

Implementation of an Android-Based Disaster Management System

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Abstract: - The Philippines is one of the most disaster prone countries in the world and it lacks an efficient disaster management system that will help in times of need especially during the rescue and relief phase. For this reason, there is a need for a system that will help in the efficient provision of rescue and relief to the disaster-affected areas. Since the use of mobile phones in the Philippines is widespread, the disaster management system was implemented as a mobile application and the application environment used was Google's Android. The disaster management system Android application known as MyDisasterDroid determines the optimum route along different geographical locations that the 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. Geographic locations can be entered either through the MyDisasterDroid application or via SMS and to determine the most optimum route, genetic algorithm was applied.

Key-Words: - disaster management, wireless mobile technology, Android, travelling salesman problem, genetic algorithm, MyDisasterDroid

1 Introduction

A report released by the United Nations' International Strategy for Disaster Reduction (UNISDR) based on a new Mortality Rate Index (MRI) ranks the Philippines no. 12 among 200 countries and territories most at risk from earthquakes, floods, tropical cyclones, and landslides [1]. Indeed, through the years, the Philippines because of its geographic location has been devastated by several natural disasters. It has claimed the lives of thousands of people and damaged billion worth of property. Even with the recurrent calamities, there is still the absence of an efficient disaster management system that will help the people in times of calamities.

2 Disaster Management

The process of disaster management involves four phases: mitigation, preparedness, response, and recovery. The mitigation phase is the attempt to reduce disaster risks by focusing on long-term measures of eliminating disasters. The preparedness phase is the development of an action plan for an upcoming disaster. The response phase is the mobilization of services and relief when disaster strikes and the recovery phase is the restoration of the affected area to its previous state [2].

2.1 SAHANA FOSS

SAHANA is a free and open source disaster management system. It is a web-based collaboration tool that addresses common coordination problems during a

disaster. It is a set of pluggable, web-based disaster management solution that provides solutions to problems caused by the disaster and it is designed to help during the relief phased of a disaster. It has been already deployed in different disaster areas including the Philippines during the Southern Leyte Mudslide Disaster in 2006 [3]. However, the current disaster management system does not include a system that will aid in the response phase during the disaster. The response phase includes search and rescue operations as well as the provision of emergency relief. In this phase, efficiency is important because during this kind of situations, time is of the essence. A second delay may cause someone's life. Thus, a system that determines the most optimum route for the volunteers and rescuers to take in order to serve the most number of people and provide maximum coverage of the affected area in the shortest possible time will be beneficial.

2.2 Using Wireless Mobile Technologies

The use of wireless mobile technology in the Philippines is prevalent. A study showed that one Filipino in two is a subscriber to a mobile phone service [4]. Because of its wide coverage, it may be used in a disaster management system.

A study in Bangladesh established that wireless mobile technologies can be used in disaster information management. Results showed that mobile technology may be used to disseminate pre-disaster warnings and post-disaster announcements, to receive information

about relief needs, and to exchange information about health hazard [5]. In disaster management, geographic locations of those in need is important. Their locations can either be determined using the mobile network system or through the use of an integrated Global Positioning System (GPS).

2.1.1 Android Mobile Development Environment

There are a number of mobile development environments. One of which is Android created by the Open Handset Alliance. Android is an open and comprehensive platform for mobile devices. It is designed to be more open than other mobile operating systems so that developers, wireless operators, and handset manufacturers will be able to make new products faster and at a much lower cost. The end result will be a more personal and more flexible mobile experience to the user [6]. For this reason, this mobile development environment was used in the implementation of the disaster management system.

3 Travelling Salesman Problem (TSP)

Determining the most optimum route along different geographic locations is similar to the travelling salesman problem wherein geographic locations represent city coordinates and the rescuers or volunteers represent the travelling salesman.

The travelling salesman problem is stated as follows: "Given a finite number of cities and the distance (or cost) of travel between each pair of them, find the shortest (or cheapest) way of visiting all the cities and returning to the starting point."

The travelling salesman problem is formally described as a permutation problem with the objective of finding the path of the shortest length (or the minimum cost) on an undirected graph that represents cities or nodes to be visited. The travelling salesman starts at one node, visits all other nodes successively only one time each, and finally returns to the starting node. Given n cities, named $\{c_1, c_2, \dots, c_n\}$, and permutations $\{\sigma_1, \sigma_2, \dots, \sigma_n!\}$, the objective is to choose σ_i such that the sum of all Euclidean distances between each node and its successor is minimized. The successor of the last node in the permutation is the first one. The Euclidean distance d , between any two cities with coordinates (x_1, y_1) and (x_2, y_2) is calculated by:

$$d = \sqrt{|x_1 - x_2|^2 + |y_1 - y_2|^2} \quad (1)$$

The problem with the travelling salesman problem is the rapid increase on the number of possible routes when

the number of cities increase [7]. However, this can be solved using optimization techniques.

4 Genetic Algorithms

A number of algorithms have been developed to solve the TSP and even genetic algorithms have been applied to it.

