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WiFi-based ad-hoc Network for Disaster Management

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ABSTRACT

Countries around the world face hundreds of natural calamities every year. In our country, the most recent being the floods that affected the state of Kerala and Uttarakhand. Most of the people living near water sources were stranded at homes. Despite the deployment of rescue teams to find them, the operations took longer than expected, resulting in loss of life. In any case, the effectiveness of a search and rescue is evaluated by the quick response.
As disasters disrupt communication mediums, valuable information regarding the location of the affected persons cannot be passed on to rescuers effectively. This results in delayed response and time is crucial when it comes to saving lives.
By creating a system that can be used by rescuers and affected persons alike, the delays caused by poor communication can be overcome. An ad-hoc network can be set up onto which this system can be implemented. These network credentials are made aware to people beforehand. At the time of the disaster, this WiFi network can be accessed by people to give information about their location and other parameters like current status, headcount, etc to an android application. Wi-Fi hotspots can be set up on individual phones so that nearby devices can also connect to the network. The database is designed to store information about people. This information can be used by the search and rescue team to reach affected people along with necessary supplies.

Key words : Ad-hoc, disaster area networks, disaster response, Wi-Fi hotspot, router.

1. INTRODUCTION

Our country faces hundreds of natural calamities every year [1]. Studies show several patterns on how disasters keep recurring in some areas. As a result of poor planning of strategies, rescue operations become ineffective where there is no protocol of mitigation. Being prepared for a disaster can help in a lot of ways to avoid the drastic effect of a disaster.
The most recent of times our land was affected by the worst floods during 2018 and 2019. Flash floods like these happen in a few hours and rescuers are not prepared to tackle them. In such flood-prone areas, people cannot organize themselves quickly enough and pass information after the wake of the disaster.
Most of the people living near water sources were stranded at homes. Places near riverbanks can be classified as high-risk areas. they need to be well prepared to handle such disasters.
Search and rescue teams were deployed to find them. But without knowing the exact location or number of people the task to rescue them becomes very difficult. First responders are usually people who know the area well. They are not well equipped to handle the situation
But it wasn't feasible to search all the houses as some people had already left to the relief camps

2. LITERATURE REVIEW

There are several systems that try to tackle the same problem, ie, creating a communication system after a disaster. Natural calamities leave all telecommunications services disabled as telephone wires and cell towers may be destroyed. As time is critical, the best approach is to create an ad-hoc network that can be accessed by people quickly and easily. This network might be able to get crucial initial information that can then be used to save lives.
The choice of the network is not wired as there are already limitations to what can be done. Most of the area might be flooded or unreachable depending on the calamity. It can also be dangerous to navigate in these areas a few hours after floods due to downed power lines etc.
Hence wireless networks are required. They do have a lot of limitations but it is more feasible than other methods.

There is plenty of research being done in creating ad-hoc networks. A wifi based mesh network [2]. The communication is based on IEEE 802.11b,g,n Wi-Fi standards. Here the wifi network provides the backbone for communication between the smart devices that are

connected to the network. The wifi nodes can be placed 100 meters apart and provide a range in that area.

Wifi hotspot method of transfer is when a device repeatedly broadcast network join beacons [3] so that any devices in the vicinity can connect to them. this is done periodically so that new devices can readily join the network along with existing devices

Another application to send data from sensors using Zigbee modules is discussed here [4]. They can monitor parameters recorded by the sensors remotely. This has useful applications in a disaster management system. It is used to measure environmental parameters like air quality, water levels, wind levels, etc. several other use-cases are also discussed in that paper. The relevance to this paper is that we can use these modules to make a more informative analysis of ambient conditions also.

Techniques discussed in [5] are more about hastily formed networks or HFN with particular importance of CISCO being able to use WiMAX to support agencies to provide a network that can be used to make emergency communication possible.
Another method was to use SATCOM or satellite internet that operated directly from satellites. The main drawback of this system is that poor weather conditions can impair the connection.
They also discuss the possibility of a WiFi-based mesh network [5] to which devices can seamlessly connect to and perform data transfer.

