In this project, I created an Android client application using Eclipse IDE on a laptop computer, and the outcome is a .apk file which can be installed on the Android smart phone. The Android phone should be able to access the Internet, take photos, record and play videos, and use GPS features. The web application is written by C# language under ASP .NET framework and can be deployed on any platform that has .NET runtime environment, such as Windows, Linux, and Mac. The web application has the capability of displaying data on the Google map. As Google does not supply Google maps API for C#, Google Maps JavaScript API is applied instead for this project.

In order to maintain consistent layout for all web pages, master page technique is applied to create a site-wide page template in ASP.NET. A master page is a special type of ASP.NET page that defines the common appearances among all content pages, while a content page is an ASP.NET page that is bound to the master page. Changing the master page's layout or formatting, all of its content pages' output will be updated as well.

The formatting and layout rules are specified in the CSS file, which is referred to via a <link> element in the master page's <head> section. These various rules define the look and feel of each <div> element, and they apply to both the master page and all the content pages.

In this web application, Google Maps are embedded in ASP .NET Web page so that the searched emergency situation records from the server database can be displayed as pins on Google Maps. Firstly, a Google map user control for ASP .NET is needed, which will be initialized on PageLoad event of the container Web page. Secondly, a class named GoogleObject is defined, and a web service called GService is created providing Web methods to manage the GoogleObject. Thirdly, a JavaScript file is constructed to serve as a wrapper of ASP.NET calls and the Google Maps JavaScript API functions. On PageLoad event of aspx page, the DrawGoogleMap method of the JavaScript file is called by the Google map user control. After the Google Maps are shown successfully within the Web page, the user can use the search function of the Web application to search for interested emergency situations already stored in the server database. The queried records will be shown on the Google Maps as pin markers in correct locations based on the latitude/longitude information. Map zoom in and out is available, and clicking a pin marker will pop out an information window that can take the user to the detailed information page of the corresponding emergency situation. Delegate and event handler are defined in Google map user control where a JavaScript function is written to serve as code interface for event listening. Once map double click or pin drag events get fired on the Web page, corresponding JavaScript functions are invoked to act on Google Maps. Parameters are passed through Web methods defined in the GService file.

Adding the emergency website as Web reference to the Web application project, the web application can then access the emergency information database and fetch queried results through web methods supplied by the web service developed by Tengda [6]. The web service provides three search methods: searchByUsername, searchByAddress, and searchByDate [6].

III. REQUIREMENTS AND SOFTWARE DESIGN

A. Requirement

The In this project, I created an Android client application using Eclipse IDE on a laptop computer, and the outcome is a .apk file which can be installed on the Android smart phone. The Android phone should be able to access the Internet, take photos, record and play videos, and use GPS features. The web application is written by C# language under ASP .NET framework and can be deployed on any platform that has .NET runtime environment, such as Windows, Linux, and Mac. The web application has the capability of displaying data on the Google map. As Google does not supply Google maps API for C#, Google Maps JavaScript API is applied instead for this project.

B. Web Application Design

Visual Studio 2008 is used to develop the web application. As for this project, ASP.NET WebSite is preferred because some programmed elements such as Google Map objects have to be employed.
C. Android Client Design

For the Android client development, first step is to create an android project in the Eclipse IDE. Be sure to select Google APIs for built target in order for Google Maps to show up.

Add the following lines in the AndroidManifest.xml file to get access to the internet and obtain permission for using GPS and writing SD memory card.

```xml
<uses-permission
    android:name="android.permission.INTERNET" />
<uses-permission
    android:name="android.permission.ACCESS_FINE_LOCATION" />
<uses-permission
    android:name="android.permission.GET_ACCOUNTS" />
```

Android.view provides basic user interface classes to handle screen layout and interaction with the user [11]. Based on android.view, we can create all the view pages such as the main page, about page, upload page and query page.

In order to access the server database via .NET web services, a soap library named Ksoap2-android is employed which is lightweight and efficient and particularly suitable for Android platform. Ksoap2-android is licensed under MIT, and now is also available for Maven and Ant [12]. The Ksoap2-android library can be downloaded from Google code [13].

Ksoap2-android relies on a basic object called SoapObject. For this SoapObject, there are three variables that will setup a link to the web service: the Web Service Namespace, the Web Service Method Name and the Web Service URL.

In addition to the SoapObject, we need a Soap Envelop as well as an Http Transport object. With these two objects, we can invoke the .NET web services and obtain query results from the emergency information database.

Google provides a Maps external library, or say Google Maps API, to make it easier for developers to add the powerful mapping capabilities to their application. This library is named com.google.android.maps that includes a group of classes that will help in the manipulation of maps.

The key class of Google Maps library is MapView which displays a map with data received from Google Maps service. In order to display Google Maps data in a MapView, we have to register with the Google Maps service and obtain a Maps API Key. After that, add the Key to the layout xml file as follows:

```xml
<com.google.android.maps.MapView
    android:id="@+id/mapview"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:clickable="true"
    android:apiKey="0gaWhlJH36Xn3ndMGgVXGhF_daywpmlUKBdotig" />
```

With the functions provided by MapView methods, retrieved data can be shown as pins on Google Map. Clicking each pin, a message box will pop out as shown in Figure 7.
Fig. 7 Google Maps on Android Phone
Click "Show details" button on the message box, corresponding detailed information page will display like below.

![Fig. 7 Google Maps on Android Phone](image)

To play video file, a VideoView should be added on the detailed information page layout.

