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Collecting Earthquake Disaster Area Information Using Smart Phone

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Abstract—**In recent years, the number of major earthquakes has increased and caused severe damage to buildings and other rigid structures and even large number of casualties. Timely and accurate earthquake disaster information is required for quick rescue response. As the popularity of smart phones which offers a more advanced computing ability and connectivity than a phone, we introduce an earthquake disaster area information collection system using smart phones which allows the public to use their phones to upload pictures, videos, texts and demands data of earthquake disaster area to the backend server, and we also detail the algorithm of selecting an earthquake for a picture or video according their GPS location. It is useful for commander to make a fast and good rescue solution for emergency response.**

Keywords- Earthquake; disaster information; smart phone; emergency rescue response; android; iPhone

I. INTRODUCTION

In recent years, many big earthquakes, such as WenChuan earthquake with magnitude 8.0 occurred on May 12, 2008 and Tohoku-Oki Earthquake with magnitude 9.0 occurred on March 11, 2011, happened frequently which had caused large number of casualties and economic losses. When an earthquake happens, Seismological experts will report the earthquake information including moment, location, magnitude and depth of earthquake by computing the observation data received from kinds of seismic instruments. But they are not enough for commanders to make a reliable and fast decision for emergency response because they don't know the realistic disaster area information, such as how many people died or were injured, the road was through or not, the building toppled down or not. A good rescue solution depends on accurate, real-time abundant of disaster area information. There are many approaches to collect the disaster info, such as phone report which is quick but not accurate and unmanned plane taking pictures that is accurate but not real-time. Only people in earthquake disaster area know the truth of disaster, so we should collect disaster information via them.

With the rapid development of mobile communication technology, more and more people own their own smart phones that used to take pictures and videos or navigate, etc. It provides another chance to collect earthquake disaster area data using smart phones, such as android phones, iPhones, etc. Current, smart phones are already used in different sectors like medicine, banking, government and education. Ref [1], Ref [2] and Ref [3] have introduced the usage of smart phones in disaster information collection sector. Ref [4] developed a Web-GIS system for real-time field data collection using a personal mobile phone.

In this paper, we introduce a collection system of earthquake disaster information using smart phones, which provides a new channel to collect pictures, videos, and text information of earthquake disaster area combines with GPS (Geographic Position System) location and to publish them to the Internet using smart phones. This is helpful for commanders and specialist to distinguish the range of earthquake and macro-disaster situations and then to make a correct emergency rescue solution. We also give a tentative algorithm for associating an earthquake to an uploaded picture or video based on its' the longitude and latitude.

The rest of this paper is organized as flowers. Section 2 introduced the related work. Section 3 details the system design and implement of collecting earthquake disaster area information using smart phones. Section 4 presents the algorithm of selection an earthquake for a picture or video. Section 5 describes the future work of this system. Finally, Section 6 concludes this study and section 7 is an acknowledgement.

II. RELATED WORK

Nowadays, earthquake, typhoon and other natural disasters happen frequently, which cause large number of casualties and economic losses. Making a good emergency rescue solution needs efficient disaster area information. Smart phones provide an alternative way to collect disaster information. Recently, Baidu [10] had provided a mobile version for Android phones which permit users to search on phones. Facebook [12] had also developed different clients for different phones. In disaster information management field, China Earthquake Networks Center [11] had issued a version of CENC for Android phones, iPhones, and Windows Phones, respectively, all these versions provided a latest earthquake list and related information, such as moment, place, depth of earthquake.

There are many approaches to collect earthquake disaster area information. European-Mediterranean Seismological Center [8] provides a web online system to allow users to share their experience or to publish pictures of earthquake on web pages. U.S. Geological Survey [9] also develops a web site named DYFI (Did you feel it?) to collect earthquake information from the public. If one wants to publish some disaster data, he/she must export the data from phones/cameras and upload them to web using personal computers, so these systems are not handy and in-time. Hu, Tao [1], etc. introduce a system that allows users to upload accurate, reliable and instant disaster information combines with GPS information using mobiles, but they only describe a PDA client demo developed using C++ programming. Seop[2], etc. developed a disaster information reporting and status transmission system, which was used to gather disaster information consisting of location, images, video, and text by smart phones and the disaster status information was transmitted to the web page by SMS (Short Message Service), it is not suitable to earthquake disaster. Ref [3] introduced a mobile disaster management system using Android technology which determines the optimum route along different geographical locations that volunteers and rescuers need to take in order to serve the most number of people and provide maximum coverage of the area in the shortest possible time. Ref [5] designed a mobile client-backend server architecture that uses sensor-equipped mobile devices to measure earthquake ground shaking.

