Chapter 3
Optimizing Resource Management With Edge and Network Processing for Disaster Response Using Insect Robot Swarms

U. Vignesh
Vellore Institute of Technology, Chennai, India

K. Gokul Ram
Vellore Institute of Technology, Chennai, India

Abdulkareem Sh. Mahdi Al-Obaidi
https://orcid.org/0000-0003-2575-0441
Taylor's University, Malaysia

ABSTRACT

The potential of emerging technology to transform disaster response is examined in this review study. We investigate how, by overcoming the constraints of conventional cloud-based processing in disaster areas, edge computing enables insect robots for real-time data gathering and analysis at the network edge. We examine studies on KubeEdge for reliable network deployment using insect robots and Social Sensing-based Edge Computing (SSEC) for processing social media data. We explore network processing methods that leverage Mobile Cloud Computing (MCC) and show how they overcome issues such as bandwidth limitations and low battery

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life. This study examines how developments in edge computing, network processing, resource management, and multi-robot systems might benefit disaster response by highlighting the potential of insect robots as indispensable instruments that will ultimately result in quicker and more efficient reaction times.

I. INTRODUCTION

Tragically, disasters are happening more and more frequently. According to the Centre for Research on the Epidemiology of Disasters (CRED), 421 natural disasters worldwide claimed over 10,000 lives in 2022 alone. With their catastrophic effects on densely populated places, earthquakes such as the one that rocked Turkey and Syria in February 2023 emphasize how urgently disaster response efficiency needs to be improved. In situations like this, traditional approaches frequently falter. Despite their importance, large search and rescue teams have limits. According to a 2021 study published in the Journal of Disaster Research, the challenges of negotiating debris might result in average response times of 72 hours in cases of collapsed structures. Unmanned aerial vehicles (UAVs) provide a more comprehensive view, but their efficacy is restricted by their short battery life and susceptibility to inclement weather. Tragic consequences may result from these delays. According to a 2016 Nature Geoscience study, quicker reaction times during earthquakes may be able to prevent up to 40% of total fatalities. It is obvious that creative solutions are required to close these gaps and speed up response. With their special talents, insect-sized robots have enormous potential to transform disaster relief efforts.

The fast-evolving subject of microrobotics presents a novel method for disaster response. Inspired by their biological counterparts' agility and mobility, insect-sized robots have enormous potential for negotiating dangerous and complex settings that are inaccessible to conventional approaches. Because of their small size, they can squeeze through tiny openings, hide beneath rubble, and get to stranded survivors in crumbling buildings. Their integrated sensors can also collect essential information to help with search and rescue operations, such as temperature, humidity, and audio characteristics. Although using insect robots has great potential, data communication issues must be resolved first. Their small size limits the amount of raw data they can transmit by limiting transmission bandwidth and processing power onboard. Furthermore, real-time data processing and analysis are required to derive meaningful insights from disaster zones due to their dynamic and frequently unpredictable nature.

Disaster zones are inherently dynamic. It might be necessary to process substantial amounts of sensor data from a widespread robot deployment during the first response phase. Subsequent stages may concentrate on an in-depth examination of