GPS Location Alert System

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Abstract: Traditionally alerts are based on time. But there are many situations the alerts are based on your current location and not based on time. It is difficult to find the persons in a particular location where some disaster is going to happen. In this situation fixing the search area and accurate location is difficult. In this modern era we have mobile devices capable of finding the user’s current location using the Global Positioning Systems (GPS). In this paper we use our own algorithm “Extended Polygon Match Algorithm using Quadtree” to find whether a mobile is within a defined polygon shaped area using their GPS coordinates. This algorithm determines the spatial indices of the polygon region and mobile user’s Current location. We build a prototype system using Android software to send alerts to mobile devices within the defined geographical area. This mobile application will alert you if you are in that defined geographical region and you can know the distance between you from the defined reminder location.

Keywords: Location-alarm, GPS, Quadtree, Spatial, Android

I. INTRODUCTION

The purpose of the Paper is to provide the system to find the missing persons or to guard the people located in the defined geographical area where the disaster is going to happened. Previous System uses Skyhook or cellular triangulation to find the users’ location. Everyday technology is growing, so we are in a situation to update the system [1]. By using current technologies in smart phones like GPS [8], we can find more accurate location of the mobile user in a faster manner. In Existing system, Geographical Information System (GIS) is used to produce reports using their own maps. There are some disadvantages in existing system like expensive licensing cost, more memory needed for rendering, not getting very accurate and optimized results. The smart phones are equipped with GPS technology. Using their GPS coordinates (Longitude and Latitude) we can find their location. In our paper we propose to develop a new prototype which delivers alerts to mobile devices which are in the defined geographical area. To achieve this we define an algorithm to locate the geographical region using polygon shaped area which covers the entire defined geographical region [2]. We use Quadtree data structure to store the polygon area in the database [3]. When a disaster like earthquake or tsunami, it is difficult to define the exact geographical area which is going to be affected. So we extend the defined region such a way that the information passed to all the persons who are closer to the defined geographical area. We set a limit for the extension according to the seriousness of the disaster. The advantages of our system are less expensive, less amount of memory needed, quicker processing time and more accurate than earlier system. The Cost is reduced since we use most of open source software like Android and MySQL [7] and we use GCM(Google Cloud messaging for Android) [9] which is a service provided by Google that allows us to send or receive the message between our server and mobile devices equipped with android. This application can be implemented in indentifying the Missing Persons Location and Emergencies / Natural disaster notifications.

II. SYSTEM ARCHITECTURE

This Paper presents a framework for defining geographical region and delivering alerts in that geographical region. The architecture of the system is given in Fig. 1. It consists of four major components integrated (1) An admin application to get the GPS coordinates of the defined polygon area where the disaster may occur; (2) An alert display web application to find the target mobiles in the defined region and push message; (3) A mobile application used to register mobile with server; (4) Batch process routines to find GPS coordinates of mobile device and defined polygon region using Quadtree.
Development Environment

Eclipse 4.3 IDE is used for Java development of the batch processing. Android plug-in version 4.0 is use for the Android development. A MySQL (version 5.2.3) is used for data storage. Development licenses are obtained for both Google Maps and GCM. GCM is a service that allows you to send data from your server to your users’ Android-powered device, and also to receive messages from devices on the same connection [10]. GCM is used to register the mobile users with our application; this requires an application developed in Android to retrieve a registration ID from Google and passes this to the server. A web application using Google Maps is created to collect the GPS coordinates of a targeted polygon-shape area and the campaign information. This information is then passed to the server. At the server side an algorithm is proposed to determine if a subscriber is within the geographic area specified by the polygon. When a subscriber has been correctly identified as eligible (based on geography) they will be directed to a webpage containing details of the campaign.

2.1 Admin Module

This module is used to mark targeted region in map, generate polygon region for marked area, find Spatial co-ordinates [1] for the corner points of the polygon, store the region in a data structure called Quadtree, and using Quadtree data structure store the co-ordinates in spatial database (MySQL)[6]. The spatial data are stored in database as raw data.