In this paper, we proposed a new earthquake disaster information collection system. Smart phones such as Android phones and iPhones can upload earthquake disaster area information, such as images, videos, or text combined with GPS location. The backend server is responsible for receiving the data, labeling them on Google maps, analyzing the uploaded data and linking them with the related earthquake.

III. A USAGE SCENARIO

As is shown in Figure 1, when an earthquake happens, people in earthquake disaster area use their smart phones installed our client version of the system to take pictures or/and capture earthquake disaster in real-time, user can also give some description to the pictures or videos optionally. All these pictures, videos are uploaded to the backend server via wireless networks, such as GPRS, 3G, and Wi-Fi, etc. Backend server receives the data and stores them into MySQL database, then publishes them on web. Varied kinds of clients, includes personal computers, mobile phones, can access the related pictures or videos, and etc.

IV. DESIGN AND IMPLEMENT OF EARTHQUAKE DISASTER AREAR INFORMATION COLLECTION SYSTEM

In this section, we discuss the design and implement strategies of earthquake disaster area information collection system, which can be divided into two subsystems: smart phone subsystem and backend server subsystem. Smart phone subsystem is installed on smart phones and is responsible for taking pictures, captures, and etc. Backend server subsystem is responsible for receiving, analysis, and publication the uploaded data.

A. *Smart phone subsystem of earthquake disaster area information collection system*

This subsystem contains several functions, viewing latest pictures and videos with Google map background, taking and uploading pictures, capturing and uploading videos, sending text to server, and sending some demand data, such as food, water or medical supplies, to backend server.

1) Viewing latest pictures and videos module. When starting, it firstly retrieves phone’s location information, then creates a new overlay layer on Google map for latest earthquake information, finally, add another two overlay layers for pictures and videos, respectively. As is shown in Fig. 2, earthquake pictures and videos are marked different icons. When an icon is clicked, the related earthquake information such as pictures, videos, or text messages will be shown as is shown in Fig. 3.

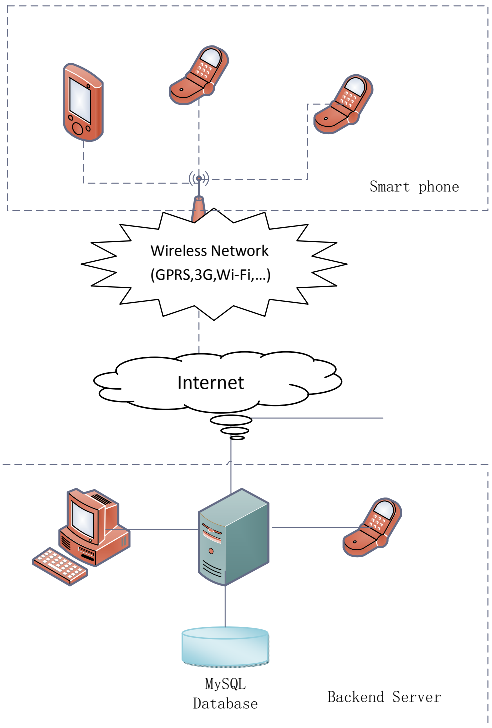

Figure 1. System concept

2) Taking and uploading pictures module. One takes photos of earthquake disaster area using the integrated camera lens of smart phone, then stores them to the SD memory card temporarily, and uploads them to the backend server via wireless finally. Considering the efficiency and popularity, we choose JPEG image file format.

3) Capturing and uploading videos module. It opens the camera lens of smart phone and then records the earthquake disaster. As is shown in Fig. 4, videos are uploaded to the backend server in real-time. We choose 3GP as video file format. Because 3GP file needs less storage space and narrow bandwidth, so it is appropriate for usage on phones [6].

4) Sending text to server. This function gives users a tool to write text message, which will be send to backend server via HTTP protocol, not SMS.

5) Sending demand data module. In earthquake disaster area, there are some demands of food, water, tents, and medicine, etc. They can tell backend server what and how many they need.

You can add title or other description to the uploaded pictures or videos optionally. Pictures, videos and text messages, demand data are transmitted to the backend server combined with GPS information. So the server knows where are the data from, they can be used to compute the relation between pictures, videos, texts or demand data and earthquakes.

There are mainly three types of mobile terminals poisoning techniques: region identification positioning through network, integrated GPS positioning and A-GPS positioning. Because of limited precision of region identification positioning through network and establishment of location server for A-GPS positioning, we consider the integrated GPS positioning method.

