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Role of Technology in Safer Evacuation during Emergency Response

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Abstract: Due to unpredictable nature of damage and the internal structure of the building it becomes mandatory to think how to act promptly in case of causalities. The big question is how to protect people from damages and send them to safer area. The technology allows monitoring and controlling such events dynamically. An evacuation model based on latest technology allow people to get escape from such situations in real time thereby saving the lives as well as reducing the economic losses. This paper focused on the role of technology in evacuation strategies during an emergency.

Keywords: Disaster, Emergency, Technology, evacuation, IOT

1. Introduction

According to [1], a disastrous situation may cause damage to entire community in terms of loss of life, environmental degradation, and economic losses beyond the control. In case of sudden disasters such as fire, earthquake, chemical disasters in densely populated buildings it's really difficult to evacuate people to the safer places. The economic loss due to such events may turn out to be $2.9 billion according to a survey done by Center for Research on the Epidemiology of Disasters. The maximum economic losses are in countries with huge infrastructure. A loss of $1 trillion is faced by US, followed by other countries.

Most earth-quake prone countries are China, Indonesia, Iran and Pakistan. Most of the threats from sea are faced by small island states in the Pacific region and countries like the Maldives. Floods are faced by Bangladesh and parts of China and India each year.

The technology cannot prevent such disasters but it plays an important role in preparedness such as early warning system and recovery during post disasters.

To be more effective and secure evacuation not just building evacuation plan is required but traffic management also play a key role. It deals with evacuating the affected area and to monitor the traffic in other parts of the city to avoid congestion and road blockages. This makes use of the sensors and cameras to collect and manage the data efficiently. People can also make use of GPS for traffic monitoring and altering the routes to avoid congestion in real time**.**

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2. Evacuation Technologies used in the Past

To handle disastrous situation whether it is natural or man-made, a system is required. Technology plays an important role for implementing an emergency response system. For effectively managing the situation certain information is required to be collected such as alternative escape routes, traffic situations. Various technologies such as laser light, smoke and heat sensors, robots with emergency alarms are being used in early evacuation systems.

An intelligent fire system is designed using Heat and Smoke Sensors [2]. Speech synthesizer passes safety instructions verbally in case of any causality in Emergency situations. Laser Light is being used by this study which changes its intensity with change in smoke density and directed people to safer exit [3]. Use of Autonomous robot with ultrasound as a technology for designing an evacuation system as a firefighter is proposed[4].

This worked on the principle of setting an alarm and was suitable for many warehouses. To handle dynamic situation there was a need to design adaptive solutions which work in all type of changing conditions. An adaptive evacuation system is simulated using Mesh routing protocol for evacuation and sensors to analyze danger automatically by sensing the environment [5].

This suggested the storage of communication equipment underground so as to enable communication even during floods[6]. Smoke sensors along with multiple sensors such as water flow sensor etc with multiple alarms allow an individual to find an escape to a safer place during an emergency in case of fire accidents in lesser time with high success rate[7]. The study improved the evacuation facility with introduction of agents. A protocol is simulated to allow interaction and communication during an evacuation process[8].

3. Advanced Integrated Evacuation Technologies

The latest techniques are required for data collection during evacuation so as to facilitate faster and safer evacuation. Techniques such as Cloud computing, big data and Artificial Intelligence are currently being used by various studies. Internet of Things can also play an important role in preparedness using the intelligence of various interconnected objects[9].

Crowdsourcing allow us to share disaster related data in the form of images, videos and audios with

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the help of smart phones. This helps in improving the response services in real time. Maps of congested areas can be made available using some applications based on Crowdsourcing. ArcGIS is an application that uses contextual tools for analysis and visualization of data. It helps in collaboration and sharing using maps, reports and various other applications.

A study [10] is conducted using crowd optimization with IOT technology. This simulated an evacuation model with minimum response time using grid and floor plan.

The technique of Network flow model is used in [11] where the infrastructure based on IOT is adapting itself to work even in case of dynamic environments. The behavior of human in panic situations is yet to be taken into account by this study. This study [12] proposed an evacuation system with improved efficiency by integrating n IOT based technology with GIS. The effect of smoke on evacuation system is studied by this paper.

The crowd sensing techniques can disseminate information faster by integrated it with social media[13]. Rather than using conventional cloud computing framework for disaster management, Fog computing[14] with data offload mechanism predict early disaster so that early information can be easily disseminated in no time.

Some multi-agent systems can automatically sense the environmental condition with the help of sensors based on context awareness. These systems collect, aggregate and then analyse the situation in no time. Real time cooperation is required during the response which can be facilitated by Context awareness. This study [15] makes use of integration of fog computing with context awareness for information collection, processing and dissemination.

Artificial Intelligence also helps in predicting the disaster as well during evacuation. In disaster response, AI helps in predicting the messages on social media platform and tries to classify them during a philanthropic crisis.

Artificial Intelligence for Disaster Response (AIDR) collected messages posted by public on social network in real-time and apply algorithmic techniques to process it by using various classification techniques. This technique helps to classified informative and non-informative tweets during Pakistan Earthquake in the year 2013. Various studies worked on the designing the shortest path algorithms during evacuation. The studies [16][17] used dijkshtra algorithms for best evacuation plan. They have suggested the solutions which work in static environment and also there is no automatic congestion management. The [18][19] suggested the Ant colony

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optimization techniques for finding the safe escape.

Big data technology manages the disasters efficiently by speeding up response activities thereby saving human lives. This [20] investigated pedestrian navigation in indoor open spaces with big data collected through video recordings. Model designed using Simulation tools can help public building architects, to optimize designs considering the pedestrian behaviours in open spaces. This [21] studied the social media spatiotemporal analytics to explore the evacuation travel patterns during Hurricane Matthew. Due to limitation on survey data during evacuation, social media provide very useful information for real-time disaster management.

Deep Learning technology is an effective learning approach, and is being used in various domains such as vision, speech, text etc. It uses learning approach during evacuation to predict the mobility of humans and tried to model it using a simulator to predict human behavior during different situations [22]. This paper [23] proposed evacuation plan using network flow and deep learning algorithms with precise ECT and an average regression error of about 2%. In this paper [24] deep learning algorithms with GPUs are used to predict urban traffic behavior during evacuation. This suggested the use of big data technologies for planning an effective traffic management to deal with real time data.

The various optimizations algorithms have been suggested by the studies. Since most of the studies have offered solutions which can work in static environments. Dynamic solutions are required which can be made possible by introducing algorithms in [15][16][18].. Dynamic risk and human behavior in panic situations are required to be studied. Various learning mechanism using deep learning[22][23][24] helps in facilitating the improved evacuation plans.

4. Conclusions

Technology is vital for livewire communication channels to enable rescue and aid services in a crisis situation. Victims of disaster need vital resources for survival in a disaster and ICT contributes to it. It helps us to become ready to face the problem for the next disaster. Different ICT based techniques during evacuation are studied. Evacuation plans can be improved by collection of real time data from social networking sites such as twitter. An enhanced evacuation model is required to be simulated by considering the dynamicity into account through temporal deep learning techniques with introduction of context awareness into account.

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