©2025 Published in 7th International Symposium on Natural Hazards and Disaster Management
16-18 May 2025 (ISHAD2025 Diyarbakır - Türkiye)

Phoenix Signal: A Novel Tethered Drone System for Continuous Communication During Earthquakes

[1]Batu Aydinlar and [1]Ali Mehmet Baler
[1]ENKA High School, İstanbul, Türkiye

Abstract

The 2023 Turkey earthquake highlighted critical communication failures where GSM operators were disabled in many locations. Phoenix Signal, a patent-pending innovation, solves this problem with a tethered drone providing continuous high-speed internet for up to 500 users via an embedded access point. This reliable system, independent of fragile networks, ascends 90 meters and is generator-powered for 24-36 hours of operation, overcoming battery limitations. Messages and calls are relayed globally via satellite from the drone's access point to a base station's Starlink® receiver. This innovation has the potential to speed disaster response and save lives.

Key words: Disaster, communication, tethered drone, satellite, wi-fi connection

1. Introduction

During earthquakes, the most critical time to rescue people trapped under rubble is the first 72 hours. These three days are when destruction peaks, roads are blocked, and electricity and communication networks are down. Identifying which collapsed buildings have signs of life is incredibly challenging. Some survivors were rescued during past disasters thanks to communication through texting to social media or contacting others via their phones [1].

One major problem during these critical hours is the collapse of the GSM infrastructure, which is the main communication means for many [2]. For years, experts and GSM companies in Turkey have discussed creating an alternative communication network to prevent such breakdowns. However, the 2023 earthquake showed that this goal is still far from being achieved [3].

Drones can quickly be deployed to disaster areas, and efforts have been made to use traditional unmanned aerial vehicles (UVAs) technology with access points to re-establish communication [4-7]. However, they've faced significant challenges: they typically have short flight durations, need expertise, and, worst of all, still rely on the already damaged GSM infrastructure [8].

The Phoenix Signal, a patent-pending innovation (patent no: 2024/021051), ensures uninterrupted communication by transferring local message and telephone signals to a satellite through a Starlink®-connected access point linked to its receiver. It accelerates rescue efforts and carries the potential to increase survival rates in the critical hours after an earthquake.

*Corresponding author: Address:

2. Materials and Method

The drone uses a heavy-lift octocopter frame capable of carrying payloads such as a satellite internet module (e.g., Starlink®). It connects to a ground station via a robust, lightweight cable that supplies continuous power and transmits data, enabling uninterrupted flights of up to 24–36 hours. This marks a significant improvement over battery-powered drones limited to 20–40 minutes. With power sourced from a generator, there is no need for frequent recharges.

The tether has two core functions: providing power for extended flights and transmitting data to ensure a stable signal. An automated cable reel manages tension and retraction, maintaining drone stability even in high winds. This system permits altitudes of up to 90 meters (300 feet), enabling satellite internet connectivity and wide-area Wi-Fi broadcasting.

Flight control is managed by Pixhawk PX4 controllers, with high-efficiency brushless motors and carbon fiber propellers minimizing energy consumption. Weather-resistant materials and IP-rated components allow for reliable operation in harsh conditions.

Incorporating HPE Aruba Networking access points with Wi-Fi 6 technology, the system leverages OFDMA (Orthogonal Frequency Division Multiple Access) and multi-user MIMO (multiple-input and multiple-output) to optimize performance, reduce interference, and accommodate growing IoT(internet of things) demands.

3. Results

A prototype tethered drone system was assembled and subjected to hardware testing, incorporating essential components such as the tethered power supply, satellite internet module, and Pixhawk® PX4 flight controller. The prototype was evaluated under controlled conditions to assess its performance in maintaining stable altitude, ensuring continuous power delivery, and sustaining reliable communication via the satellite module.
The results indicated that the drone successfully operated at an altitude of 300 feet with uninterrupted connectivity for prolonged durations, thereby confirming the feasibility of the tether and power management systems.

4. Discussion

The Phoenix Signal tethered drone system represents a new approach to disaster communication, addressing a critical gap in emergency response infrastructure. This innovation combines connected power, an access point, satellite internet, and a durable design that provides a communication path that does not require base stations, ensuring uninterrupted connectivity when traditional systems fail. Its hybrid power and data transmission system, featuring a lightweight, high-strength tether that supplies power from a ground-based generator while relaying data, enables continuous operation for up to 36 hours, surpassing conventional battery-operated drones. Such systems have significantly enhanced operational reliability in disaster zones, where prolonged aerial presence is essential [9].

Traditionally, UAVs are used for search and rescue missions during disasters. Drones capture aerial images to assess structural damage and determine the extent of the catastrophe. They can also carry body heat cameras that can help locate individuals. Larger drones deliver essential supplies to people stranded in isolated disaster areas. UAVs, sensitive to human and animal sounds, are also being developed to take acoustic recordings [10].

Natural disasters such as earthquakes, hurricanes, and floods frequently disrupt terrestrial communication networks, severely interfering with rescue operations and isolating affected populations [11]. When disasters strike and emergency call systems become overloaded, individuals turn to social media platforms to communicate and ask others for help [12]. This method becomes even more complicated when the communication and energy infrastructure in the region collapses, leaving people more desperate to reach their loved ones. A tragic example occurred during the 2023 Kahramanmaraş earthquakes in Turkey, where widespread destruction of telecommunications and power networks left survivors struggling to contact family and emergency services, exacerbating the chaos and desperation in the aftermath [13].