3. PROPOSED SYSTEM

A network can be created in a variety of ways. The effectiveness lies in how it is implemented in a given situation. A network-based in wifi can be set up fairly easily with almost everyone carrying a wifi capable device with them at all times. The process can be made more intuitive and simple using an interface that allows people to communicate to the rescuers in the event of a disaster, rescuers can set up an ad-hoc network. The main aim is that people can log onto this network via their mobile phones in order to communicate with the rescuers via an android application.
A long-range wifi transmitter keeps the system accessible to people in the affected area. The android application can be used to update details like location, number of people, required supplies, etc. A common database is maintained at the administration end. Such a system can reduce the time needed to identify the location of the people and the rescuers can be prepared.

3.1 Interface

An android application is used by the affected people as an interface to be able to communicate to the rescuers. This app needs to be pre installed by users in the area.[3]

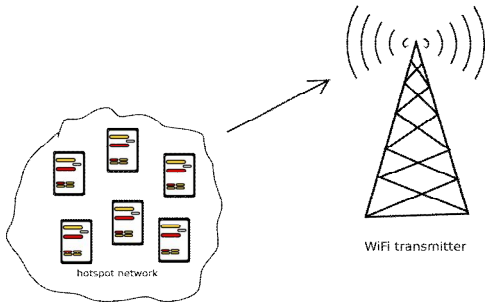

Figure 1: Disaster victims transmit information to rescuers via wifi

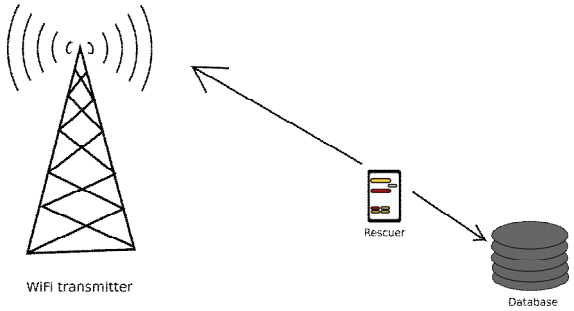

Figure 2: Disaster victims transmit information to rescuers via wifi

The files can be sent to other users using any peer to peer sharing so that new users can also join the network.
User registration is made when the network is active and basic information is required like name, contact number, location, etc.
These details are stored in a database at the rescuer's end. Whenever a user is using the network, the rescuers are notified and the information is accessed.
The application can be used to send information in the form of text that can indicate the names of people who are currently there with the user, their requirements, their location and how to reach there.
Real-time location can allow the rescuers to track movements. The application is developed in Android Studio and is lightweight.
An SOS message can be sent to the rescuer who is nearby who can then update the status in the database.
Other rescuers can view these updates so no redundant operations are carried out. Once that victim is rescued, the status of the database can be changed and the entry cleared.

3.2 WIFI Network

This network can be created by the rescuers in the form of a long-range wifi transmitter or by users who can create a local hotspot to which other users can connect to.
This creates a mesh network that can cover an area. For severely affected areas and remote areas the effective range may be reduced.
Both rescuers and users are on the same network and they can bidirectionally send and receive data.

3.3 Server

This is built and maintained at the end of the rescuers who can access it for information sent by other rescuers in that area. This server is made using Python.

3.4 Client

The client is running the latest version of the android application. This application is configured to connect with the network hosted by the server. This application does all the functions that are discussed in this paper.

4. SYSTEM ARCHITECTURE

The system is basically a peer to peer communication system that can be used in the time of a disaster to convey messages to nearby rescuers.
The basic function can be described in the following steps.

1. Install the application

   Users need to install the application to their smart devices. The application is lightweight and is supported on all android devices. The application itself is intuitive and easy to use. New users can register to the network using their names and other basic information. This information is used to make an entry in the database.
   The application has a dedicated SOS button that can be used to send distress signals. Other data include text fields that can be used to specify the number of people in the vicinity, possible safe routes etc.

