AN AUTONOMOUS STANDBY DRONE EQUIPPED TELECOMMUNICATION TOWER: RESTORING COMMUNICATION DURING DISASTER MANAGEMENT

A PROJECT REPORT

Submitted by

MOHAMED THARIK HUSSAIN S (421121104072)

PRABHAKAR S (421121104085)

PRAKASHRAJ K (421121104089)

MUGIL KUMAR K (421121104074)

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Affiliated to Anna University, Chennai-25

Gangarampalayam, Villupuram – 605 108

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IFET COLLEGE OF ENGENEERING

BONAFIDE CERTIFICATE

Certified that this project report **“An Autonomous Standby Drone Equipped Telecommunication Tower: Restoring Communication During Disaster Management”** is the bonafide work of **“MOHAMED THARIK HUSSAIN S (421121104072), PRABHAKAR S (421121104085), PRAKASHRAJ K (421121104089),MUGIL KUMAR K (421121104074)”** who carried out the project work under my supervision.

SIGNATURE	**SIGNATURE**
Dr.M.MARGARAT	**Dr.U.PALANI**
HEAD OF THE DEPARTMENT	**SUPERVISOR**
PROFESSOR**,**	PROFESSOR**,**
Department of ECE,	Department of ECE,
IFET College of Engineering,	IFET College of Engineering,
Villupuram – 605108	Villupuram – 605108

Submitted to the Viva voce Examination held on ___________________________

INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

This project presents the development of an autonomous standby drone-equipped telecommunication tower, designed to restore communication during disaster management. Natural disasters, such as earthquakes, floods, and hurricanes, often result in the failure of traditional telecommunication infrastructure, which significantly hinders rescue operations and the coordination of emergency services. To address this challenge, an autonomous drone system is proposed, equipped with communication modules capable of acting as temporary telecommunication towers. This project addresses this challenge by developing an innovative solution utilizing drones equipped with vibration sensors. The drone's autonomous capabilities enable it to detect disruption in communication networks and deploy standby drones without human intervention. Additionally, the system can provide a communication link to affected areas until ground infrastructure is restored. The proposed drone-based telecommunication tower system is designed to be rapidly deployable, highly reliable, and cost-effective, offering a practical solution for disaster-stricken regions where traditional communication systems are compromised. Through simulation tests and field trials, the effectiveness of the drone-based communication system will be evaluated, offering a promising approach to enhancing emergency response capabilities and maintaining critical communication during and after seismic events. Future work will explore integration with AI-driven decision-making, real-time navigation, and larger-scale drone deployments for widespread communication restoration.

TABLE OF CONTENTS

CHAPTER NO	CONTENTS	PAGE NO

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviation	Expansion
UAV	Unmanned Aerial Vehicle
IDE	Integrated Development Environment
BLDC	Brushless Direct Current (motor type)
Li-Po	Lithium Polymer
I2C	Inter-Integrated Circuit
ESC	Electronic Speed Controller
LCD	Liquid Crystal Display
AI	Artificial Intelligence

CHAPTER 1

INTRODUCTION

1.1 General

Natural disasters often cause severe damage to telecommunication infrastructure, disrupting communication at a time when it is most critical for rescue and relief operations. In such scenarios, restoring communication quickly is essential to coordinate emergency responses, guide evacuation, and provide information to affected populations.

This project presents the development of an autonomous drone-based telecommunication system that acts as a temporary communication tower during such emergencies. The drone is equipped with vibration sensors to detect disruptions in the communication network and operates without human intervention. When a failure in the communication network is detected, the system autonomously deploys a standby drone to provide temporary connectivity in the affected area.

The drone system is designed to be rapidly deployable, cost-effective, and reliable. It supports wireless communication, allowing affected regions to stay connected until ground-based infrastructure is restored. The system is tested through simulations and field trials to validate its performance. In future developments, integration with artificial intelligence for decision-making and real-time navigation will be explored to enhance large-scale deployment and autonomous operations.

1.2 Domain Overview

Telecommunication Engineering plays a central role in ensuring reliable communication, particularly during emergencies. In the context of this project, it focuses on restoring communication networks that are disrupted due to natural disasters. By enabling temporary communication links through aerial platforms, this domain helps maintain connectivity when ground-based infrastructure is damaged or non-functional.

Embedded Systems are crucial for managing the internal functions of the drone, including sensor processing, flight control, and communication module operation. The embedded controllers interpret data from vibration sensors and other onboard instruments, allowing the drone to autonomously respond to network failures and execute predefined tasks without human input.

Wireless Communication Networks form the backbone of the drone-based communication system. They facilitate data exchange between drones, user devices, and emergency services. This domain ensures that the drones can function as mobile communication nodes, enabling voice and data services in areas where regular network coverage is unavailable due to infrastructure collapse.

Autonomous Systems and Robotics provide the intelligence and mobility required for the drone to act independently. This includes the ability to detect disruptions, plan routes, deploy in affected zones, and maintain stable flight while acting as a communication hub. The integration of robotics allows the drone to operate in hazardous environments without direct human control.

Disaster Management and Emergency Response is the domain where the practical application of this technology comes into play. By enabling quick deployment and temporary communication restoration, the system supports rescue teams, facilitates coordination among emergency services, and helps affected populations stay informed and connected during critical times.

1.3 Objectives

The primary objective of this project is to develop an autonomous drone-based telecommunication system capable of restoring communication services during natural disasters. This system aims to address the challenges posed by the failure of conventional telecommunication infrastructure in emergency situations. The key objectives are as follows:

- To design and develop a drone equipped with telecommunication modules that can act as a temporary communication tower in disaster-affected areas.
- To integrate vibration sensors that detect disruptions in ground-based communication infrastructure, enabling autonomous activation of the drone system.
- To enable autonomous deployment and navigation of standby drones without the need for human intervention, ensuring rapid response during emergencies.
- To establish a wireless communication link that can provide temporary connectivity for affected regions until permanent infrastructure is restored.
- To test and validate the functionality of the system through simulations and field trials under various disaster scenarios.
- To propose a scalable and cost-effective solution that can be deployed across different geographical regions for disaster response and recovery.
- To explore future enhancements involving AI-based decision-making, real-time mapping, and swarm drone technology for broader communication coverage.

