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Drone Setup for Line-of-Sight Communication During Disasters

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Abstract:

Drones have become indispensable instruments in disaster relief efforts, facilitating prompt evaluation of impacted regions and transportation of assistance to unreachable spots. Coordinating rescue operations and transmitting vital information, however, requires efficient communication between drones and ground control stations. This study examines the creation and application of a drone configuration intended for line-of-sight communication in emergency situations. This study investigates the hardware and software components necessary for establishing dependable communication links in difficult circumstances through an extensive review of the literature and case studies. The study looks on the operational rules, communication protocols, and deployment processes for using drones in emergency situations. Examples from the real world demonstrate how well the suggested drone configuration works to improve situational awareness and enable effective communication during disaster response.

Keywords —**Drones, Disaster Management, Communication Systems, Line-of-sight, Emergency Scenarios, Hardware components, Software solutions, Communication protocols, Deployment procedures, Disaster response operations.**

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I. INTRODUCTION

A. *overview of web real-time communication and its use in disaster relief:*

With its revolutionary approach to online collaboration and interaction, Web Real-Time Communication (WebRTC) is at the forefront of contemporary communication technologies. With no additional plugins or software installations required, WebRTC is an open-source initiative developed by

tool in enabling smooth communication between

Google that facilitates real-time communication within web browsers and applications. WebRTC proves to be an effective rescue teams, responders, and ground control stations during disaster relief efforts, where timely and efficient communication is essential for organizing rescue operations and providing aid to impacted areas. WebRTC is especially well-suited for disaster relief scenarios because of a number of important capabilities that it provides. Initially, drones that are fitted with

WebRTC-capable cameras and sensors can communicate directly with nearby drones or ground control stations through its peer-to-peer communication capabilities. Reliable communication is ensured even in remote or disaster-affected locations where traditional communication networks may be disrupted, thanks to its decentralized communication architecture, which lowers latency and dependency on centralized infrastructure. Second, WebRTC addresses security issues related to sensitive information transferred during disaster response operations by using strong encryption technologies to protect the confidentiality and integrity of sent data. This guarantees that sensitive data, such position coordinates, live video feeds, and telemetry data, is shielded from manipulation and unwanted access. Furthermore, WebRTC's compatibility with various web browsers and platforms ensures interoperability across different devices and operating systems, allowing rescue teams to seamlessly communicate and share information regardless of their location or equipment. In our research work, we investigate how WebRTC might be included into drone systems used for relief efforts in disaster situations. We look into how rescue teams and other responders working in difficult environments might benefit from WebRTC technology by having better situational awareness, more efficient communication, and better coordination. Through the utilization of WebRTC, our study endeavours to establish a resilient communication framework that permits unmanned aerial vehicles to convey vital information in real time, such as telemetry data and live video feeds, so promoting more effective and efficient disaster relief operations. Real-time peer-to-peer communication over various networks is made possible by core WebRTC components, STUN (Session Traversal Utilities for NAT) and ICE (Interactive Connectivity Establishment).

The public IP addresses and ports of devices hidden behind NAT (Network Address Translation) routers can be found with the aid of STUN servers. In order to create direct peer-to-peer connections using WebRTC, this information is essential.

ICE finds the most effective communication path between peers by avoiding firewalls and NAT devices whenever possible. It does this by using STUN and other approaches such as TURN (Traversal Using Relays around NAT).

In order to facilitate internet connection, routers employ NAT (Network Address Translation) technology to convert a device's private IP address within a local network to a public IP address. In WebRTC, direct peer-to-peer communication requires NAT traversal.

