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An AI-Enabled Smartphone-Based Self-Rescue System For Disaster Management

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ABSTRACT

Recent pervasive earthquakes have resulted in extensive disruption of electrical power and cellular infrastructures, endangering innocent lives globally. The extensive seismic disaster has rendered power and communication infrastructure inoperative, while limited manpower and resources have rendered standard rescue efforts and equipment ineffective and protracted, resulting in the loss of critical golden hours. The growing prevalence of powerful wireless devices, such as smartphones, suggests their widespread availability among catastrophe victims, serving as a significant resource for coordinating rescue operations. This study presents a smartphone-based self-rescue system, termed Rescue Me, designed to facilitate disaster rescue and relief activities. The fundamental concept of Rescue Me is that a collection of smartphones possessed by individuals trapped or entombed beneath collapsed structures *establishes a one-hop network to transmit distress signals efficiently to neighboring rescue teams to facilitate rescue efforts. We assess the suggested methodology using comprehensive simulation experiments and juxtapose its performance with the established scheme Team Phone. The simulation results demonstrate that the proposed method can markedly decrease the scheduling vacancy for broadcasting distress signals and enhance the probability of discovery with minimal compromise to network longevity, suggesting a potentially effective strategy to accelerate disaster rescue and relief efforts.*

Index : *Earthquake disaster management, Smartphone-based rescue system, Self-rescue networks, Disaster communication, Wireless ad hoc networks, One-hop communication, Distress signal broadcasting, Search and rescue operations, Infrastructure failure, Emergency response systems, TeamPhone comparison, Golden hour rescue, Network longevity, Simulation-based evaluation, Probability of victim discovery.*

I.INTRODUCTION

There has been a significant increase in unexpected natural disasters, including tornadoes, earthquakes, hurricanes, and tsunamis, in recent years. Earthquakes significantly cause loss of innocent lives and environmental destruction worldwide, with their epicenters capable of occurring anywhere, rendering no location immune to pervasive seismic activity[2]. On September 4, 2016,a 5.6-magnitude earthquake occurred in Oklahoma, affecting six adjacent states in the U.S. The Ecuador earthquake on April 16, 2016, resulted in 272 fatalities and over 2,500 injuries[3]. An earthquake occurs suddenly yet can cause extensive destruction to infrastructure, buildings, and residences in a brief timeframe. Following the disaster, victims were unable to use their communication devices, such as smartphones, tablets, or laptops, to inform their families and friends of their safety or to ascertain the well-being of their loved ones due to the physical damage to communication infrastructures or the absence of necessary energy for operation[4]. Crucially, although numerous individuals may be ensnared beneath the debris, the sufferers possess a significant likelihood of survival if they are identified and extricated within the "Golden 72 Hours.[5]"

If a critically injured individual does not receive prompt medical attention, the likelihood of survival diminishes swiftly[6]. Therefore, to reduce losses and preserve innocent lives globally, it is imperative to strategize and execute swift disaster relief operations. Nevertheless, when an earthquake transpires, the rescue teams or disaster relief planners predominantly encounter the following challenges. Initially, due to the unpredictable nature of the present earthquake crisis, formulating a strategy or making decisions on the prioritization of rescue operations such as targeted rescue zones, distribution of rescue teams, or allocation of equipment poses significant challenges[7]. Secondly, the affected regions are undeniably extensive, spanning from a few miles to multiple U.S. states; nevertheless, the availability of rescue teams and manpower is, in practice, quite limited. Third, the failure of power and communication infrastructure has rendered the affected area a black patch, devoid of Wi-Fi and 4G-LTE services, isolating it from, external connectivity[8]. Finally, the majority of r e s c u e t e a m Continue to depend significantly on conventional operations and technology, including detection dogs, video cameras, and sound sensors. In summary, conventional rescue techniques and equipment are ineffective and protracted, resulting in the loss of the critical golden hour[9]. Conversely, smartphones have evolved into indispensable electronic devices that individuals consistently carry for communication and social interaction, or position in readily accessible locations[10]. The number of smartphone users in the United States is projected to reach 148.68 million in 2019, while the global total is anticipated to surpass 2 billion by the same year. Consequently, with the rising prevalence of smartphones, they can be presumed to be widely accessible among catastrophe victims and serve as essential tools for coordinating rescue activities[11]. Following the 2010 Haiti earthquake, there were roughly 2.8 million active mobile subscribers among a population of 10 million, providing data for monitoring population mobility in the impacted area. This article aims to design an innovative catastrophe self-rescue system utilizing the increasingly prevalent smartphone in disaster zones[12]. Our principal contribution is encapsulated as follows: We suggest a smartphone-based self-rescue system, termed Rescue Me, to facilitate disaster rescue and relief efforts. The fundamental concept of Rescue Me is that a collection of smartphones possessed by survivors ensnared or entombed beneath collapsed structures establishes a one-hop network to transmit distress signals efficiently to proximate rescue teams for operational assistance. We create a tailored Simulation framework and execute the proposed scheme for experimental analysis[13].