2.1.1 Setting Polygon Region

Fig. 2(a) Part of Map Contains the target region, 2(b) Minimum Square Contains the Target Region and 2(c) Polygon Region Contains the Target Region.

2.2 Alert Display Module

This module is used to retrieve all Registered mobile users from the database, find the current location of the registered users, get their longitude, latitude of their location, convert longitude and latitude into spatial co-ordinates, compare the spatial co-ordinates with the polygon region, if it is within the region push a alert message to that user’s mobile and if the Mobile user requests for traffic information push the message contains traffic information to the mobile user
2.3 Batch Process Module

It is an automated module which runs automatically at regular interval fixed by admin (For Example 30 Seconds). It Queries the database for registered mobile users and retrieves their current location from GCM. It updates the registered mobile users’ current location in the database. It checks the changes in polygon region and updates it in the database. The Raw data of polygon region are processed in this module and stored as refined data that is in Quadtree tree data structure [5].

2.4 Mobile Registration Module

This module provides the registration screen to the android mobile users, Registration request is sent to Admin, Admin register the mobile user with GCM (Google Cloud Messaging) and the details are stored in the database, User Id and Password will be created for mobile user.

III. ALGORITHMS AND IMPLEMENTATION

In this paper we first mark the target area using Google Maps. Then the region is fitted into a square region that fits the marked region. The entire square region co-ordinate is stored in the data structure Quadtree using our algorithm Extended Polygon Match Algorithm using Quadtree.

![Marked target region on the map](image1)

![Minimum square region that fits entire marked region](image2)
Find the GPS Co-ordinates Longitude and Latitude of the top left corner and bottom right corner of the square region. Using the below mention formula we can find the distance between the two opposite corners.

\[
\begin{align*}
dlon &= \text{lon2} - \text{lon1} ; \\
dlat &= \text{lat2} - \text{lat1} ; \\
a &= (\sin(dlat/2))^2 + \cos(\text{lat1}) * \cos(\text{lat2}) * (\sin(dlon/2))^2 ; \\
c &= 2 * \arctan(\sqrt{a}, \sqrt{1-a}) ; \\
d &= R * c \text{ (where R is the radius of the Earth 6373 km)}
\end{align*}
\] (1)

Using Initial GPS coordinates of Square region and distance \( d \), we can further divide the square region into four quadrants until it reaches minimum defined size of square.

A quadtree is a tree data structure in which each internal node has exactly four children. Quadtrees are most often used to partition a two-dimensional space by recursively subdividing it into four quadrants or regions [11]. Sample Quadtree Structure depicted in below figure 5. In below figure Grey colored box represents partially filled region, white represents the empty region and wherein black represents fully filled region [4].

\[
\begin{figure}
\centering
\includegraphics[width=\textwidth]{quadtree.png}
\caption{Structure of quadtree}
\end{figure}
\]

Let us consider overall square region as root node Split the overall Square in to four equal quadrature “NW”, “NE”, “SW” and “SE”. Sub divide the regions until the minimum pixel range reached or the division is enough to represent the full marked region.

\[
\begin{figure}
\centering
\includegraphics[width=\textwidth]{quadtree.png}
\caption{Splitting the square regions into quadrants}
\end{figure}
\]

\[
\begin{figure}
\centering
\includegraphics[width=\textwidth]{quadtree.png}
\caption{Representation of Quadtree for our region}
\end{figure}
\]
Here we extend the region at leaf node, which is partially filled or fully filled, to a fixed value ‘e’ so that the alert message will reach the registered mobile users who are not in defined geographical region but they are nearby the region up to the distance ‘e’.