CHAPTER 2

LITERATURE SURVEY

2.1 Title: Iot-based Autonomous Search and Rescue Drone for Precision Firefighting and Disaster management.

Journal: IJACSA

Year: 2022

The proposed model integrates IoT devices, sensors, and autonomous navigation technologies to assist in firefighting, search, and rescue missions. The drone is equipped with thermal imaging cameras, environmental sensors, and wireless communication modules, enabling it to locate trapped victims, detect hazardous zones, and relay real-time data to command centers. The system uses IoT- based networking for seamless data transfer and cloud-based storage for incident records. The paper highlights the system's potential to minimize human risk and improve operational efficiency during emergencies. It concludes that integrating drones with IoT and autonomous control systems provides a scalable, reliable, and cost-effective solution for modern disaster management challenges.

2.2 Title: Development of Drone for Search and Rescue Operation in Malaysia Flood Disaster.

Journal: IE&T

Year: 2021

Focuses on designing and implementing a drone-based system to support search and rescue missions during Malaysia's recurring flood disasters. The study addresses the limitations faced by conventional rescue teams, such as restricted access to submerged or isolated areas. The proposed drone system is equipped with high- resolution cameras, GPS modules, and wireless communication units to perform aerial surveillance, victim identification, and real-time location reporting. The drone is capable of autonomous flight paths and manual control, enhancing its flexibility in diverse flood scenarios. Results from field tests demonstrated that the drone could significantly improve response speed and operational coverage while minimizing risks to human rescuers. The study concludes by recommending the integration of drone technology into Malaysia's national disaster management framework for safer, faster, and more effective emergency response.

2.3 Title: Drone Applications for Supporting Disaster Management

Journal: WJE&T

Year: 2022

Explores the diverse roles of drone technology in enhancing disaster management operations. The study reviews various case studies and technological advancements where drones have been effectively deployed in natural disasters such as earthquakes, floods, wildfires, and hurricanes. Key applications discussed include aerial damage assessment, search and rescue, supply delivery, and temporary communication restoration. The paper highlights how drones equipped with cameras, sensors, and communication modules can access remote or hazardous areas, providing critical real-time data to emergency response teams. It also addresses the benefits of using autonomous drones for reducing human risk and improving response speed. The authors conclude that integrating drones into disaster response systems offers a cost-effective, scalable, and reliable solution, making them an essential tool for modern disaster preparedness, mitigation, and recovery strategies.

2.4 Title: Autonomous Aerial Surveillance Drone

Journal: IJCRT

Year: 2024

Focuses on the design and implementation of an intelligent, unmanned aerial vehicle (UAV) for autonomous surveillance applications. The study highlights the growing need for real-time aerial monitoring in scenarios such as disaster management, border security, and environmental observation. The proposed drone is equipped with GPS modules, HD cameras, and obstacle detection sensors, allowing it to navigate autonomously along predefined paths while capturing and transmitting live visual data to control centers. The paper emphasizes the system's ability to function independently, reducing the need for continuous manual operation and minimizing human risk in hazardous environments. Test results demonstrated reliable autonomous operation, accurate data acquisition, and real-time communication. The study concludes that such drones can significantly enhance situational awareness, operational efficiency, and safety in various emergency and surveillance scenarios.

CHAPTER 3

3.1 Existing System And Its Disadvantages

Current disaster communication systems heavily rely on traditional telecommunication infrastructure, such as cell towers, fiber-optic cables, and satellite links, to maintain connectivity. While these systems are reliable under normal conditions, they are highly vulnerable during natural disasters like earthquakes, floods, hurricanes, and other catastrophic events. The destruction or inaccessibility of ground-based communication infrastructure often leads to a complete communication blackout, hindering emergency responses and delaying rescue efforts.

In the aftermath of a disaster, the restoration of communication networks typically takes days or even weeks, which is critical during the first few hours or days following an emergency. Existing solutions for temporary communication restoration, such as mobile communication vehicles or temporary towers, are often limited in range, expensive, and require significant human intervention to set up. These methods are not designed to operate in environments where infrastructure is severely damaged or when rapid deployment is required.

The primary disadvantages of existing systems include:

- **Vulnerability to physical damage**: Traditional telecommunication infrastructure is highly susceptible to damage from natural disasters. Cell towers, power lines, and underground cables can be destroyed, leaving large areas without communication.
- **Slow recovery times**: The time required to restore conventional infrastructure often delays disaster response efforts. Emergency teams may not be able to communicate effectively with one another, impeding coordination.

- **Limited mobility and coverage**: Mobile communication units and temporary towers can provide short-term solutions but are limited by their mobility and coverage area. They may not be able to reach all affected zones, especially in remote or hard-to-reach areas.
- **High cost and resource dependency**: Setting up mobile towers or using vehicles for communication restoration involves significant financial and human resources, which are often in short supply during a disaster. Additionally, these solutions are not easily scalable for large-scale disaster recovery.
- **Human intervention requirements**: Most existing solutions require manual setup and management, which can be time-consuming and inefficient, especially during large-scale disaster events when every minute counts.

CHAPTER 4

4.1 Proposed System

The proposed system aims to address the limitations of existing telecommunication infrastructure during natural disasters by utilizing autonomous drones equipped with communication modules to serve as temporary telecommunication towers. These drones are designed to be rapidly deployable, self-sufficient, and capable of restoring communication networks in areas where ground-based infrastructure has been compromised. The system focuses on autonomous operations, minimal human intervention, and rapid communication restoration to enhance disaster response capabilities.

4.2 Advantages of the Proposed System

- **Rapid Response:** The autonomous drone system can be deployed immediately after a disaster, providing instant communication capabilities in affected areas, reducing recovery time, and enabling faster response from emergency services.
- **Scalable and Cost-Effective:** Unlike traditional mobile towers or communication vehicles, the drone-based system can be scaled up by deploying multiple drones simultaneously, offering flexible solutions depending on the extent of the damage. Additionally, drones are a cost-effective alternative to traditional communication infrastructure.
- **Minimal Human Intervention:** Once activated, the drones can autonomously handle deployment, navigation, and communication management, minimizing the need for human involvement and allowing emergency teams to focus on critical tasks.
- **Coverage in Remote and Hazardous Areas:** Drones can reach areas where conventional infrastructure is not easily accessible, such as mountainous regions, flood zones, or areas with destroyed roads. Their ability to navigate complex terrains enhances their versatility.

