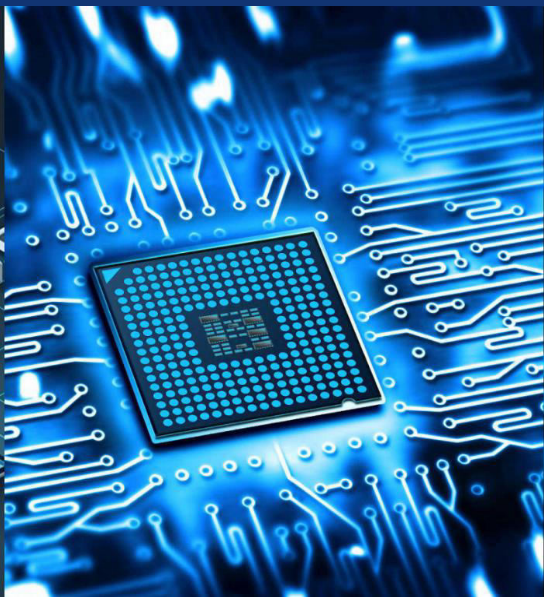
ISSN(O): 2320-9801
ISSN(P): 2320-9798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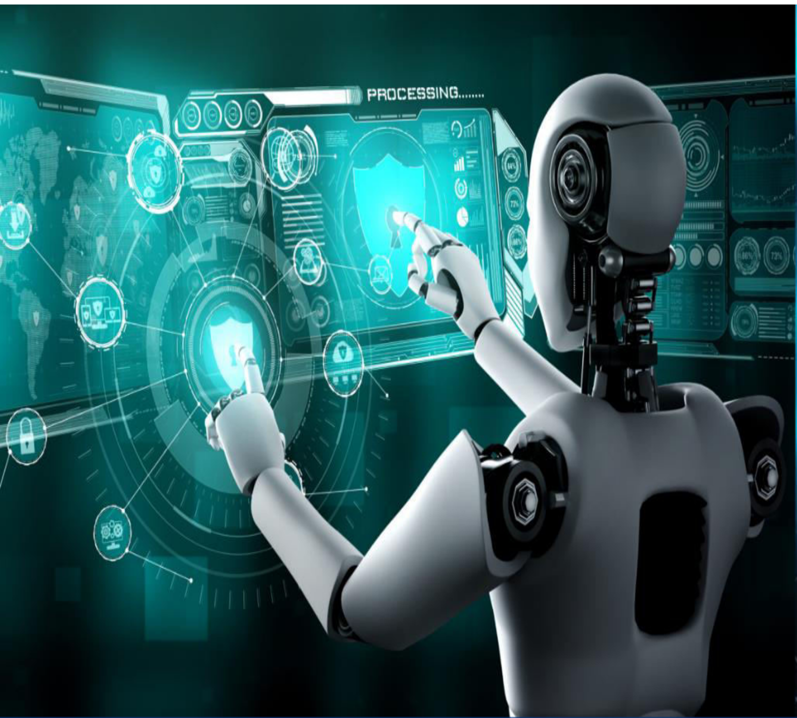

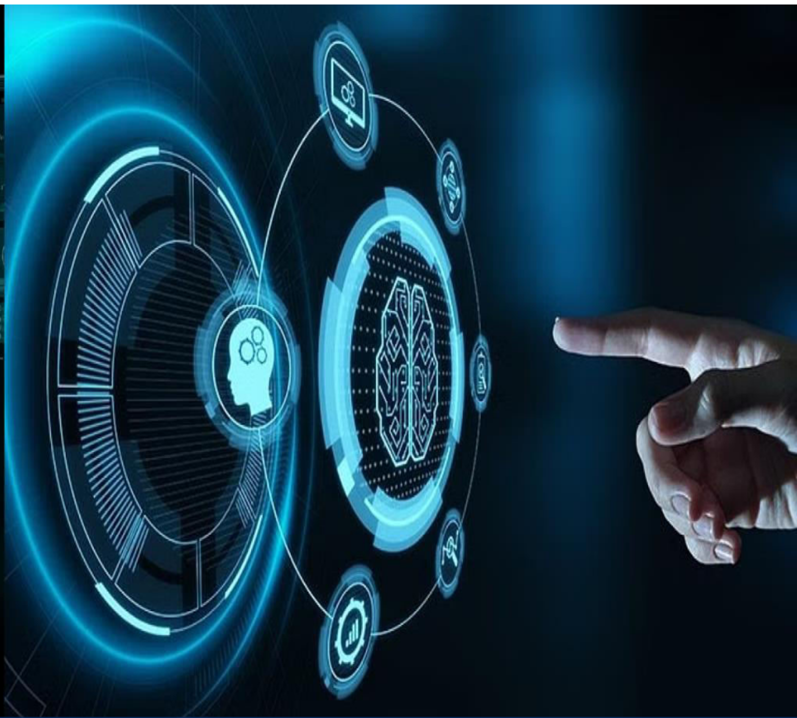

Impact Factor: 8.625

Volume 13, Issue 1, January 2025

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International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Mini Drone with Proximity Alert