Phoenix Signal features a tethered drone with a high-performance access point with Wi-Fi 6 technology and a portable satellite internet kit (such as Starlink®). The Tethered drone's ability to ascend to 90 meters ensures optimal signal coverage for up to 500 simultaneous users. When a mobile phone sends a signal, it travels through the drone's Wi-Fi network to the satellite, enabling fast communication. Unlike traditional tethered drones limited to surveillance or lighting, this design prioritizes restoring crucial communication capabilities wherever local infrastructure is compromised. The Phoenix Signal's modular design, which allows for the addition of thermal imaging and environmental sensors, further enhances its adaptability to diverse disaster scenarios. Another benefit of the tethered drone is that it does not require the expertise needed for traditional UVAs operation and can be learned quickly.

Despite its advantages, the system faces challenges, including regulatory hurdles related to tethered drone operations in urban areas and the logistical complexities of deploying generators in disaster zones [14]. However, the growing emphasis on disaster resilience in global policy frameworks, such as the Sendai Framework for Disaster Risk Reduction, underscores the need for innovations like the Phoenix Signal [15]. The tethered drone's access point's coverage area becomes limited in challenging weather conditions, as it may struggle to stay airborne. Future iterations could explore renewable energy integration, such as solar-powered ground stations, to improve sustainability and reduce dependency on fuel supplies.

Conclusions

In conclusion, the Phoenix Signal exemplifies how advanced drone technology, satellite connectivity, and innovative engineering can redefine disaster response. By ensuring reliable communication in the critical aftermath of disasters, this system has the potential to streamline rescue operations and save lives. Further field testing and partnerships with humanitarian organizations will be essential to validate its real-world efficacy and scalability.

Acknowledgements

We extend our sincere gratitude to Burhan Şengün for his mentorship throughout our project. Additionally, we would like to thank İlhan Tosyalı, Oğuzhan Eren, Celal Şengör, Mehmet Emin Kiriş, and Orkut Aktaş for their contributions to the development of our innovation. We also appreciate the editorial support provided by Cemil Yıldız.

References

[1] Yurdigül Y, Bayraktar R, Çil S. A study on Kahramanmaraş Earthquake survivors : "Social media platforms were more effectively used than the traditional media". Connectist: Istanbul University Journal of Communication Sciences, 2024,(66), 211-229.

[2] Ke SS, Wu BR, Hsu C. Damage assessment of mobile communication facilities subjected to major earthquakes. Journal of the Chinese Institute of Engineers, 2022, 45.6: 501-512.

[3] Akgül SK, Pazarbaşı B. Bir Depremin Yıkım Dalgaları. Hiperlink Eğitim İletişim Yayın Gıda Sanayi ve Pazarlama Tic. Ltd. Şti., 2024.

[4] Merwaday A, Guvenc I . UAV assisted heterogeneous networks for public safety communications. In 2015 IEEE wireless communications and networking conference workshops (WCNCW) IEEE, 2015, pp. 329-334.

[5] Guan M, Feng Z, Jiang S, Zhou W. Tethered Balloon Cluster Deployments and Optimization for Emergency Communication Networks. Entropy, 2024, 26(12), 1071.

[6] Saif A, Shah NSM, Alnoamani A, Ameen A, Curry E, Al Khattat VHF et al. Resilient Skies: Advancing Climate-Resilient UAVs for Energy-Efficient B5G Communication in Challenging Environments. In: 2024 4th International Conference on Emerging Smart Technologies and Applications (eSmarTA). IEEE, 2024. p. 1-7.

[7] Xu Z. Application research of tethered UAV platform in marine emergency communication network. Journal of Web Engineering, 2021, 20(2), 491-511.

[8] Matracia M, Saeed N, Kishk MA, Alouini MS. Post-Disaster Communications: Enabling Technologies, Architectures, and Open Challenges. IEEE Open Journal of Vehicular Technology 5 (2024): 219-229.

[9] Hanafi MH, Rahim MZ, Hamzah HH, Fadzulli F, Marwah OMF, Omar Z et al. Analysis of

Battery-based and Direct Current Generator Drone Power System. IJETT Journal, 2024, 72 (5): 216-226.

[10] Papyan N, Kulhandjian M, Kulhandjian H, Aslanyan L. Ai-based drone assisted human rescue in disaster environments: Challenges and opportunities. Pattern Recognition and Image Analysis, 2024, 34.1: 169-186.

[11] Gomes T, Tapolcai J, Esposito C, Hutchison D, Kuipers F, Rak J.et al. A survey of strategies for communication networks to protect against large-scale natural disasters. In: 2016 8th international workshop on resilient networks design and modeling (RNDM). IEEE, 2016. p. 11-22.

[12] Glass TA. Understanding public response to disasters. Public Health Reports, 2001, 116.Suppl 2: 69.

[13] Dinçer AE, Dinçer NN, Tekin-Koru A, Yaşar B, Yılmaz Z. The impact of Kahramanmaraş (2023) earthquakes: A comparative case study for Adıyaman and Malatya. International Journal of Disaster Risk Reduction, 2024, 110: 104647.

[14] Tamer S. Evaluation of Flight Permissions of Unmanned Aerial Vehicles in Turkey. Avrupa Bilim ve Teknoloji Dergisi, 2022, 35: 616-624.

[15] Morote, ÁF. Sendai Framework for Disaster Risk Reduction (2015-2030): A Before and After for Teaching Natural Risks. In: Geography Education and Explorations on Human Development and Culture. IGI Global Scientific Publishing, 2025. p. 99-130.