Genetic algorithms are computational models inspired by evolution that provides a potential solution to a specific problem. It has a wide range of applications from optimization, test pattern generation, voice recognition, and image processing. It solves problems by mimicking the same processes Mother Nature uses. Usually, when we want to solve a particular problem, we are looking for some solution, which will be the best among others. The space of all feasible solutions is called a search space (state space). Each point in the search space represents one feasible solution. Each feasible solution can be "marked" by its value or fitness for the problem. Genetic algorithm starts with a set of solutions (represented by chromosomes) called population. Solutions from one population are taken and used to form a new population. Its motivation is hope that the new population will be better than the old population. Solutions which are selected to form new solutions (offspring) are selected according to their fitness – the more suitable solution has a higher chance to reproduce. This is repeated until some condition (e.g. no. of populations or improvement of the best solution) is satisfied [8].

5 System Implementation

Using the travelling salesman problem as basis and using genetic algorithms to generate a solution, an Android-based disaster management system named MyDisasterDroid was implemented.

5.1 Overall System

Fig. 1 shows the MyDisasterDroid system. First, geographic locations of people in need are set. There are two ways that locations can be set: using the application installed in MyDisasterDroid or sending location via text or short message service (SMS) to MyDisasterDroid.

Based on the TSP, the Euclidean distances between locations are then calculated using (1).

Fig. 2 shows a block diagram of the genetic algorithm implementation used for MyDisasterDroid. Based on the figure, after setting the locations and computing the Euclidean distances, initial solutions or chromosomes are generated. These chromosomes represent probable routes along the set locations. Then,

the fitness of each solution (or chromosome) are calculated. This is equal to the summation of the Euclidean distances between the different locations based on the order set by the particular solution. The shorter the distance, the fitter the solution.

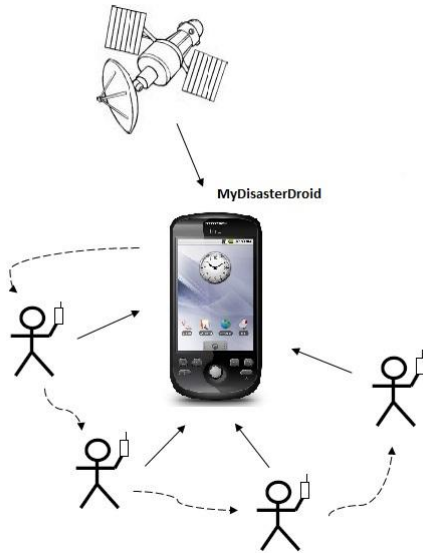


Fig. 1 MyDisasterDroid System

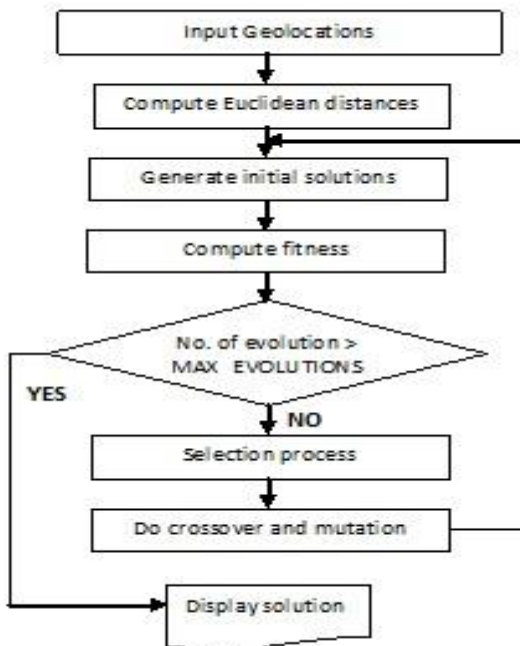


Fig. 2 Block Diagram of the Genetic Algorithm Implementation

After a specified number of evolutions (128 evolutions), a new set of solutions are selected. There are a number of selection operator algorithms: best fit chromosome selector algorithm (or elitism), threshold selector algorithm, and tournament selection algorithm.

The tournament selection algorithm was used because it can easily adjust the selection pressure by changing the tournament size and it is also increasingly used as a genetic algorithm selection scheme [9]. In tournament selection, tournaments are held among a few chromosomes chosen based on a probability. The winner of each tournament or the chromosome with the higher fitness is selected to be copied to the new population. With a selection probability of 0.5 and tournament size of 50, solutions were selected.

Crossovers and mutations were then done on the solutions to generate a much fitter solution. For the crossover algorithm, the greedy crossover was used. In this algorithm, the first location of one parent solution is selected. It compares the distances from that particular location to all locations and chooses the closer one as the next destination for its route. If the nearest location is already a part of the route, another location is chosen.

After a crossover is performed, mutation takes place. The swapping mutation operator was used wherein the genes (representing the different locations) are swapped. As end result, a new generation of solutions are produced and eventually, after successive generations, an optimum route is determined. This route is then displayed on the MyDisasterDroid application.

5.2 Android Mobile Application

Fig. 3 shows the welcome screen of the MyDisasterDroid application. This application is based on the Android operating system.