- **Integration with Existing Emergency Systems:** The drone-based communication system can integrate with existing disaster management tools, providing real-time data and communication support to emergency response teams.

4.3 Proposed Model

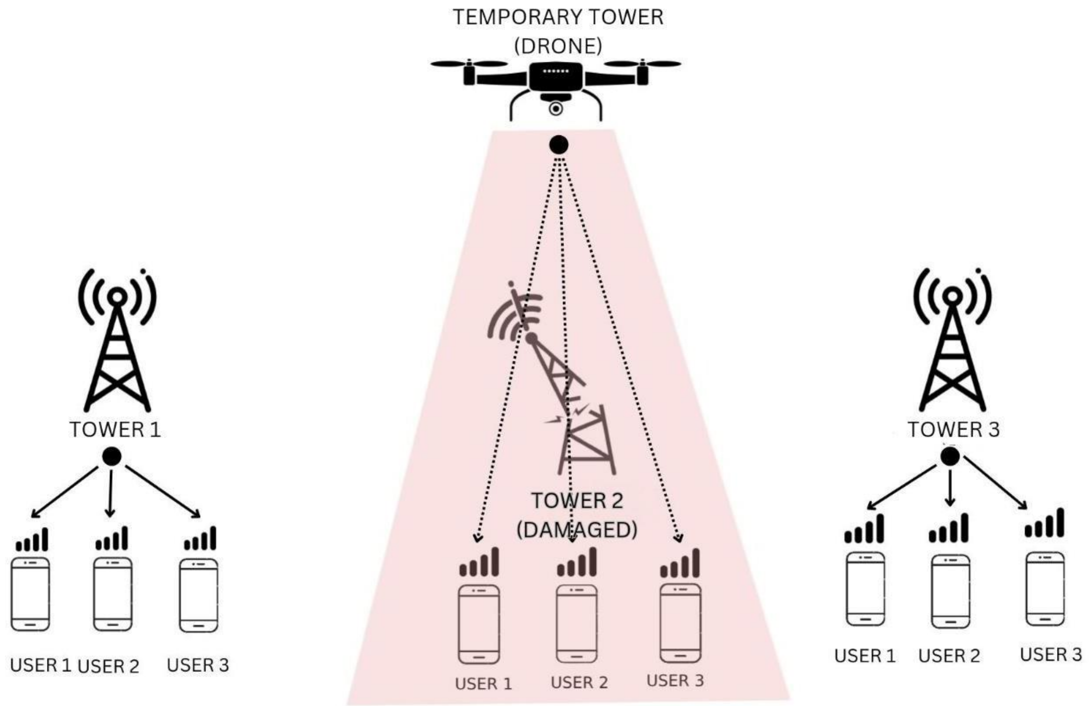

Fig.4.3. Proposed Model

4.4 System Modules

The proposed autonomous drone-based telecommunication system is structured into several functional modules, each responsible for a specific aspect of the system's operation. These modules work together to ensure efficient communication restoration, autonomous deployment, and reliable surveillance during disaster scenarios.

1. Sensing and Detection Module

This module is responsible for monitoring the environment and detecting disruptions in existing communication infrastructure. It uses vibration sensors and other onboard environmental sensors to detect abnormal ground movement, structural failure, or the sudden loss of network signals. When such a disruption is detected, it triggers the deployment of the drone system.

2. Autonomous Navigation Module

The navigation module governs the drone's ability to fly independently without human control. It utilizes GPS, IMU (Inertial Measurement Unit), and obstacle avoidance sensors to plan and execute safe flight paths. This module ensures that the drone can reach affected areas quickly and adjust its path in real time based on terrain and obstacles.

3. Communication Module

This core module enables the drone to function as a temporary telecommunication tower. It includes wireless communication technologies such as LTE, Wi-Fi, or mesh networking. The module establishes a network connection that allows communication between users in the disaster zone and emergency response teams. It also ensures seamless data transfer and voice communication.

4. Control and Processing Module

This module handles decision-making and coordination among the drone’s subsystems. It is built on an embedded controller (e.g., Raspberry Pi or Arduino) that processes sensor data, controls flight behavior, and manages communication links. It integrates data from the detection and navigation modules to perform autonomous operations effectively.

5. Power Management Module

The power module ensures that the drone's components operate efficiently during missions. It includes battery monitoring, solar power integration (if applicable), and energy optimization algorithms. This module aims to maximize flight duration and reliability during long-term deployment.

6. Ground Station Interface Module

This module allows operators to monitor and, if necessary, manually control the drones from a ground station. It provides a user interface for mission planning, status monitoring, and emergency override. While the system is primarily autonomous, the ground interface ensures human oversight in critical situations.

7. Data Logging and Analysis Module

All sensor data, communication logs, and mission records are collected and stored by this module. It is used for post-deployment analysis, system evaluation, and improving the drone's performance in future missions. The data also helps in generating reports and validating system reliability during field trials.