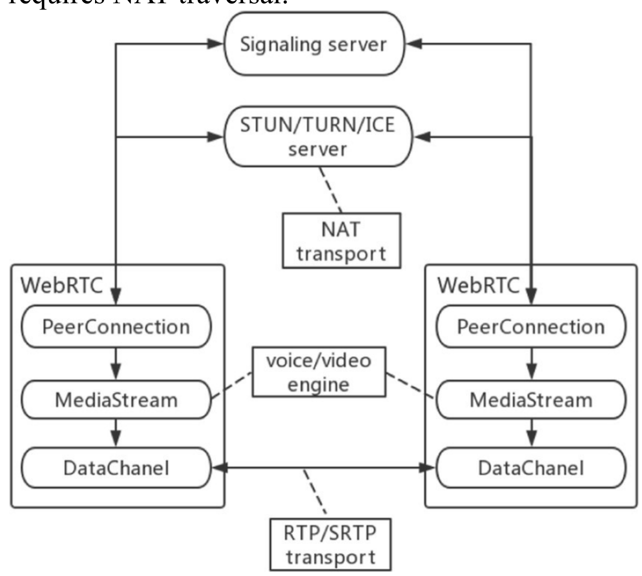

Fig. 1: Drones communicating between each other.

B. ***Overview of Drone Kit and Its Role in Disaster Relief Operations:***

A robust software development kit (SDK) called Drone Kit was created to make it easier to create apps for drones, or unmanned aerial vehicles (UAVs). Drone Kit, created by 3D Robotics, offers a full suite of tools and APIs (Application Programming Interfaces) that let developers work with drones, automate flight procedures, and collect telemetry data for further examination. To improve the functionality and autonomy of drone systems, Drone Kit is a critical enabler in the context of disaster relief operations, as drones are essential for assessing damage, surveying affected areas, and delivering help to inaccessible locales. Because of its userfriendly APIs, drone Kit is an excellent tool for disaster response situations.

Developers may program drones to do a variety of activities autonomously, including aerial surveys, 3D mapping, and supply deliveries. By reducing the need for manual intervention and increasing mission efficiency, this feature enhances rescue operations. Drone Kit also makes real-time telemetry data access possible, allowing ground control stations to get vital data such as GPS positions and battery levels. This functionality is essential in emergency scenarios as it gives operators fast information to make wise decisions. Additionally, the SDK's support for sensor and payload integration enables customization, making it possible to deploy specialized drones with cutting-edge capabilities for improved environmental monitoring, damage assessment, and search and rescue in times of crisis. In this study, we investigate how to improve the autonomy, functionality, and performance of our drone systems for disaster assistance by integrating drone Kit. Our goal is to create unique applications that allow drones to carry out activities like aerial surveillance, infrastructure inspection, and payload distribution in disaster-affected areas on their own by utilizing Drone Kit's tools and APIs. Our research aims to equip rescue teams with cutting-edge drone capabilities through the integration of Drone Kit, enhancing their ability to respond effectively to emergencies and perhaps saving lives.

C. ***Integration of WebRTC and Drone Kit:*** The integration of WebRTC and Drone Kit offers a powerful solution for enhancing communication, control, and collaboration in drone operations, particularly in disaster response scenarios where rapid and effective coordination is paramount. By leveraging the strengths of both technologies, responders can improve their situational awareness, response capabilities, and ultimately, the outcomes of disaster relief efforts.

D. ***Scope of the study:***

The goal of the project is to create an integration framework that will enable ground control stations and drones to communicate and exchange data in real time by merging WebRTC and Drone Kit functionalities. A prototype system that demonstrates this integration in disaster response scenarios will be built through prototyping and testing, with its performance, scalability, and dependability assessed. Performance evaluation will measure things like latency, bandwidth usage, and video quality; usability testing and user feedback will get information from stakeholders. Future study areas and optimization recommendations for the framework will be offered, with the ultimate goal of improving emergency responders' situational awareness and operational effectiveness.

II. *METHODOLOGY FOR INTEGRATING WEBRTC AND DRONE KIT IN DISASTER RESPONSE SCENARIOS:*

A.***Drone Kit Functions:***

Beyond simple takeoff and landing operations, DroneKit's feature set includes essential tasks like yaw control, waypoint navigation, and real-time telemetry retrieval. DroneKit's APIs offer yaw control, which allows the drone to rotate precisely along its vertical axis. This allows for orientation and direction changes while in flight. The ability to perform intricate flight maneuvers, hold desired headings, and maximize aerial imaging or surveying operations all depend on its feature. To further enable drones to follow predetermined flight paths or carry out mission-critical operations with accuracy and efficiency, DroneKit also gives operators the ability to set and explore waypoints autonomously. By giving pilots access to vital flight information such as GPS locations, altitude, battery levels, and sensor readings, real-time telemetry retrieval improves situational awareness even furthur.