To compare performance, we reexamine the existing technique Team Phone [6] and adapt it to function within the established simulation framework. We evaluate and examine the performance of Rescue Me and Team Phone regarding network longevity and the scheduling availability for broadcasting distress signals through comprehensive simulation studies[14]. The simulation results demonstrate that the proposed method can substantially decrease the scheduling vacancy for broadcasting distress signals and enhance the probability of discovery with minimal compromise to network longevity, suggesting a potentially effective strategy to accelerate disaster rescue and relief efforts[15].

2. RELATED WORKS

research represented in studies [1]–[24] highlights significant advancements across IoT security, machine learning, cryptography, smart systems, and data-driven applications. The foundational work by Lavanya and Natarajan [1] introduced a certificate-free collaborative key agreement based on IKEv2 for IoT, addressing secure lightweight communication. Complementing this, further IoT-centric analyses include ANN-based routing integration [2] and efficient elliptic-curve and hash-based cryptographic enhancements [3][4]. Security-related contributions such as DoS detection using Quine-McCluskey [5] and optimized Tabu Search-based classifiers [7] strengthen intrusion mitigation in modern networks. Additional applied machine learning innovations include gesture recognition for real-time volume control [6], adaptive curriculum roadmap systems [8][10], EEG-based emotion recognition using hybrid ResNet models [9], and several healthcare-oriented AI applications like early neurological disorder detection [18], lung cancer diagnostics [19], and handwritten medical prescription interpretation [22]. Smart grid optimization using IoT and support vector regression [17], sustainable IoT-based biodiversity-focused connectivity solutions [24], and environmental protection studies such as dye removal from wastewater [21] further showcase the multidisciplinary impact. Advances in authentication and computer vision, including face and license plate-based recognition [11], recursive CNN anomaly detection in X-ray security scans [13], and perceptual video summarization using keyframe extraction [14], contribute to enhanced automated security systems. Broader AI and data-centric works include decentralized federated genomic analysis [16], fraud detection with hybrid personalized profiling [23], gesture and gait-based depression detection models [12], power flow optimization using Hidden Markov Models in renewable-integrated grids [15], and seamless presence detection for visually impaired individuals [20], collectively emphasizing the diverse and evolving landscape of AI-, IoT-, and cryptography-driven research.

III.LITERATURE SURVET

System / Study	Authors & Year	Description	Merits	Demerits
Rescue Me	Xitong Zhou (2018)	One-hop ad-hoc distress network	Energy efficient; Higher discovery	Simulation only
TeamPhone	Lu, Cao & La Porta (2016)	Messaging + self rescue	Prototype tested	No evacuation guidance
Smartphone Finder	Maruyama & Miyazaki (2019)	Wi-Fi based detection	No phone modification	Needs scanners

BLE Beacon System	Recent	BLE triangulation	Low power; High accuracy	Needs BLE scanners
S2S	Unspecified (2020)	Voice activated rescue	Hands-free alerts	False alarms; Noise sensitive

