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Faster Evacuation after Disaster: Finding Alternative Routes using Probable Human Behavior

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Abstract

This poster presents an app that can help disaster affected communities find efficient and safe evacuation routes to reduce the loss of human and resources, both during and after a disaster has hit. This proposed app will navigate people seeking evacuation through suitable routes based on geographical condition, structural vulnerability, disaster severity, traffic density, human mobility, etc. The choice of most effective and safe evacuation paths primarily relies on stochastic probability of human movement and requires frequently updated data. In order to achieve this, the app uses real time GPS data by simulating the movement pattern of its users connected to network as well as their previous movement patterns when they are found offline. This simulation process will find out the less congested and safer routes for faster traversal. Users can use these path suggestions to safely drive themselves out of the disaster stricken area. In case of a user being offline, this app will use data stored on the device to suggest evacuation routes based on human mobility pattern. The implementation of this idea will help the app users evacuate safely and quickly, thus minimizing human casualty due to disaster fatality.

Motivation

Bangladesh, being a calamity prone country, faces a disruption in communication when a disaster strikes. Therefore, a large number of lives is in constant uncertainty with a huge scarcity of food, shelter etc. due to the occurrence of flood, cyclone etc. However, this situation can be improved by an effective and well managed disaster evacuation planning. Whenever, a disaster strikes, getting real time data about distressed people's mobility or possible way-outs becomes quite a challenge. Most of the time, data collection during that period is hardly possible because people are scattered and since the government runs a survey as a whole, location of each individual remains out of reach. As a result, there is panic all over and probable estimation on people's response to emergency is all that can be done [3]. This app targets to navigate app users to safety at the fastest possible time using real time data of their locations and mapping their probable behavior on the face of emergency [2]. Mobility of a panic stricken community depends mostly on their situation around and their immediate response for evacuation [1] which is a pure stochastic event, based on simulation on data obtained.

Methodology

Data collected are simulated using Dynamic Adaptive Routing technology [6]:

- Mimics the reactive route choice behavior of the evacuees.
- Dynamic route choice:

1. Evacuees update their routes based on the prevailing traffic condition.
2. Update their routes based on Logit Splitting Model applied to the k-shortest paths: $p_{ij}^t = \frac{exp[-\theta F_{ij}^t(l)]}{\sum_f exp[-\theta F_{ij}^t(f)]}$ where i is the current node, θ is a model parameter, j is the destination node, $F^t_{ij}(l)$ is the disutility of path l at time t.