4.5 System Architecture

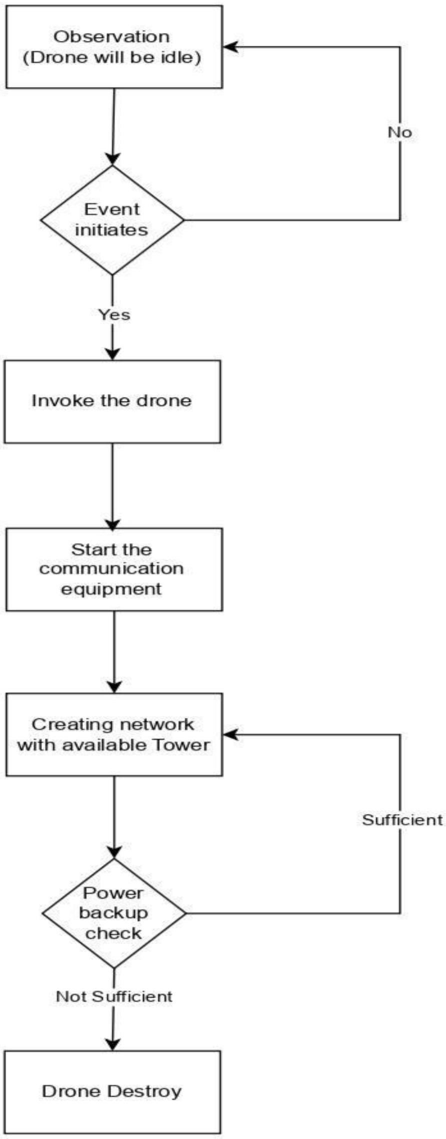

Fig 4.5 Block Diagram

The system architecture of the autonomous standby drone-based telecommunication tower is designed for intelligent, event-driven operation with minimal human intervention. In its idle state, the drone remains in continuous observation mode, monitoring for any abnormal events such as disruptions in existing communication networks or vibrations caused by natural disasters. If no disturbance is detected, the drone stays inactive. However, once an event is identified—such as a seismic activity or infrastructure failure—the system triggers the activation sequence.

Upon detecting a valid disruption, the drone is automatically invoked and transitions from its standby mode to active deployment. It powers on its modules and initiates its communication equipment. The drone then attempts to establish a network by connecting with any available or partially functioning telecommunication towers in the vicinity. If a connection is successfully formed and deemed sufficient, the drone proceeds to create or enhance the communication network in the affected area, thereby ensuring connectivity for emergency responders and victims.

4.5 System Requirements

Base station Components:

- 16x2 LCD screen
- Vibration sensor
- Hc12
- Nanao
- Pin wire

Drone Components:

- Arduino UNO
- 1000 kv brush less dc motor 4
- Hc 12
- Mpu 6050

- Esc 30 amps
- Battery 2200
- Quadcopter frame
- Propellers
- Wires

Software Requirements:

- Arduino IDE

4.5.1 Drone Frame:

Fig 4.5.1 Drone Frame

The drone frame is the structural foundation that holds all essential components, including the motors, propellers, sensors, battery, and control units. It plays a crucial role in maintaining balance, distributing weight evenly, and absorbing vibrations during flight. A well-designed frame ensures stability and durability, especially during extended missions or under harsh environmental conditions such as wind, rain, or debris in disaster zones. Typically, materials like carbon fiber, fiberglass, or lightweight aluminum are used due to their excellent strength-to-weight ratio. Carbon fiber is particularly favored for its rigidity, low weight, and resistance to corrosion and impact, making it ideal for drones used in emergency response and telecommunication restoration.

4.5.2 Vibration Sensors:

Fig 4.5.2 Vibration Sensors

Vibration sensors play a critical role in detecting structural instability and seismic activity, especially in systems designed for disaster response. In the context of autonomous drones for communication restoration, these sensors are used to monitor physical vibrations or shocks in the environment that may indicate infrastructure damage, such as the collapse of communication towers.

4.5.3 Hi screen LCD

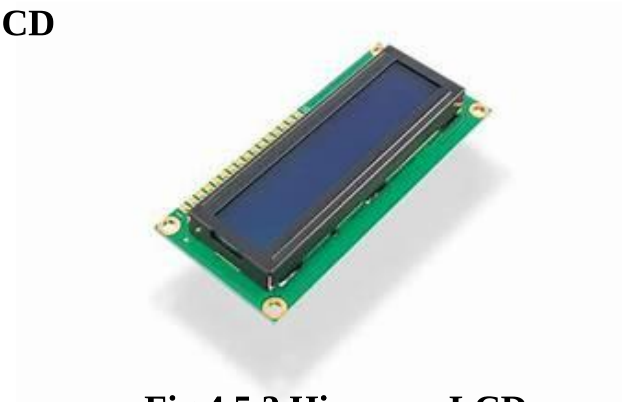

Fig 4.5.3 Hi screen LCD

A Hi-Screen LCD (Liquid Crystal Display) is a compact, high-resolution display module commonly used in embedded systems and drone interfaces for real-time monitoring and data visualization. In autonomous drone applications, it serves as a local display unit that can show essential information such as battery status, GPS coordinates, sensor readings, network status, and flight mode. These screens are especially useful during ground setup or manual intervention, allowing operators to quickly assess the drone’s readiness or troubleshoot issues without needing a computer interface.

4.5.4 Hc12 receiver

Fig 4.5.4 Hc12 receiver

The HC-12 is a versatile wireless communication module commonly used for long-range data transmission in embedded systems. It operates in the 433 MHz frequency band and can achieve communication distances of up to 1 km in open space, depending on the antenna and power settings. The module supports both point-to-point and point-to-multipoint communication, making it suitable for applications such as sensor networks, remote control systems, and data logging. It features a simple serial communication interface (UART), allowing easy integration with microcontrollers like Arduino and Raspberry Pi.

4.5.5 Arduino Nano

Fig 4.5.5 Arduino Nano

The Arduino Nano is a small, compact microcontroller board based on the ATmega328P chip, making it ideal for projects where space is limited. It is part of the Arduino family, which is known for its simplicity and ease of use. The Nano features 14 digital input/output pins, 8 analog inputs, and a USB connection for easy programming. Its small size allows it to be easily integrated into various electronics projects, such as robotics, home automation, and sensor-based systems.

4.5.6 Arduino UNO

Fig 4.5.6 Arduino UNO

The Arduino UNO is a popular and easy-to-use microcontroller board based on the ATmega328P chip. It is widely used by beginners and hobbyists for electronics and programming projects. The board features 14 digital input/output pins, 6 analog inputs, a USB connection for programming, a power jack, and a reset button. It can be powered through USB or an external power source. With the Arduino IDE software, users can write and upload code to control LEDs, sensors, motors, and other electronic components, making it ideal for learning embedded systems and prototyping.

4.5.7 1000 kb Brushless dc motor

Fig 4.5.7 1000 kb Brushless dc motor

A 1000 kV brushless DC (BLDC) motor is a type of electric motor that spins at 1000 RPM (revolutions per minute) per volt applied without load. These motors are known for their high efficiency, durability, and low maintenance since they do not have brushes that wear out. When using four 1000 kV BLDC motors, they are commonly configured in applications like quadcopters or other multi-rotor drones, where each motor contributes to lift, stability, and maneuverability.