Vehicle Control: Drone Kit's APIs make it possible to program drones to perform essential functions like take off, landing, waypoint navigation, and mission planning on their own. In emergency situations where manual assistance may be difficult or unfeasible, these features are crucial for organising.

Telemetry Retrieval: Drone Kit is used to retrieve real-time telemetry data, such as GPS coordinates, altitude, battery levels, and sensor readings. Making decisions and assessing the situation is made easier with the help of this data, which offers vital insights into the condition and functionality of drones during missions.

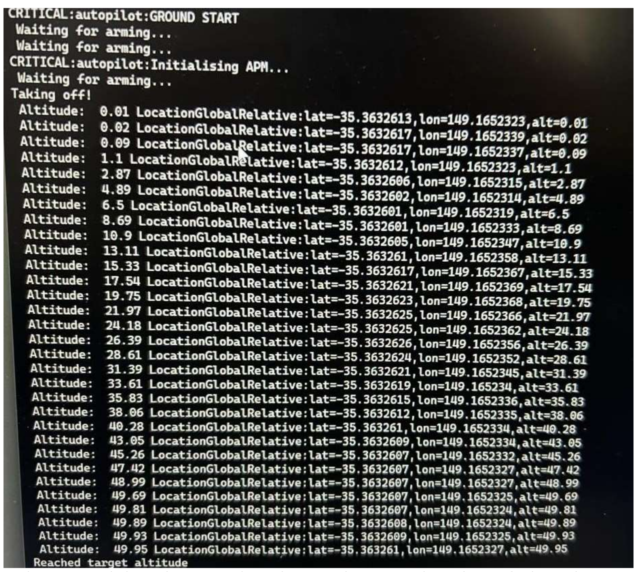

Fig.2: Altitude, Latitude and Longitude of the drone in command prompt.

Mission Planning: Drone Kit makes it easier to create mission scripts that automate drone operations in response to human commands or preset criteria. This capability makes it easier to carry out missions, increases operational effectiveness, and enables flexible reactions to shifting circumstances in disaster-affected areas.

B. ***Use of Raspberry Pi Module:*** The drone's ground control station is a software program that runs on a Raspberry Pi module. To communicate with the drone and enable control commands and telemetry data exchange, this program interfaces with Drone Kit's Python API. The Raspberry Pi application contains the functionality for giving the drone control commands, including yaw, speed, and direction. Furthermore, the drone's telemetry updates are received, processed, and sent back to the pilots in real time.

An essential part of the integrated system, the Raspberry Pi application serves as a central centre for coordinating drone operations, carrying out commands, and tracking mission progress.

C. ***WebRTC Integration for Peer-to-Peer Communication:***

Using WebRTC, smooth peer-to-peer communication is established between the Pixhawk flight controller, the Raspberry Pi ground control station, and a web interface that can be accessed by remote operators. With this connectivity, the drone's onboard camera can feed live footage in real time to the web interface, allowing for remote visualization of the drone's immediate environment. Additionally, WebRTC-established communication channels make it easier to send vital telemetry data from the Pixhawk flight controller to the web interface, such as drone location, altitude, speed, and sensor readings. Because of this bidirectional connectivity, remote operators are guaranteed to have a thorough situational awareness, which empowers them to make decisions and modify mission parameters in real time in response to telemetry data received.

D. ***Web Interface Development:***

For easy communication with the drone and instant access to telemetry data, a user-friendly web-based interface must be developed. For precision drone operation, this interface, which can be accessed from any device with a basic web browser, provides user-friendly controls like speed sliders and directional buttons. The interface uses WebRTC data channels to dynamically update and show realtime telemetry data derived directly from the drone, such as its location, speed, and altitude. It does this by utilizing HTML, CSS, and JavaScript. This allinclusive telemetry data display gives operators a better understanding of the situation, which helps them make wise decisions and maintain exact control over the mission's execution. Furthermore, the web interface's best performance, dependability, and responsiveness are guaranteed by the integration of Flask for drone Kit, React for WebRTC, and Node.js Express for communication.