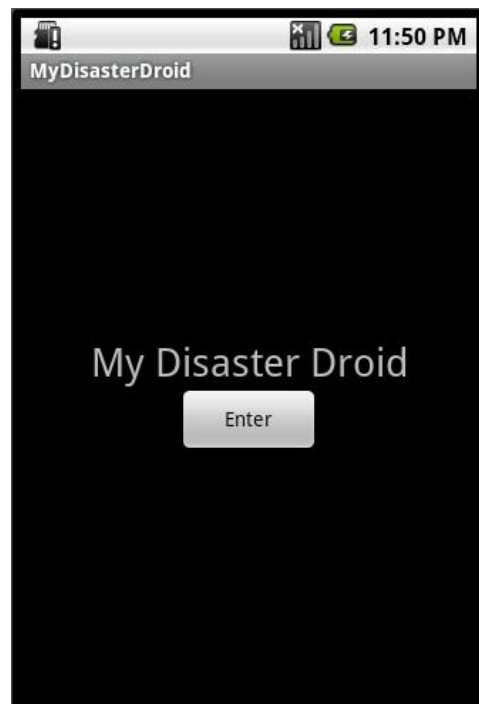


Fig. 3 MyDisasterDroid Welcome Screen

5.2.1 Application Views

Upon entering MyDisasterDroid, it shows two views: MapView and ListView as shown in Fig. 4. MapView shows the location map and it is based on Google Maps while the ListView shows a list of the people in need, their corresponding locations, and their distance from MyDisasterDroid.



Fig. 4 MyDisasterDroid Application Views

MapView also provides different map images. Fig. 5 shows the location map in Satellite View. Fig. 6 shows the location map in Street View. Fig. 7 shows the location map in Traffic View.

Set locations are identified as Android markers on the map as shown in Fig. 8. These markers correspond to the geographical locations described Section 5.1. Upon click of the Show Me The Route! button, the optimum route among these locations is displayed. Dynamic recalculation of the routes can be done with just a click of the said button.

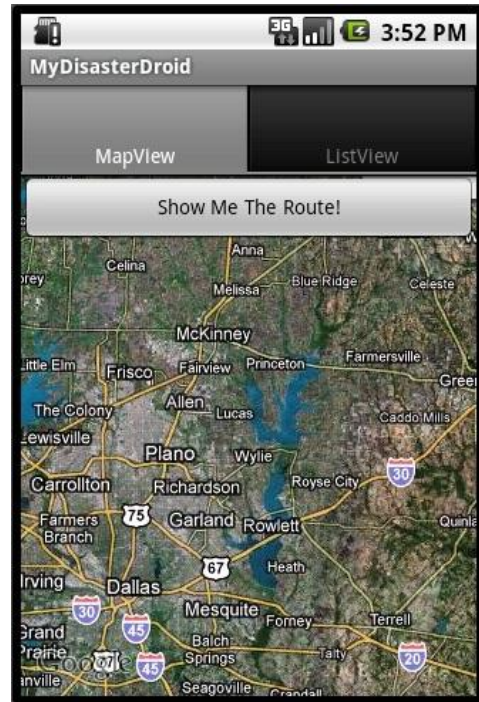


Fig. 5 MyDisasterDroid Satellite View



Fig. 6 MyDisasterDroid Street View

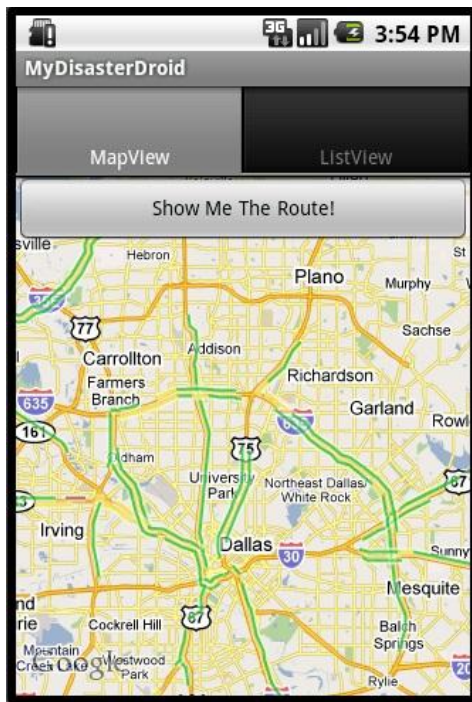


Fig. 7 MyDisasterDroid Traffic View



Fig. 8 MyDisasterDroid Geolocations

directly to MyDisasterDroid. Determining the optimum route along the different geographic locations is similar to solving the travelling salesman problem wherein the geographic locations correspond to the cities and the rescuers or volunteers correspond to the travelling salesman. Using genetic algorithm, an optimum route along the given geographic locations was determined. Indeed, MyDisasterDroid is an application that can be used during the response phase in a disaster especially when time is very important.

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6 Conclusion

A disaster management system that facilitates the logistics for the rescue and relief operations during a disaster known as MyDisasterDroid was implemented in an Android- based mobile phone. Geographic locations of the people in need were sent via SMS or inputted