IV. SMART PHONE BASED WIFI TECHNOLOGIES

The develops a mechanism to enable the devices to discover their neighbors autonomously and transmit data of disaster- affected area by different network to Wi-Fi access points using a smart phone-based Wi-Fi tethering technique. In the novel architecture called energy aware disaster recovery network using Wi-Fi tethering is proposed to create the desired network infrastructure using wireless device. The basic idea is to make use of Wi-Fi tethering technology ubiquitously available on wireless devices, like smartphones and tablets, to set up an ad hoc network for data collection in disaster scenarios. The proposes a smart phonebased post-disaster management mechanism in the disaster affected areas using the concepts of Wi-Fi tethering, where smartphones in the affected areas may turn themselves into temporary Wi-Fi hotspots to provide Internet connectivity and important communication abilities to nearby Wi-Fi-enabled user devices. In the concept of multichip device-to-device communication network systems integrating with different wireless technologies is proposed to deliver messages using only user's mobile devices, send out emergency messages from disconnected areas, and share information among people gathered in evacuation centers. In the robot snakes with hyper-redundant body and unique gaits is proposed to offer a promising solution to search and rescue applications in the disaster. Unmanned aerial vehicles aided disaster rescue system is proposed to locate possible victims in, where unmanned aerial vehicles fly around the disaster area and sniff out wireless signals from any mobile devices to support the search team to narrow down the search area within meters. The presents a smartphone-assisted victim localization method in which smartphones belonging to trapped victims and other people in disaster affected areas can self- detect the occurrence of a disaster incident by monitoring the radio environment and can self-switch to a disaster mode to transmit emergency help messages with their location coordinates to other smartphones nearby. To locate other neighboring smartphones also operating in the disaster mode, each smartphone runs a rendezvous process. In the application, also referred to as SOS Cast, is proposed to propagate SOS messages from trapped survivors through a direct communication between smartphones. By collecting SOS messages that include significant information such as their name, state, and location, rescuers can estimate the locations of the survivors. Without relying on any infrastructure, the presents a new algorithm that allows the smartphones of the rescuers and victims to seamlessly collaborate in order to estimate the locations of the victims by using both the received signal strength indicator of the Wi-Fi signals and the GPS information of the rescuers' smartphones. The proposes a smartphone and IoT devicesassisted emergency and recovery method in a post- disaster environment, where smartphones can utilize the IoT devices in the disaster affected areas to successfully relay the emergency messages to other smartphones.

4.1 PROBLEM STATEMENT

The system is not focusing disaster area in quick and fast way due to less speed devices. The system doesn't present a Smart phone assisted victim localization Method in which smart phones belonging to trapped victims.

V. SMARTPHONE-BASED SELF-RESCUE SYSTEM

The system proposes a smartphone-based self-rescue system, also referred to as Rescue Me, to assist the operations of disaster rescue and relief. The basic idea of Rescue Me is that a set of smartphones carried by survivors trapped or buried under the collapsed infrastructure forms into a one- hop network and sends out distress signal in an energy-efficient manner to nearby rescue crews to assist rescue operations. The system develops a customized simulator framework and implements the proposed scheme for experiment study. For performance comparison, we revisit an existing approach Team Phone and modify it to work in the developed simulation framework.

5.1 feature of project

The system is more effective since it is proposed by Fast Rescue Me Techniques using GSPs. The system is very fast since Rescue Me: Smartphone-Based Self Rescue System is totally based on WiFi System.

VI.IMPLEMENTATION

Modules: 1. Disaster Source In this module,

the data Disaster Source will browse the data file related to Disasters and initialize the nodes, then select a node & send to the particular shelter like Hospital, Apartment, and Cottage. Data Source will send their data file to routing server and in a routing server less distance node will select and send to the particular end user. After receiving successful the data provider will get response from the router.

2. Router Server In this module, the Routing server consist of n-number of nodes (A, B, C, D, E and F) to provide a data service. The Routing Server will receive the data file from the Source and select a less distance node and send to the particular end user. If any attacker will found in a router, then the Routing Server will select another less distance node and send to particular end user. In a routing server we can assign node distance, view node details and view attackers. If we want to assign distance, then select node name and enter new distance and submit, then it will be stored in a routing server.

3. GPS In this module, we can do some operation such as view path trajectory and view attack destination. If we click on view path trajectory, then we will get all information about path with their tags such as city name, metadata, time & date. In GPS we can view an attacker details with their tags such as attacker name, city name, Mac address, time and date.

4. Shelter (Hospital,Cottage,Apartment) In this module, there are n-number of end users are present (A, B, C and D). The end user can receive the data file from the Source via Routing Server. The end user will receive the file by without changing the File Contents. Users may receive particular data files within the router only.

5. Attacker Attacker is one who is rerouting the trajectory node. The attacker will select the node and inject fake key to the particular node. After attacking successful the attacker details will store in GPS and Routing Server with their tags such as attacker name, city name, IP address, time & date.

VII Methodology

7.1. Requirement Analysis

Analyze typical disaster scenarios (e.g., earthquakes, building collapses) where victims may be trapped and unable to communicate manually. Identify the limitations of existing emergency communication infrastructure during disasters.