B. Backend server subsystem of earthquake disaster area information collection system

As shown in figure 5, backend server subsystem is composed of several components, web publication, web receiver, video receiver, 3gp2flv, analysis, management and data access utility modules.

1) Web publication. This component contains several web pages and java classes which are deployed on Tomcat web application container. It is responsible for the publication of pictures, video, and texts based on Google map. One can browse these pages via Internet Explorer, Firefox, and other browsers. This is similar to the viewing latest pictures and videos module of smart phone subsystem.

Figure 2. Map view

Figure 3. Earthquake information view

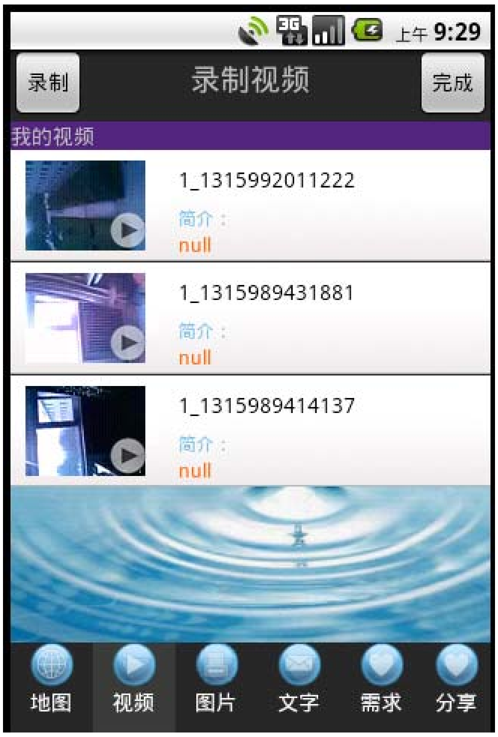

Figure 4. Video listing view

2) Web Receiver. All uploaded data except videos are received by web receiver, including pictures, texts and demands data. Pictures are attached by a client request with application/octet-stream content type. As the words length of

texts message and demands data is brief, we transfer them form smart phones to the backend server using HTTP header.

3) Video Receiver. It is a daemon which watches the uploading requests of smart phones. When a new uploading request coming, it starts a new thread to receive the data, firstly, it receives and parses the basic information of video, such as moment, longitude, latitude, who, title, and description, then begins to receive video body and save it to a temporary file of video temporary directory, and then start 3gp2flv module to convert it to flash video format described as follows.

4) 3gp2flv module. Once video receiver module receiving the video file, it starts and convert the 3GP video into flash video format (.flv), because flash video format has been accepted as the default online video format by many sites [7]. When video file conversion completed, the video basic information will be saved to MySQL database using data access utility.

5) Management module. Management module maintains a real-time earthquake list by retrieving the earthquake observation result of China Earthquake Networks Center. When a new earthquake happens, it will be added into the local database, including moment, longitude, latitude, depth, and magnitude.

6) Analysis module, which is responsible for automatic assignment the earthquake to an uploaded pictures or videos as detailed in section V.

7) Data access utility module is responsible for the access to MySQL database, including searching data from or storing data to database.

V. ALGORITHM OF SELECTION AN EARTHQUAKE FOR A PICTURE OR VIDEO

When one uploaded a picture or video, the analysis module will assignment a possible earthquake with it. According to the experience, only the earthquake whose magnitude is greater than 5.0 may felt inside by most. The severity of the local effects depends on the complex combination of the earthquake magnitude, the distance from the epicenter, and the local geological and geomorphological conditions.

As shown in Figure 6, if one uploaded a picture P at position A in the latest two days, there were two earthquakes happed named e1 and e2, how to judge the fact affected by P is the result of e1 or of e2. It is obviously that d1, the distance between A and e1, is shorter than d2, the distance between A and e2. But the magnitude of e2 may be greater than e1's. So it is not enough to make a decision relying on the distance, it may affected by magnitude, moment of earthquake, and other factors. To solve this problem, we simply the computation model and only consider three factors: distance, magnitude and moment of earthquake.

Assuming while one uploaded pictures or videos all earthquake information had been updated to the database. We defined a map relation between the earthquake magnitude and the epicentral distance, that is to say, the radius of affection range of an earthquake, as listed in Table 1. The greater is magnitude, the wider is affection radius of earthquake.

The selection algorithm is described below. Firstly, it gets the first earthquake object e from earthquake list Queue and computes the distance between e and position A, secondly, if the magnitude and epicentral distance is matched in Table 1 and then test retEarthquake variable, if retEarthquake is null, we assign the value of e to retEarthquake , d to d1, the moment of e to t1, otherwise, assigns the distance d to d2, the moment of e to t2 and while d1 and d2 is less than 50KM, we then consider the moment of earthquake factor, if the moment of e is more recently than retEarthquake's moment, then choose e. When d1 or d2 is greater than 50KM, we select the more nearly earthquake as a result. Finally, we return the selected earthquake retEarthquake, if there is no possible earthquake, its value is null. All results will be verified by administrators.