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ABSTRACT: The Mini Drone with Proximity Alert is an advanced autonomous drone system designed to enhance safety and obstacle avoidance in dynamic environments. This project utilizes an Arduino Nano microcontroller to integrate a network of ultrasonic sensors, ensuring real-time detection of obstacles in the drone's flight path. When obstacles are detected within a predefined proximity, the system processes the sensor data and triggers alert mechanisms such as LED indicators, buzzers, or automated flight adjustments to avoid collisions. Lightweight materials and efficient electronic component placement ensure portability and optimal battery life, making the drone suitable for various indoor and outdoor applications. The drone's software is developed using the Arduino IDE, featuring custom algorithms for sensor data processing, proximity detection, and autonomous navigation. Additionally, the drone offers mobile application integration via Bluetooth communication, enabling remote monitoring and control, as well as real-time telemetry feedback, including proximity alerts and battery status. Field tests demonstrate the drone's reliability in avoiding obstacles and maintaining safe flight paths, highlighting its potential use in surveillance, search-and-rescue operations, and educational purposes. The Mini Drone with Proximity Alert provides an innovative solution for safe drone operation in complex and confined environments..

KEYWORDS: Mini Drone, Proximity Alert, Autonomous Drone, Obstacle Avoidance, Arduino Nano, Ultrasonic Sensors, Real-Time Detection, Collision Prevention, LED Indicators, Buzzers, Automated Flight Adjustments.

I. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), commonly referred to as drones, have seen significant advancements in recent years, making them an integral part of industries ranging from agriculture to defense. Among these, mini drones are particularly noteworthy for their compact size, cost-effectiveness, and versatility, especially in applications where maneuverability and ease of deployment are critical. This paper presents a detailed exploration of the design, development, and implementation of a Mini Drone with Proximity Alert, a project aimed at enhancing the safety, functionality, and usability of small UAVs[1].The Mini Drone with Proximity Alert is designed to address key challenges in drone operation, including collision avoidance and navigation in constrained or dynamic environments.

Traditional drones, despite their utility, often lack adequate mechanisms to detect and respond to obstacles effectively, leading to potential damage or operational inefficiencies. By integrating advanced proximity sensing technologies, this project seeks to mitigate such risks, ensuring safer and more efficient drone operations[2].The proposed system leverages compact hardware components, including the Arduino Pro Mini microcontroller and an F3 EVO flight controller, to ensure precision and low power consumption. Proximity detection is enabled through a LIDAR Module, which offers high-accuracy distance measurement. Visual and auditory feedback is provided by LEDs and a buzzer to alert users in real time of potential obstacles. Complementing this hardware is a robust software framework that orchestrates sensor data processing, flight control, and user interaction, ensuring seamless operation[3].

The application potential for a mini drone with such capabilities is vast. From short-range surveillance and monitoring in crowded urban settings to navigation in complex indoor environments, the enhanced situational awareness offered by proximity alerts makes these drones valuable tools. Furthermore, their small size and affordability expand accessibility, allowing them to be used in educational, research, and hobbyist contexts as well as in critical professional applications like disaster management and search-and-rescue missions[4].

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This paper outlines the complete methodology employed in developing the Mini Drone with Proximity Alert, encompassing the selection of components, hardware integration, and software design. It also addresses the challenges encountered during the design process and provides an evaluation of the drone's performance in simulated and real-world scenarios. By the end of this paper, readers will gain insights into the practical aspects of mini drone design and the potential future directions for drones equipped with proximity alert systems.

II. RELATED WORK

Obstacle Avoidance in Autonomous Drones: Research studies and projects focusing on collision prevention in drones using ultrasonic sensors, infrared sensors, or LIDAR systems, such as the development of path-planning algorithms for dynamic environments.
Proximity Detection Systems: Implementations of sensor networks in robotics for proximity detection, highlighting advancements in real-time obstacle detection and avoidance algorithms.
Arduino-Based Drone Systems: Existing projects utilizing Arduino microcontrollers for drone navigation and automation, emphasizing the simplicity and flexibility of Arduino for prototyping autonomous systems.
Integration of Bluetooth Technology in Robotics: Case studies on mobile application integration with drones, enabling remote control and monitoring using Bluetooth for telemetry data like battery status and flight diagnostics.
Search-and-Rescue Drone: Examples of drones employed in search-and-rescue missions that navigate through confined or hazardous environments using obstacle detection and autonomous flight systems.
Real-Time Telemetry Feedback: Investigations into telemetry systems that provide live updates on drone performance, flight status, and environmental conditions, contributing to safer drone operations.