Establish system objectives:

Enable smartphones to autonomously assist in self-rescue. Minimize power consumption for prolonged operation. Increase likelihood of victim discovery by rescue teams.

7.2. System Design and Architecture

Design a smartphone-based self- rescue framework with the following components:

Self-Rescue Mode: Activates when the user is trapped or unresponsive. Ad-hoc Network Formation: Smartphones of nearby victims form a cooperative wireless network (e.g., Wi-Fi or Bluetooth-based). Periodic Distress Signal Broadcasting: Devices broadcast distress signals containing location or identification information.

7.3. Detection of Emergency Situations Implement methods to detect potential emergencies automatically or via minimal user interaction: Manual activation by the user if possible. Automatic triggers based on external events (e.g., sudden fall detection, lack of movement, no cellular signal). Integration with disaster warning systems, if available.

7.4. Cooperative the Signal Scheduling Algorithm Develop an energy-efficient scheduling mechanism where smartphones: Alternate signal transmission to avoid collisions and conserve battery. Form clusters based on proximity to coordinate broadcasting.

7.5. Distress Signal Broadcasting Smartphones broadcast distress signals periodically using Wi-Fi Direct, Bluetooth, or other wireless technologies.

Distress signals contain: User identification (anonymous or encrypted for privacy). Approximate last known location (if GPS is available). Device-specific information to assist rescue teams.

7.6. Rescue Team Detection and Interaction

Rescue teams equipped with detection devices (e.g., smartphones, laptops with appropriate apps) can: Scan for distress signals in the affected area. Estimate the location of trapped victims based on signal strength or triangulation. Communicate with survivors if Bi-directional communication is supported.

7.7. Energy Consumption Optimization

Incorporate low-power communication technologies (e.g., Bluetooth Low Energy, Wi-Fi Sleep Modes). Optimize the frequency and timing of distress signals to balance energy use and discoverability. Implement cooperative clustering to avoid redundant transmissions within groups of victims.

7.8. Implementation and Testing Develop a prototype Android application is implementing the proposed system. simulate disaster scenarios in controlled environments to test: Signal discoverability by rescue teams. Battery consumption patterns. Effectiveness of cooperative scheduling. Conduct field tests in real-world-like conditions if possible.

7.9. Evaluation and Performance Metrics

Evaluate system performance based on: Discovery rate by rescuers. Energy efficiency and battery life extension. Network formation success rate among nearby victims. Signal coverage range in different environmental conditions.

7.10. Deployment Considerations

Package the application for easy installation on smartphones. Explore integration with existing emergency apps or disaster alert platforms. Raise awareness among potential users to encourage app installation in disaster-prone regions.

VIII. RESULTS AND DISCUSSION

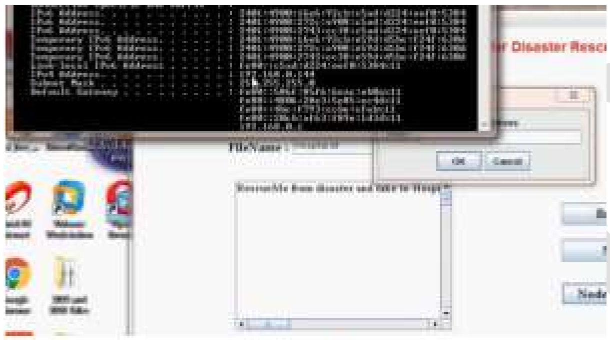

Fig 8

The text in the image describes a program that helps configure network connections and manage network nodes. User Input: The program requires the user to enter a "Node Router IP Address" to set up network connections. Functionality: The program has buttons for "Browse," "Send," and "Node Initialization," suggesting it can perform tasks like selecting files, sending data, and setting up network nodes.

IX .FUTURE SCOPE AND CONCLUSION

This study presents a smartphone-based self- rescue system to facilitate catastrophe rescue and relief efforts. The fundamental concept of Rescue Me is that a collection of smartphones held by survivors trapped or buried beneath fallen infrastructure establishes a one-hop network to transmit distress signals efficiently to nearby rescue teams, facilitating rescue efforts. We assessed the proposed methodology using comprehensive simulation tests and contrasted its performance with the established technique Team Phone. The simulation results demonstrated that the proposed method can substantially decrease the schedule vacancy for broadcasting distress signals and enhance the probability of discovery with minimal compromise to network longevity, suggesting a potentially effective strategy to accelerate disaster rescue efforts.

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