4.5.8 Mpu 6050

Fig 4.5.8 Mpu 6050

The MPU-6050 is a motion sensor module that combines a 3-axis gyroscope and a 3-axis accelerometer on a single chip. It can detect rotation and movement in all directions, making it useful for stabilizing drones, robots, and other electronic projects. It communicates with microcontrollers like Arduino through the I2C interface.

4.5.9 ESC 30 Amps

Fig 4.5.9 ESC 30 Amps

A 30-amp Electronic Speed Controller (ESC) is a device used to control the speed and direction of a brushless DC motor. It takes signals from a flight controller or microcontroller and adjusts the motor's power accordingly. A 30A ESC can handle motors that draw up to 30 amps of current, suitable for medium-sized drones and RC vehicles.

4.5.10 2200 mAh Battery:

Fig 4.5.10 2200 mAh Battery

A 2200 mAh battery, usually a Li-Po (Lithium Polymer) type, is a rechargeable power source commonly used in drones and RC electronics. The “2200 mAh” rating means it can supply 2200 milliamps for one hour. It provides reliable power for motors, sensors, and controllers, offering a balance between capacity and weight.

4.5.11 Drone propeller

Fig 4.5.11 Drone propeller

A drone propeller is a rotating blade that generates lift and thrust to make the drone fly. It works by spinning rapidly and pushing air downward, which creates an upward force that lifts the drone. Drones usually have multiple propellers (like 4 in quadcopters), with some spinning clockwise and others counterclockwise to keep the drone stable and allow it to move in different directions.

CHAPTER 5

5.1 Implementation

The implementation of the autonomous drone-based telecommunication tower system involves the integration of various hardware and software components to function as a cohesive, self-operating unit.

The process begins with assembling the drone platform, including the frame, propulsion system, vibration sensors, communication units and a power management system. Once the hardware is integrated, the embedded system—typically built using a microcontroller or single-board computer like an Arduino is programmed to manage sensor inputs, flight control, and communication logic.

Vibration sensors are calibrated to detect seismic activity or structural failures, which serve as triggers for drone deployment. When triggered, the drone autonomously takes off using pre-programmed navigation routines.The onboard communication module is then activated to establish a temporary wireless network, allowing people in the disaster area to connect and communicate.

A Hi-Screen LCD display may be used on the ground station or drone for real-time system feedback, such as flight status, signal strength, or error alerts. The entire system is tested in simulated environments and controlled field trials to ensure reliable performance under emergency conditions. The integration of all modules ensures a robust, autonomous response system capable of rapidly restoring communication infrastructure during disasters.

CHAPTER 6

6.1 Methodology

1. Component Selection and System Design

The first step involves identifying and selecting appropriate components required for the drone-based telecommunication system. This includes choosing a durable and lightweight drone frame, efficient propulsion system, vibration sensors for disruption detection, GPS for navigation, and wireless communication modules for signal transmission. Careful consideration is given to component compatibility, power efficiency, and integration ease. The system layout is then designed to ensure proper placement and connectivity of each module, optimizing the drone's balance and functionality.

2. Sensor Calibration and Data Acquisition

Once the sensors are installed, they must be calibrated to detect real-world environmental triggers such as ground vibrations or tower failures. This process involves tuning sensitivity levels to avoid false triggers while ensuring accurate detection of disaster events. The vibration sensors continuously collect and transmit data to the embedded controller, which monitors these signals in real-time to determine whether deployment conditions are met.

3. Embedded System Programming and Integration

The embedded system, typically powered by a microcontroller or single-board computer, is programmed to process sensor inputs and control the drone's response. This includes writing logic to interpret vibration data, trigger autonomous takeoff, initiate GPS-based navigation, and manage power distribution. All components—including sensors, communication modules, and motor controllers—are integrated into a cohesive unit through hardware interfaces and control scripts.

4. Autonomous Deployment and Navigation

Upon detecting a qualified disruption event, the drone is autonomously deployed. It lifts off and navigates to the disaster-affected area using GPS coordinates and pre-programmed waypoints. Obstacle avoidance mechanisms, such as ultrasonic or infrared sensors, help ensure safe travel even in complex environments. Once in position, the drone hovers or lands at a suitable elevation to optimize communication coverage.

5. Communication Activation and Network Establishment

After reaching the designated location, the drone activates its communication modules to create a temporary wireless network acting as a mobile telecom tower. This network allows affected users or emergency responders to reconnect and transmit data. The system remains active as long as sufficient battery power is available. Real-time performance is monitored and logged for further analysis, allowing future refinements.

CHAPTER 7

TESTING AND RESULT

7.1 Flight Test

To validate the operational readiness and stability of the drone for emergency communication deployment, comprehensive flight tests were conducted in controlled outdoor environments. The primary objective was to assess the drone’s ability to autonomously respond to vibration-triggered commands, maintain stable flight, and effectively establish a wireless communication link with the base station.The test procedure began with the base station simulating a seismic event using controlled vibrations. Once the vibration sensor detected activity exceeding the preset threshold, the Arduino Nano processed the signal and transmitted a deployment command via the HC-12 wireless module.

The drone’s HC-12 module, linked to its Arduino UNO, received this command and initiated the flight sequence.Upon receiving the signal, the Electronic Speed Controllers (ESCs) powered the 1000 KV Brushless DC motors, and the propellers achieved adequate thrust for liftoff. The onboard MPU-6050 sensor managed the drone’s orientation and balance, continuously adjusting motor speeds to maintain stability.

The drone consistently achieved stable vertical takeoff, hovered at a controlled altitude, and demonstrated reliable communication feedback to the base station. The drone maintained continuous wireless data exchange over distances up to 800 meters in open areas, confirming the system’s effective range and stability.
Battery performance was monitored during each test, with a single 2200mAh Li-Po battery providing an average flight time of 8-10 minutes per charge, ensuring sufficient duration for emergency deployment tasks.

Fig 7.1.1 Flight test

7.2 Communication Range Test

The communication range test was conducted to evaluate the performance and reliability of the wireless link between the base station and the drone unit using HC-12 wireless modules. The objective was to measure the maximum effective distance for stable data transmission in practical conditions, which is crucial for ensuring uninterrupted control and feedback during emergency drone operations.