2. Connect to the ad-hoc network

   Once the app has been installed, the users need to connect to the ad-hoc network using their registered name. This is done so that the rescuer can update the database on how many people are served or not to avoid redundant rescue operations. The main reason for such a system where the rescuers maintain a database is to organize search and rescue operations. In case a user is new and has not been registered, there is an option to send an SOS message which only contains the name and GPS data. This information is sent as soon as a connection is made to the wifi network

3. Register/send information

   After the connection has been made, the next step is to send and receive information. This is the main feature of the application. It enables users to pass on crucial information to the rescuers. The data fields are put in a way that only the minimum necessary information is gathered. They are used by the first responders to quickly identify and reach the users who sent the message.
   The idea is that users send information about the location and the number of people present, routes that can be navigable, etc. This piece of information can be used by the rescuers to organize a search and rescue for the given information.

4. Notify the rescuer

   Once the data has been sent to the wifi network, it reaches any rescuer in the range of the WiFi network. The application constantly broadcasts the SOS signal so that it can be intercepted by nearby users or rescuers. A user may send data to multiple rescuers redundantly but only one single entry is made for the user in the database. This helps to make organized rescue operations. The number of people present is a piece of important information because the rescuers can be ready with resources to help that many people. Basic requirements will be available with the rescue personnel, any special requirements can be specified. It can be special medication, medical aid, mobility tools, etc. If people are trapped under structures, there might be a need for special tools like crowbars, levers, etc. With this information, they can be prepared.

5. Update the server with victim details

   When rescuers get a message regarding the people in an area, they update a local database. This contains the information passed by the users. There are multiple entries and a new entry is searched for redundancy. If it already exists, the new entry is discarded. If

6. Change status of entry after rescue

   After the rescue operation is completed that particular entry is removed from the database

5 RESULT

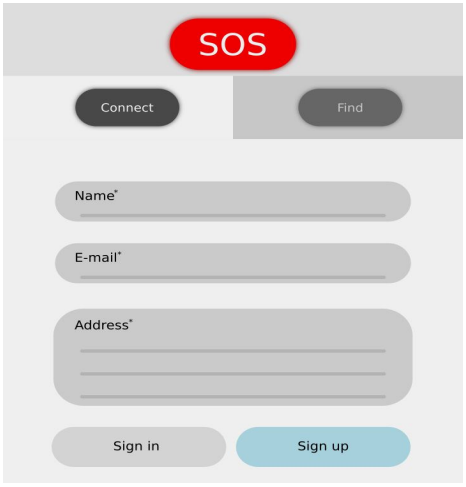

Figure 3: Front page of the android application

This page allows the user to sign up to the system. They should be able to do so after finding the network and connect. The data collected is used to initialise an account. Otherwise the user can choose to sign in.

Figure 4: Finding available connections

This page allows users to connect to a network from a list of networks available. This network is provided by the rescuers in the area affected by the disaster. Users can login to their

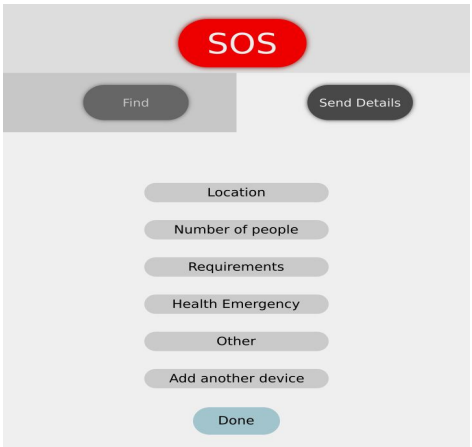

Figure 5: Options to send data to the server

The final tab is used to send specific data. The SOS button on top acts like a beacon that broadcasts messages to nearby devices and the server.

6 CONCLUSION

This system is a support for people who are affected by the calamity in the first few days. As there are many variables involved in deploying a system like this on the field, reliability and performance are subjective to specific scenarios. The application as a whole is a proposal to approach disaster management.

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