III. SYSTEM IMPLEMENTATION

A. Hardware Requirements:
Arduino Pro Mini–
The Arduino Pro Mini is a compact and lightweight microcontroller board, ideal for applications like mini drones where size and weight are critical. It is powered by the ATmega328P chip, offering 14 digital input/output pins (6 PWM outputs) and 6 analog inputs, ensuring versatile connectivity for sensors and actuators. Operating at either 3.3V or 5V, it consumes minimal power, enhancing battery efficiency in drones. The board is designed for projects requiring low-profile designs, as it lacks a USB interface, requiring an external FTDI adapter for programming. Its small form factor makes it suitable for integrating into confined spaces like drone frames. The Arduino Pro Mini supports real-time sensor data processing and motor control essential for autonomous navigation. Its compatibility with Arduino IDE ensures easy customization and development, making it a popular choice for drone and robotics projects.

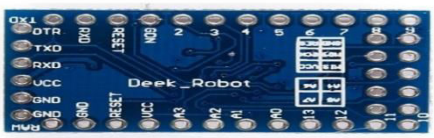

Fig1:Arduino Pro Mini

F3 EVO Controller–
The F3 EVO Controller is a lightweight and versatile flight controller widely used in mini drones and quadcopters. It is based on the STM32F303 microcontroller, offering a powerful 72 MHz ARM Cortex-M4 processor with a built-in floating-point unit (FPU) for efficient real-time flight calculations. The controller supports multiple flight modes, including acro, stabilized, and autonomous, making it suitable for beginners and advanced pilots. Equipped with a range of ports, it allows seamless integration with sensors, ESCs, and communication modules. Its small size and low weight make it ideal for compact drones, ensuring high maneuverability without adding bulk. The F3 EVO supports popular open-source firmware like Betaflight or Cleanflight, enabling customizable flight performance. Additionally, it features

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a built-in PPM, SBUS, and DSM receiver, simplifying connectivity and setup. This controller is highly favored for its balance of functionality, performance, and ease of use in drone projects.

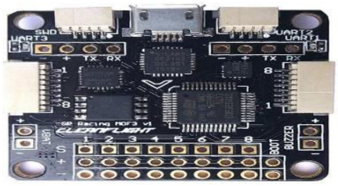

Fig2: F3 EVO Controller

Piezo Buzzer–

The piezo buzzer is an electronic device which generates sound through it. The buzzer is used as an indication to the user. It is used in the car reversing system and braking system as an indication. It is based on the principle of piezoelectricity discovered in 1880.

Fig3: Buzzer

LIDAR Module –

The LIDAR module is a compact and precise distance measurement sensor used in applications like mini drones for obstacle detection and proximity alerts. It operates by emitting laser pulses and measuring the time taken for the reflected light to return, providing accurate distance readings in real-time. Known for its high resolution and range, the LIDAR module enables drones to detect obstacles and navigate safely in dynamic environments. Its lightweight and small form factor make it ideal for integration into drone systems without compromising flight performance. The module supports a wide detection range and is effective in low-light and challenging conditions, ensuring reliable operation. It can be easily interfaced with microcontrollers or flight controllers, facilitating smooth communication for autonomous navigation. LIDAR modules are widely used in robotics and drones for their precision, efficiency, and ability to enhance obstacle avoidance capabilities.
force when driven.

Fig4: LIDAR Module

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Li-Po Battery –

A Li-Po (Lithium Polymer) battery is a rechargeable power source commonly used in mini drones due to its lightweight and high-energy density characteristics. Unlike traditional Li-ion batteries, Li-Po batteries have a flexible pouch design, allowing them to be made in various shapes and sizes to fit compact drone frames. They offer high discharge rates, making them ideal for the rapid power demands of drone motors and electronics. Li-Po batteries provide a long cycle life and stable voltage output, ensuring consistent performance throughout the flight. These batteries are available in different capacities, allowing for customization based on the drone's power needs. However, they require careful handling, as overcharging or over-discharging can lead to performance degradation or potential hazards. Li-Po batteries are an essential component in drone systems, offering a balance between power, weight, and size.

Fig5: Li-Po Battery

A. Software Requirements:

The software requirements for the Mini Drone with Proximity Alert typically include:

Arduino IDE: This integrated development environment is used for programming the microcontroller (e.g., Arduino Nano), enabling the writing, compilation, and uploading of code for controlling drone functions such as sensor data processing, flight control, and obstacle avoidance.