The base station was programmed to continuously transmit a trigger command signal, while the drone's HC-12 module, interfaced with the Arduino UNO, actively listened for incoming data. The test began at a distance of 1 meter and increased gradually in 1-meter increments. At each distance, the system was evaluated for signal strength, data accuracy, and response time.

Results showed that clear and reliable two-way communication was maintained up to 10 meters. Beyond this range, noticeable signal loss, increased latency, and incomplete data transmissions were recorded.In urban conditions with walls and obstructions, the communication range further reduced to 6–8 meters.

These results highlight the importance of optimizing antenna configurations, positioning, and possibly integrating signal repeaters or higher-powered modules in future enhancements to extend the communication range for broader emergency applications.

Fig 7.2.1 Communication Range Test

7.3 Result Analysis

The experimental testing and performance evaluation of the Autonomous Standby Drone Equipped Telecommunication Tower provided valuable insights into the effectiveness, reliability, and limitations of the system in simulated disaster scenarios. A series of targeted tests were conducted to assess individual components and the fully integrated system.The vibration sensor connected to the Arduino Nano consistently detected seismic activity when the vibrations exceeded a preset threshold. The response time from detection to transmitting a deployment command via the HC-12 wireless module was recorded at an average of 3 seconds, making the system highly responsive for emergency applications.

The 16x2 LCD display successfully displayed alert messages, enhancing situational awareness at the base station.The communication range test was conducted to determine the maximum reliable distance between the base station and the drone’s onboard wireless module. In open conditions, the system maintained stable two-way communication up to 10 meters, while in obstructed environments like rooms or areas with light structures, the range reduced to 6–8 meters.

However, beyond this range, noticeable signal degradation and occasional data loss were observed. Upon receiving the deployment command, the drone's ESCs powered the 1000KV Brushless DC motors, enabling steady lift-off. The MPU-6050 sensor effectively managed balance and orientation, maintaining stable flight and hover. Across multiple trials, the drone achieved an average flight time of 8–10 minutes on a fully charged 2200mAh Li-Po battery, which is sufficient for short-distance, rapid-response operations.

In conclusion, the system effectively achieved its intended functionality by detecting seismic activity, deploying the drone autonomously, and establishing temporary communication links within a limited range. The results affirm the project’s viability as a rapid-response communication system during disasters, while highlighting areas for future enhancements such as extended range, improved battery capacity, and real-time video surveillance integration.

CHAPTER 8
CONCLUSION AND FUTURE SCOPE

8.1 Conclusion

The project titled "An Autonomous Standby Drone Equipped Telecommunication Tower: Restoring Communication During Disaster Management" successfully demonstrates an innovative and practical solution for addressing communication failures in disaster-affected areas. The integration of vibration sensors, autonomous drone technology, and wireless communication modules resulted in a functional system capable of detecting seismic activities and swiftly deploying a drone to establish temporary communication links.

During the testing phase, the vibration detection system proved highly responsive, accurately identifying simulated tremors and triggering the drone deployment process within an average of 3 seconds. The drone, designed with MPU-6050 sensors, ESCs, and 1000KV Brushless DC motors, achieved stable vertical flight, hover, and descent, with a consistent flight duration of 8–10 minutes on a 2200mAh Li-Po battery. The HC-12 wireless communication modules maintained reliable two-way communication up to a distance of 10 meters in open areas, ensuring efficient command transmission and status reporting.

Although limited in communication range and operational time, the system effectively validated the concept of using drones as temporary communication hubs during disasters when conventional infrastructure is compromised. This project highlights the crucial role of unmanned aerial systems in modern disaster management strategies, offering rapid deployment and localized coverage where ground-based networks are damaged or inaccessible.

Overall, the project stands as a promising, adaptable, and scalable solution for emergency communication restoration, supporting first responders, authorities, and affected populations during critical situations when immediate connectivity is essential for saving lives and coordinating relief operations.

8.2 Future Scope

- **Addition of Live Video Transmission System:**

Equip the drone with an HD or thermal imaging camera and a live video feed module for real-time aerial surveillance of disaster-hit zones.

- **Integration of AI-Based Navigation and Obstacle Avoidance:**

Incorporate AI algorithms for autonomous decision-making, intelligent path planning, obstacle detection, and dynamic rerouting during emergency missions.

- **Integrating Solar Panels:**

Integrating solar panels enhances sustainability by providing continuous power and extending flight time during disaster management. It reduces reliance on traditional power sources, ensuring self-sufficiency in remote areas.