/* Pseudo code for quadtree creation and comparison of mobile location with quadtree */
structure coordinate
begin
    type double long;
    type double lati;
end
/* Global variables */
type coordinate quadtop[4], quadbottom[4];
/* to find the distance between two points in the map */
function type double calculate_distance(type coordinate p1, type coordinate p2)
beg
    type double distlong = p2.long - p1.long
    type double distlati = p2.lati - p1.lati
    type double a = \sin\left(\frac{\text{distlati}}{2}\right)^2 + \cos(p1.\text{distlati}) \times \cos(p2.\text{distlati}) \times \left[\sin\left(\frac{\text{distlong}}{2}\right)^2\right]
    type double c = 2 \times \text{atan2}\left(\text{sqrt}(a), \text{sqrt}(1-a)\right)
    double d = R \times c
end /* R is the radius of the earth 6373 km */
return d
end
/* compare the location of mobile with polygon region */
function type boolean compare_location(type coordinate mob, type coordinate p1, type coordinate p2)
beg
    if (mob.long >= p1.long and mob.lati<= p1.lati and mob.long<=p2.long and mob.lati>=p2.lati) then
        return true;
    else
        begin
            return false;
        end
end
/* function to split the quadtree in four quadrant */
function split_quadtree(type coordinate p1, type coordinate p2)
beg
    type coordinate quadtop[4], quadbottom[4];
    quadtop[0].long = p1.long;
    quadtop[1].long = \left(p1.long + p2.long\right)/2;
    quadtop[2].long = p1.long;
    quadtop[3].long = \left(p1.long + p2.long\right)/2;
    quadtop[0].lati = p1.lati;
    quadtop[1].lati = p1.lati;
    quadtop[2].lati = \left(p1.lati + p2.lati\right)/2;
    quadtop[3].lati = \left(p1.lati + p2.lati\right)/2;
    quadbottom[0].long = \left(p1.long + p2.long\right)/2;
    quadbottom[1].long = p2.long;
    quadbottom[2].long = \left(p1.long + p2.long\right)/2;
    quadbottom[3].long = p2.long;
    quadbottom[0].lati = \left(p1.lati + p2.lati\right)/2;
    quadbottom[1].lati = \left(p1.lati + p2.lati\right)/2;
end
quadbottom[2].lati ← p2.lati;
quadbottom[3].lati ← p2.lati;
end

/* function to create additional square region to push message to neighbor mobile of defined region */
function create_additional_square(type coordinate p1, type coordinate p2)
begin
    if node’s NW is empty create NW square with ADDITIONAL_COVERAGE_DISTANCE;
    if node’s NE is empty create NE square with ADDITIONAL_COVERAGE_DISTANCE;
    if node’s SW is empty create SW square with ADDITIONAL_COVERAGE_DISTANCE;
    if node’s SE is empty create SE square with ADDITIONAL_COVERAGE_DISTANCE;
end

/* main function for comparison process*/
function main
begin
    define SQUARE_MIN_SIZE ← 1;
    define ADDITIONAL_COVERAGE_DIST ← 1;
    type coordinate mob ← retrieve mobile’s GPS coordinates;
    type coordinate initialtop, initialbottom;
    if (compare_location(mob, initialtop, initialbottom) == true) then
    begin
        if (square_is_partially_covered and calculate_distance(initialtop, initialbottom)<SQUARE_MIN_SIZE)
        begin
            while(true) /* infinite loop */
            begin
                split_quadtree(initialtop, initialbottom)
                split until either we reach minimum square size reached or fully covered square or empty square area
                if (the square is either in minimum square size or fully covered square or empty square area)
                begin
                    if (the square is empty) no need to push the message and the mobile is not in the defined region
                    if (the square is fully covered)
                    begin
                        push the message to mobile
                        call create_additional_square
                    end
                    if (the square is in min size)
                    begin
                        push the message to mobile
                        call create_additional_square
                    end
                end
            end
        end
    end
end

IV. CONCLUSION
Prevention and preparedness of Natural Disaster is the main goal of our paper. But the area which is
going to be affected in a natural disaster cannot be defined exactly. In this paper we propose and implement the
solution for this problem by extending the search area to certain limit according to the seriousness of the
disaster. Our Paper provides the solution to find the location of mobile users in a defined region in a faster and
efficient manner. But there are some limitations in our system, that we can use it only in a Android Powered and
GPS enabled mobile device. To overcome these limitations we have planned to implement this concept in all the
mobiles which is equipped with GPS in our future work.
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BIOGRAPHY

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