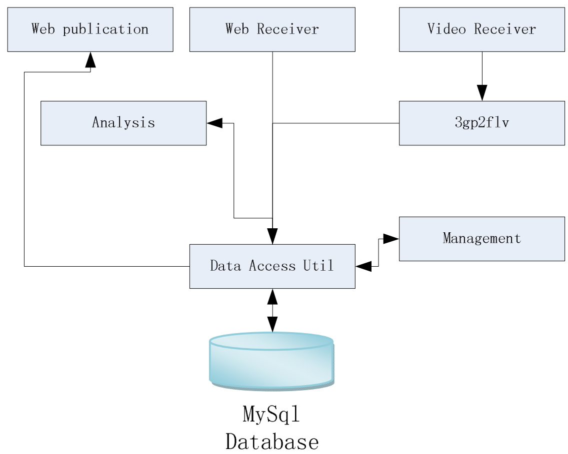

Figure 5. Components of backend server subsystem

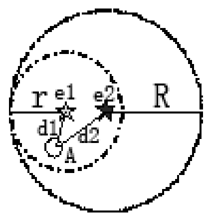

Figure 6. The case to choose an earthquake for a picture uploaded at position

TABLE 1. RELATION BETWEEN MAGNITUDE AND EPICENTRAL DISTANCE.

Earthquake Magnitude	Epicentral Distance (KM)
<5.0	0
5.0-5.9	50
6.0-6.9	100
7.0-7.9	200
8.0-8.9	300
9.0-9.9	400
>= 10	500

Algorithm Select (A, Queue)

Input:

A: Position Info object of a picture or video, includes longitude, latitude and moment of earthquake.

Queue: A queue of earthquake whose magnitude is equal or greater than 5 and happed in latest 7 days, each earthquake has several attributes, such as longitude, latitude, time, earthquake id, depth, moment of earthquake and magnitude of earthquake.

```
Output:
        The possible earthquake or null if there is no matched earthquake.
Begin
    d: INTEGER; // a variable is used to store the distance two points.
    e: Earthquake;
    retEarthquake: Earthquake;
        while Queue is not empty do
                e ← getearthquake(Queue);
                d ← compute the distance between A and earthquake e;
  if    (e.magnitude >=5 && e.magnitude <=5.9 && d <=50)
        || (e.magnitude >=6 && e.magnitude <=6.9 && d <=100)
        || (e.magnitude >=7 && e.magnitude <=7.9 && d <=200)
        || (e.magnitude >=8 && e.magnitude <=8.9 && d <=300)
        || (e.magnitude >=9 && e.magnitude <=9.9 && d <=400)
       || (e.magnitude >=10&& e.magnitude <=9.9 && d <=500)
   then
                if (retEarthquake is null) then
                  retEarthquake =e;
                   d1 = d;
                   t1 = e.moment of earthquake.
                else
                   d2 = d;
                   t2= e.moment of earthquake.
                  if (d1 <=50 && d2 <=50) then
                   // order by moment of earthquake
                          if  t2- t1 >0 then
                            retEarthquake ← e;
                              d1 = d;
                               t1 = e.moment of earthquake.
                          end if
                          else
                             //order by distance
                             if (d1 >d2) then
                             retEarthquake ← e;
                              d1 = d;
                             t1 = e.moment of earthquake.
                            end if
                          end if
                    end if
           else
                continue;
        end if
    end while;
    return retEarthquake;
  end Select
```

Future Work

In the future, there is still some work needed to do to improve the functions and efficiency of the system. This system can be expended to support more disaster, such as flood, typhoon, snowflake, fire, traffic accident and other disasters. Secondly, it is necessary to support modification of disaster information via smart phones. Finally, more spatial analysis can be support in order to provide technical support for commanders to make a reliable and fast rescue solution. In order to save a space, this paper does not introduce how to deal with high concurrent access from smart phones to provide efficient service.

Conclusion

In this paper, we introduced a novel approach for collect earthquake disaster area data using a smart phone with GPS and camera modules and HTTP protocol and socket communication technology. All survey data including pictures, videos, texts and demand data are collected, stored, shared and retrieved via the GIS system over web or smart phones, it is ideal for public to record the earthquake disaster data, and all collected data are also helpful for commanders and seismological experts to make a good rescue solution.

Acknowledgment

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