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APPENDIX – I

BASE

```
// 3 = motor 1 (right front CCW).
// 5 = motor 2 (right rear CW).
// 6 = motor 3 (left rear CCW).
// 9 = motor 4 (left front CW).

#include <SoftwareSerial.h>
#include <Servo.h>
#include <Wire.h>

SoftwareSerial HC12(10, 11); // HC-12 TX Pin, HC-12 RX Pin

Servo motor1, motor2, motor3, motor4;
const char *myDroneID = "A"; // Unique ID for this receiver
bool isFlying = false;
unsigned long lastSendTime = 0;

// MPU6050 Address
#define MPU 0x68
float accX, accY, accZ;
float gyroX, gyroY;
float accAngleX, accAngleY, angleX, angleY;
float biasX = 0, biasY = 0;

void setup()
{
   Serial.begin(9600);
   HC12.begin(9600);
 motor1.attach(3);
   motor2.attach(5);
   motor3.attach(6);
   motor4.attach(9);

   Serial.println("Drone Ready!");


   // MPU6050 Initialization
   Wire.beginTransmission(MPU);
   Wire.write(0x6B);
   Wire.write(0);
   Wire.endTransmission();
```

```
  // *Step 1: Calculate Bias Offset (Drone at Rest)*
  Serial.println("Calibrating MPU6050... Keep the drone still.");
  for (int i = 0; i < 100; i++)
  {
    readMPU6050(); // Read MPU values multiple times
    biasX += accAngleX;
    biasY += accAngleY;
    delay(10);
  }
  biasX /= 100; // Average bias value
  biasY /= 100;
  Serial.print("BiasX: ");
  Serial.print(biasX);
  Serial.print(" | BiasY: ");
  Serial.println(biasY);
}
// Stop motors
void stopMotors()
{
  int throttle;
  // Gradually decrease throttle (simulate landing)
  for (throttle = 1500; throttle >= 1000; throttle -= 50)
  {
    motor1.writeMicroseconds(throttle);
    motor2.writeMicroseconds(throttle);
    motor3.writeMicroseconds(throttle);
    motor4.writeMicroseconds(throttle);
    HC12.print("motor stoping..");
    HC12.println("");

    Serial.print("Throttle: ");
    Serial.println(throttle);
    delay(500);
  }

  Serial.println("Motors Stopped");
}

void startMotors()
{
  int throttle;
```

```
  // Gradually increase throttle for all motors
  for (throttle = 1000; throttle <= 1500; throttle += 100)
  {
 motor1.writeMicroseconds(throttle);
    motor2.writeMicroseconds(throttle);
    motor3.writeMicroseconds(throttle);
    motor4.writeMicroseconds(throttle);
    HC12.print("motor starting..");
    HC12.println("");

    Serial.print("Throttle: ");
    Serial.println(throttle);
    delay(500);
  }
}

void loop()
{

  readMPU6050(); // Read sensor data
  // sendSensorData();
  if (HC12.available())
  {
    String receivedMessage = HC12.readStringUntil('\n'); // Read full message
    Serial.print("Received: ");
    Serial.println(receivedMessage);

    if (receivedMessage.startsWith(myDroneID))
    {                                       // Check if message is for this drone
      char command = receivedMessage.charAt(1); // Get the command (1 or
2)

      if (command == '1' && !isFlying)
 {
        isFlying = true;
        Serial.println("Taking Off...");

        startMotors();

        HC12.print(myDroneID);
        HC12.print("Hi,X:");
        HC12.print(angleX);
        HC12.print(",Y:");
```

```
            HC12.println(angleY);
        }
        else if (command == '2' && isFlying)
        {
            isFlying = false;
            Serial.println("Landing...");
            stopMotors();
            Serial.println(String(myDroneID) + "BYE");
            HC12.print(myDroneID);
            HC12.println("BYE");
        }
    }
  }

  // Send MPU data every 1 second while flying
  if (isFlying && millis() - lastSendTime >= 1000)
  {
    sendSensorData();
    lastSendTime = millis();
  }
}
// Function to send MPU6050 data over HC-12
void sendSensorData()
{
  Serial.print("X: ");
  Serial.print(angleX);
  Serial.print(" | Y: ");
  Serial.println(angleY);

  HC12.print(myDroneID);
  HC12.print("Hi,X:");
  HC12.print(angleX);
  HC12.print(",Y:");
  HC12.println(angleY);
}

// Function to read MPU6050 data
void readMPU6050()
{
  Wire.beginTransmission(MPU);
  Wire.write(0x3B);
  Wire.endTransmission(false);
  Wire.requestFrom(MPU, 6, true);
```

```
  accX = Wire.read() << 8 | Wire.read();
  accY = Wire.read() << 8 | Wire.read();
  accZ = Wire.read() << 8 | Wire.read();

  accAngleX = atan2(accY, accZ) * 180 / PI;
  accAngleY = atan2(accX, accZ) * 180 / PI;
  // *Step 2: Apply Bias Correction*
  angleX = (accAngleX - biasX);
  angleY = (accAngleY - biasY);
}
```

DRONE

```
#include <SoftwareSerial.h>
#include <LiquidCrystal_I2C.h>

#define vibrationSensor 4

SoftwareSerial HC12(10, 11); // HC-12 TX Pin, HC-12 RX Pin
LiquidCrystal_I2C lcd(0x27, 16, 2);

int lastState = LOW;
const char *droneID = "A";
bool isFlying = false;
unsigned long lastSensorCheck = 0;

void setup()
{
  Serial.begin(9600);
  HC12.begin(9600);
  pinMode(vibrationSensor, INPUT);

  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print(" Drone System");
  delay(2000);
}
void displayFlightData(float pitch, float roll)
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Pitch: ");
  lcd.print(pitch, 2);
```

```
  lcd.setCursor(0, 1);
  lcd.print("Roll: ");
  lcd.print(roll, 2);
  delay(2000);
}

void extractMPUData(String receivedData)
{
  int xIndex = receivedData.indexOf("X:");
  int yIndex = receivedData.indexOf("Y:");

  if (xIndex != -1 && yIndex != -1)
  {
    float pitch = receivedData.substring(xIndex + 2, yIndex - 1).toFloat();
    float roll = receivedData.substring(yIndex + 2).toFloat();

    Serial.print("Pitch: ");
    Serial.print(pitch);
    Serial.print(" | Roll: ");
    Serial.println(roll);
    displayFlightData(pitch, roll);
    }
}

void receiveMPUData()
{
  if (HC12.available())
  {
    String receivedData = HC12.readStringUntil('\n');
    lcd.clear();
    lcd.print(receivedData);

    if (receivedData.startsWith(droneID))
    {
      if (receivedData.indexOf("Hi") != -1)
      {
        if (!isFlying)
        {
          lcd.clear();
          lcd.setCursor(0, 0);
          lcd.print("Hi, Drone");
          delay(500);
```

```
            }
            isFlying = true;
            extractMPUData(receivedData);
        }
        else if (receivedData.indexOf("BYE") != -1)
        {
             isFlying = false;
            lcd.clear();
            lcd.setCursor(0, 0);
            lcd.print("BYE");
            lcd.setCursor(0, 1);
            lcd.print("Landed");
            delay(1000);
            lcd.clear();
            lcd.setCursor(0, 0);
            lcd.print(" Drone System ");

        }
      }
    }
}

void SendDataToDrone(int currentState)
{
    if (currentState == HIGH && lastState == LOW)
    {
        HC12.print(droneID);
        HC12.println("1");
        Serial.println("Sent: 1 (Takeoff)");
        lcd.setCursor(0, 1);
        lcd.print("sent Takeoff");
        delay(1000);
    }
  else if (currentState == LOW && lastState == HIGH)
    {
        HC12.print(droneID);
        HC12.println("2");
        Serial.println("Sent: 2 (Land)");
        lcd.setCursor(0, 1);
        lcd.print("sent stop    ");
        delay(1000);
    }else if (currentState == HIGH)
    {
```

```
    lcd.setCursor(0, 1);
    lcd.print("Holding Altitude");
  }

  // Show sensor status only if drone is flying
  if (isFlying)
  {
    lcd.setCursor(0, 1);
    lcd.print("No Issue       ");
  }

  lastState = currentState;
}
void loop()
{
  receiveMPUData();

  if (millis() - lastSensorCheck >= 5000)
  {
    lastSensorCheck = millis();
    int currentState = digitalRead(vibrationSensor);
    lcd.setCursor(0,1);
    lcd.print("Checking....    ");
    SendDataToDrone(currentState);
  }
}
```