Fig.3:Web application Interface.

E.Integration of WebRTC with Socket.IO and CORS:

Web Real-Time Communication (WebRTC) is a potent technology that allows web browsers to communicate with each other in real-time without the requirement for further software or plugins. For our research project, we created communication channels between the web-based interface and the ground control station by integrating WebRTC with Socket.IO, a JavaScript library for real-time web applications. Bidirectional connection between the client-side interface and the server is made possible via Socket.IO, which enables instantaneous data transmission. This integration makes the web-based interface more responsive and interactive, allowing remote operators to easily operate the drone and get real-time data updates.

Furthermore, a key component in facilitating crossorigin communication between the web-based interface and the DroneKit server is Cross-Origin Resource Sharing (CORS). Cross-origin limitations will not prevent the ground control station from securely communicating with the DroneKit server thanks to CORS, which enables web browsers to send requests to servers hosted on separate domains. We guarantee that the web-based interface may receive telemetry data and control orders from the DroneKit server by properly implementing CORS regulations. This allows for seamless communication and interaction between the ground control station and the drone.

F.*Communication Setup:*

In order to establish wireless connectivity in the field, the communication setup makes use of outside CPE (Customer Premises Equipment) devices. The Tenda O3 and TP-Link CPE710 are two well-known devices in this configuration.

Tenda O3 Outdoor 2.4GHz CPE: Offers long-range wireless communication by using the 2.4GHz frequency spectrum.

comprises a reset button, PoE input for power, and Ethernet ports for wired network connections. furnished with a directed antenna to concentrate the signal and LED indicators to monitor the status. ideal for expanding network coverage across large stretches of terrain under a variety of meteorologicalcircumstances.usually employed to connect distant buildings or other situations where wired connections are problematic.

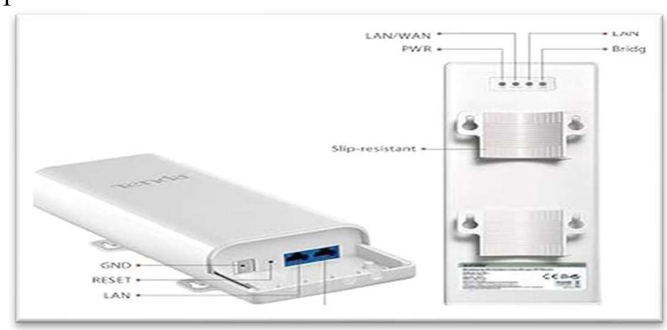

Fig.4:Tenda O3

Outdoor CPE TP-Link CPE710 5GHz AC 867Mbps23dBi:

Supports the 802.11ac wifi standard and the 5GHz frequency range for fast wireless communication. A high-gain directional antenna (23 dBi) is included for increased signal strength and range. ideal for high-bandwidth applications, with a maximum wifi speed of 867Mbps.

provides advanced security features and a variety of operation modes to enable safe and adaptable network configurations.

Employed to link distant places to a central point, either point-to-point or point-to-multipoint. Enabling connectivity in situations where wired connections are impractical or not viable, these outdoor CPE devices are essential in creating dependable wireless links for communication in diverse outside conditions.

III.CONCLUSION:

The outcomes of integrating WebRTC and implementing DroneKit features show how practical and efficient the suggested strategy is for disaster response situations.Drone mission coordination amongst peer-to-peer, telemetry retrieval, and vehicle control functions seamlessly to improve situational awareness, operational effectiveness, and decision-making. The created web-based interface offers a user-friendly platform for remote operators to communicate with the drone and obtain vital real-time telemetry data. All things considered, the combination of WebRTC with DroneKit technology offers a viable way to enhance coordination and communication during emergency response activities.

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