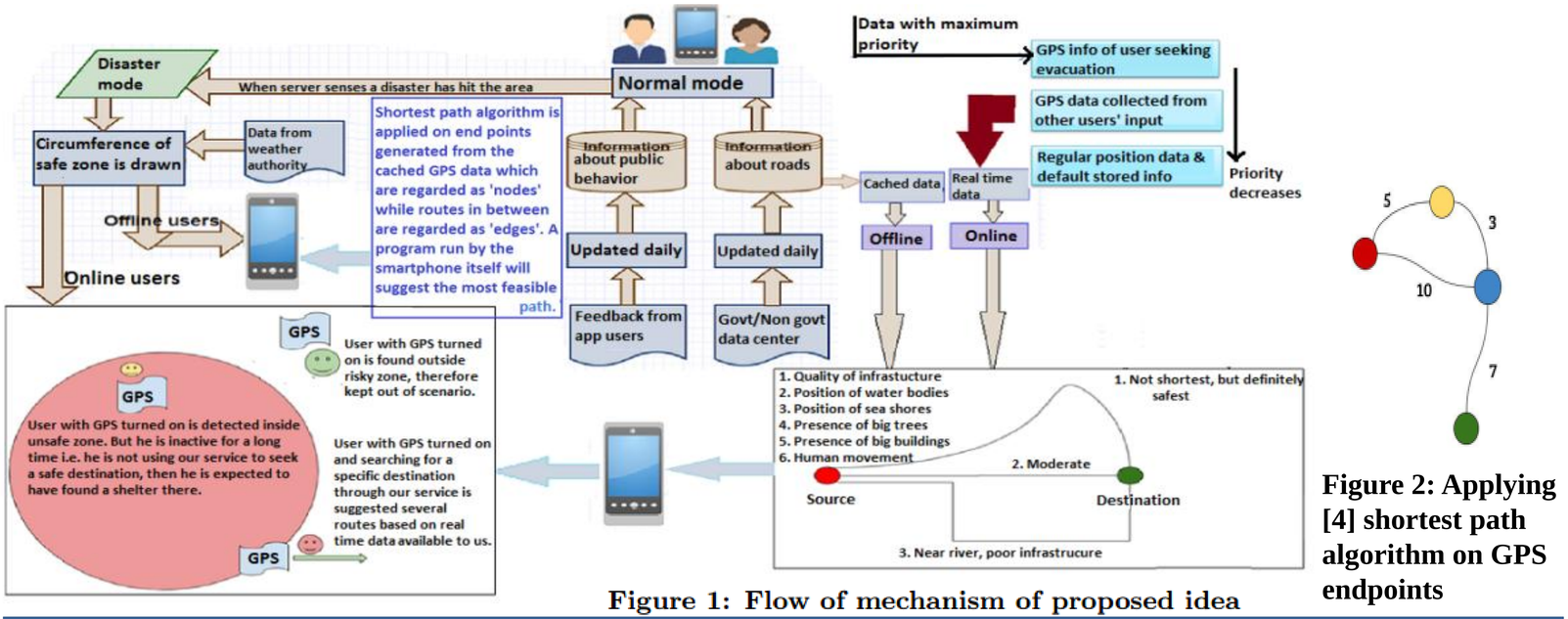

Figure 1: Flow of mechanism of proposed idea

Figure 2: Applying [4] shortest path algorithm on GPS endpoints

Analysis

Feasibility sector	Resource required	Comments
Technical	Server configuration: 16 GB RAM Working memory: 40 MB Task completion time: 5 ms Map API: Google Map	Technically speaking it is a web based and GPS dependent app with massive server side processing. All the technologies that are required to develop the system already exists. Therefore, the system is technically sound.
Financial	Number of total servers: 4+2 (backup) Per server cost: $514 Total server cost: $3084 Total system setup cost: $15500 Operating and maintenace cost: $3000 Cost for dedicated professionals: $15000 Operating cost per year: $18000	Disaster test case: Cox's Bazar, Chittagong, Bangladesh Population: 0.4 Million, Usage: 40% Total number of app subscribers: 0.16 Million Server processing capacity: 8000 requests/sec Total handling capacity: 40000 requests/server Delay metric: 5 seconds, approximate failure rate: 20% Probability of simultaneous disaster strike: 5 nearby districts
Socio economic	GPS service at user side is preferably activated Easy to use & needs no effort to look for escape Simple & requires least technical knowledge Complex jobs are mostly carried out by server	Most of the people in our country prefer lightweight apps for minimal usage of bandwidth and their user friendly nature. It will attract people at distress to use this app because panic stricken people will surely gain confidence after receiving a guideline from this app which makes this design socio economically stable.

Table 1: Feasibility analysis

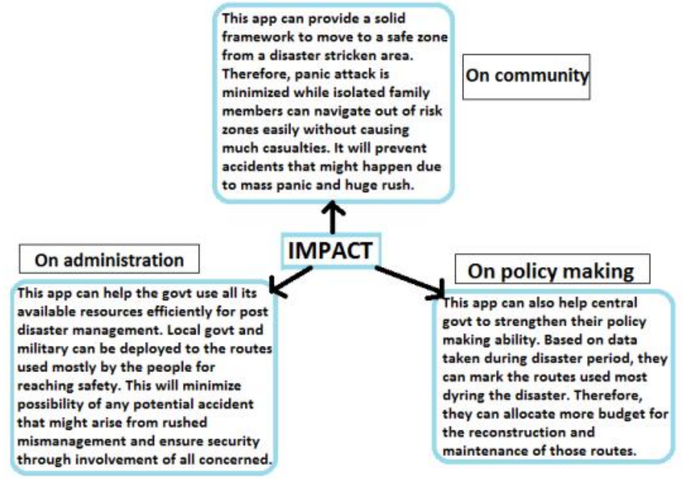

Figure 3: Impact analysis [5]

Conclusions

By ensuring a solid framework to follow during disaster periods, this app can help minimize panic and unnecessary loss of lives and resources. Privacy is also perfectly preserved as only GPS endpoints rather the total route, are taken into account. The constraint being huge data versus inadequate space and power may hamper accuracy. By integrating artificial intelligence based techniques to predict human movement, big data techniques to analyze disaster period data this app can provide even more accurate route suggestions to online users and prediction about situation to offline users. We hope to address these issues in the future versions of our app development phase.

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