We can override the method onTouchEvent(MotionEvent, MapView) of handling user touching on screen in order to add the capability of moving the marker on the Map to whatever location.

On the Google Map, we can find detailed information about the address where the incident occurs if we know its latitude and longitude. For this purpose, the class Geocoder is used which has a method `getFromLocation` that can return a list of addresses based on the latitude and longitude of the location [14].

In the upload page, we can select picture or video to upload to the emergency information database. The main idea is to make use of the MediaStore class that contains data of all available media on both internal and external storage.

Fig. 8 Detailed Information of Emergency Situation
![Fig. 8 Detailed Information of Emergency Situation](image)

After clicking the upload button on the upload page, a progress dialog with waiting message should pop out. It will stay during the uploading process. After the Android client application receives the correct return result, the progress dialog will dismiss while a success message will display.

IV. ANALYSIS AND VALIDATION

A. Android client

Android mobile application has been tested on both emulator and an Android smart phone. It mainly includes three functions: about, upload, and query.

In the about page, user can change the web service URL and click the test connection button. After waiting for several seconds, a success message comes out if the URL is working. However, if there is a problem accessing the URL through ksoap2, ksoap2 just keeps trying without return. This will cause the application to stop with exception of no response. I haven't been able to figure out how to terminate the connection testing after exceeding certain period of time yet.

In the upload page, user can input some test data and select picture and/or video to upload. All those input options have been tested and all the data were uploaded to the web server successfully.

In the query page, user can test query by date, by username or by location. All searched results show on the Google map as pins. Clicking each pin and selecting the "show details" button on the popped-out message box, the corresponding detailed information page should show up. The pictures displayed correctly if the size is not too big. ksoap2 has got another problem here. Sometimes a large amount of data transferred from the web server could not be downloaded successfully. It depends on the network status. Uploading data doesn't have such problem no matter how big the picture or video file is.

For other functionalities such as getting an address, it returns desired results with specified latitude and longitude pair once GPS is enabled. By using Geocoder, user can know the actual address corresponding to a location on the Google Map. User can also move pin to set any desired location on the set location page. Downloading video option also worked well and the downloaded video played successfully.

B. Web application

The web application allows the user to search for interested emergency information. On the main page, the user can select from a drop-down list one of the following three options: search by username, search by date and search by location. Clicking each option, a corresponding page shows up with different input parameters to be specified. Supply values for needed parameters, such as longitude/latitude and range information for search by location option, and then click the "search" button, corresponding records of emergency
information will be retrieved from the server database and displayed on the Google map as pins. Clicking each pin and then the “show details” link on the popped-out information window, a detailed information page will come out.

All three search options were tested to be working fine, and correct records of emergency information were retrieved from the database and presented on the Google map at the right locations. On the detailed information page of each emergency situation, pictures were displayed correctly, and videos were downloaded and playing successfully.

The Google map page was tested to be able to zoom in and out without problem. The current location/focus pin can be dragged and moved to a new location on the map, and the updated longitude/latitude information of the new pin location was obtained from Google Maps API successfully. For the “search by location” option, the longitude/latitude TEXT box was updated correctly whenever the pin was dragged and moved to a new location.

V. CONCLUSION

At the beginning of this paper, we introduced what emergency management is, the practical use of it, how well it had been developed and the reason why we started such a project. Then we reviewed and compared some existing systems of emergency management. We also took a look at the applicable technologies and framework. After obtaining a basic understanding of the theoretical background, we started designing and implementing the emergency information system with capability of supporting smart phone users.

For Android client part, we implemented it step by step based on Android SDK. Emergency information can be transferred successfully through the Internet. Smart phone users could upload emergency information to the web server and search for interested emergency situations. The web application using C# asp.net was successful in meeting the requirements stated earlier in the paper. It could supply users with summarized information about interested emergency situations which are shown on the Google Map as pins.

Through this project, I acquired a good knowledge of both Android SDK and web application. Ksoap2 for Android is found to be very convenient for uploading data via C# Web services. However, it has some limitations for the type of arguments to be passed as only primitive types such as Integer and String can be used in the function calls. And the format of returned value is much different from XML format. Therefore, I had to rewrite some Web methods specific for the Android client. As for result of dataset type that is obtained from the C# web service, it is very difficult to get the row value one by one. The Android XML parse methods are not applicable, and thus Java String functions (split, substring comparison and so on) are employed instead to extract the desired value.

VI. FUTURE WORK

Due to the short period of time, the developed system is not perfect yet. There are some enhancements that could be added in the future work. Some ideas are listed below:

A. Alert function

With the alert capability added, the system could be much more useful. Once a disaster or emergency incident is recognized by the system, the web server should respond quickly and send notification messages to registered smart phone users in the affected area.

B. User editing and reviewing

It is not adequate for web application to provide search function only. The database needs to add a Users table so that users can register and login to the website to have more privileges. As a registered user, one should be able to edit the information of an emergency incident uploaded by himself/herself or post comments about any emergency situation uploaded by other users and stored in the server database already.

C. Reporting

D. Web application should be able to generate statistics report for emergency management purpose.

Recovery means restoring the affected area to its original state before the incident happens. The web application should allow users to check on-going status of a particular emergency incident or provide useful warning and instructions to the public.

REFERENCES

[9] What is a Web Application?, [Online], Available:
http://webtrends.about.com/od/webapplications/a/web_application.htm