APPENDIX – II

Date: 27 Mar, 2025

Dear **Mohamed Tharik Hussain**,

Apropos to your application for interning as "Web Development Front-End - Mentorship Intern" and subsequent to our discussions we are pleased to offer you Project based Internship as **"Web Development Front-End - Mentorship Intern"** This is subject to no adverse findings arising from any of the intern background verification which is required to be carried out by the Organization. The date of your joining Raise Digital is 01 May, 2025 with the following terms of engagement as outlined below. The duration of internship will be 60 days.

Internship Hours/Duration — The working hours of the firm are 4:30PM-8.30PM. We do not follow flexi hours, so it is mandatory to complete the working hours at the home. You may be required to work on the weekends and the week offs will be provided during the weekday as agreed between the Intern and the Manager.

Location — Your place of internship will be Work from Home.

Work — You will perform all duties and obligations and comply with such orders as may be designated by the Company management which are reasonably consistent with your position as an intern.

Working in Shifts — You may be required to intern in shifts. This shall be informed to you by your manager/supervisor well in advance.

Code of Conduct — Your internship is governed by the Code of Conduct. A copy is attached. You are required to read, understand and follow it in letter and spirit.

Confidentiality — In the ordinary course of your internship you will be exposed to information about the business of the Company, its clients and customers, which is confidential or is commercially sensitive and which may not be readily available to competitors or the general public, and which if disclosed would be harmful for our reputation. All information is shared on a need-to-know basis. You shall not discuss or transmit by any means any confidential information outside the office environment or with other employees/ interns who are not otherwise authorized to know.

Intellectual Property — You agree that during your internship the 'work of art', any patent application, design, copyright or other intellectual property shall be owned by the Company, except articles written with personal opinion with prior approval from management. You agree that you will promptly inform the Company about any Intellectual Property you make or are involved in making.

Email
care@1Stop.ai

Address : 47/B, 26th Cross, Sector 3, HSR Layout, Bengaluru, Karnataka 560102

Data Protection — Ensuring the protection of our data is a requirement of the job. You shall ensure that —

- You do not disclose any personal data without prior writen approval
- You do not access information that you are not otherwise authorized to view.
- You do not access systems and IT infrastructure that you are not authorized.
- You do not treat personal data carelessly
- You secure all printouts away when not in use
- You do not share your passwords to any unauthorized person

Background Verification — As a part of the onboarding process, background check is conducted. You will be required to submit your original documents for background verification.

Data Consent — In consideration of being Interned at Raise Digital.

I hereby expressly agree as follows —
Raise Digital may collect, process and disclose my personal information/data to verify the accuracy of the information I have provided in my application form or during my recruitment process, by conducting appropriate background checks.
In this regard, Raise Digital may, amongst other, obtain a personal credit report, conduct a criminal record search, and contact the persons I have appointed as personal references during my recruitment.

Acceptance — You hereby accept the terms of Internship Please sign the offer letter in duplicate and return us one copy.

Date:

Signature:

Name:

Permanent Address:

Yours sincerely,

Neha Sharma
HR Manager | 1Stop.ai

VERIFY

Email
care@1Stop.ai

Address : 47/B, 26th Cross, Sector 3, HSR Layout, Bengaluru, Karnataka 560102

Date :20 – 04 - 2025

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Prabhakar.S(Reg. No.421121104085)** studying Final year BE (ECE) in IFET College of Engineering, Gangarampalayam, Villupuram-605108 has Successfully completed his 2 Month Internship from **12-Feb-2025 to 15-April-2025** in **Fullstack Development** with us. During the period of Internship with us he was found punctual, hardworking and inquisitive.

We wish him all the very best for his future Endeavors.

Authorized Signature

HR Manager

424F, Second Floor, Red Rose Building, Above ICICI Bank, DB Road, RS Puram, Coimbatore–641002
Website:www.neelavathsoftware.in Mobile:8248803029 Email:careers@neelavathsoftware.in

Date :20 – 04 - 2025

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Prakashraj.K(Reg. No.421121104090)** studying Final year BE (ECE) in IFET College of Engineering, Gangarampalayam, Villupuram-605108 has Successfully completed his 2 Month Internship from **12-Feb-2025 to 15-April-2025** in **Fullstack Development** with us. During the period of Internship with us he was found punctual, hardworking and inquisitive.

We wish him all the very best for his future Endeavors.

Authorized Signature

HR Manager

424F, Second Floor, Red Rose Building, Above ICICI Bank, DB Road, RS Puram, Coimbatore–641002
Website:www.neelavathsoftware.in Mobile:8248803029 Email:careers@neelavathsoftware.in

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No.9, 2nd floor,
MariyammanKoil Back side,
Vennila Nagar,Saram post ,
Puducherry - 605013.
India.

Date: 2.5.2025 No: TSC110J3
Mobile: +91 81447 87874, 82207 94827
Landline: +0413 4206373
E-mail: techcellentsolutions@gmail.com
Site: www.techcellent.in

TO WHOM SO EVER THIS MAY CONCERN

This is to certify that **MUGIL KUMAR.K (Reg No:421121104074) IFET College of Engineering** has successfully completed his/her **In Internship** in our concern in the field of **UI/UX.** This was a 2- month program (March to April) and during this period he/she has shown exemplary attitude and approach.

We wish him/her the very best in him/her future endeavours.

For Techcellent Solutions,

CEO

TECHCELLENT SOLUTIONS