Betaflight/Cleanflight: These are popular open-source firmware options for configuring and fine-tuning flight controllers like the F3 EVO. They allow users to adjust flight dynamics, set up sensors, and optimize drone performance.

Bluetooth Communication Libraries: For mobile application integration, Bluetooth libraries like SoftwareSerial or BLE (Bluetooth Low Energy) are used for establishing communication between the drone and the mobile app for real-time telemetry and control.

Sensor Libraries: Libraries such as NewPing for ultrasonic sensors or other sensor-specific libraries are needed to process data from proximity sensors and trigger alerts based on detected obstacles.

Mobile Application Development Tools: For integrating Bluetooth communication with the drone, tools like Android Studio or Xcode may be required to develop custom mobile apps that allow users to monitor telemetry, battery status, and proximity alerts remotely.

These software tools collectively enable the full functionality of the drone, including navigation, obstacle avoidance, telemetry monitoring, and user control.

The implementation process for the Mini Drone with Proximity Alert involves several key steps:

a) **Hardware Selection and Integration:** Choose lightweight components like the Arduino Pro Mini and F3 EVO flight controller to ensure compact design and efficient power consumption. Integrate ultrasonic sensors for proximity detection and a LIDAR module for enhanced obstacle avoidance. Use a Li-Po battery for optimal power supply and miniaturized drone design. Ensure that the components are securely mounted and housed within a robust, lightweight frame for durability and smooth flight performance.

b) **Software Development**: Develop firmware for the microcontroller using the Arduino IDE to process sensor data from the ultrasonic sensors and LIDAR module. Implement algorithms for obstacle detection, proximity alert

© 2025 IJIRCCE | Volume 13, Issue 1, January 2025| DOI: 10.15680/IJIRCCE.2025.1301052

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mechanisms (LED indicators, buzzers), and autonomous navigation. Integrate Bluetooth communication libraries for real-time telemetry feedback and mobile app control, enabling remote monitoring of battery status, proximity alerts, and flight conditions.

c) **User Testing and Feedback**: Conduct field testing in both indoor and outdoor environments to evaluate obstacle detection accuracy, sensor responsiveness, and flight stability. Gather feedback from users regarding drone handling, alert effectiveness, and mobile app functionality. Refine both hardware and software based on real-world performance and user input.

d) **Documentation and Deployment:** Document the system architecture, hardware setup, software implementation, and the drone's operating procedures. Create user manuals and setup guides to ensure proper usage and ease of operation. Prepare deployment kits and provide training for users to operate the drone effectively in various scenarios such as surveillance or search-and-rescue operations.

e) Monitoring and Maintenance: Set up a system for monitoring drone performance, including battery status, proximity alerts, and flight data. Provide ongoing maintenance, software updates, and technical support for users. Continuously improve the system by optimizing algorithms and adding features based on feedback, technological advancements, and changing operational requirements.

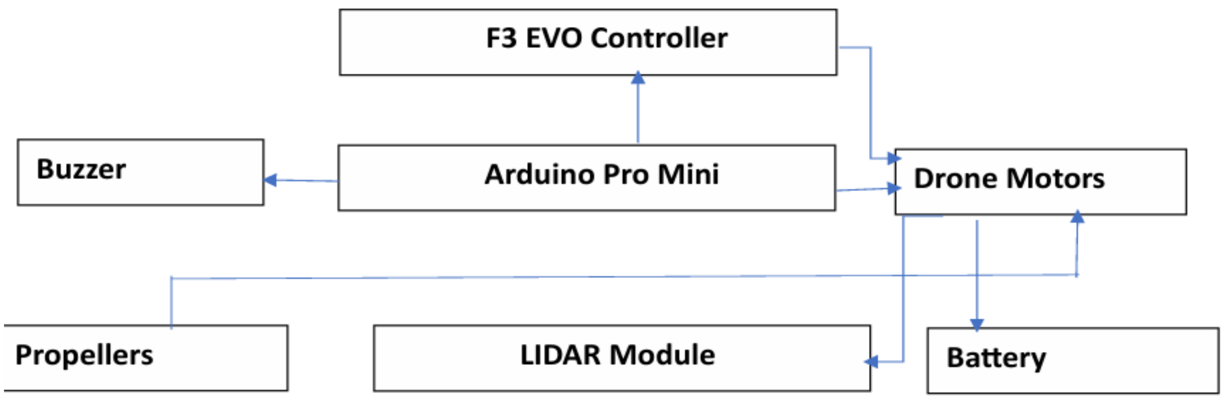

Fig6: Block Diagram

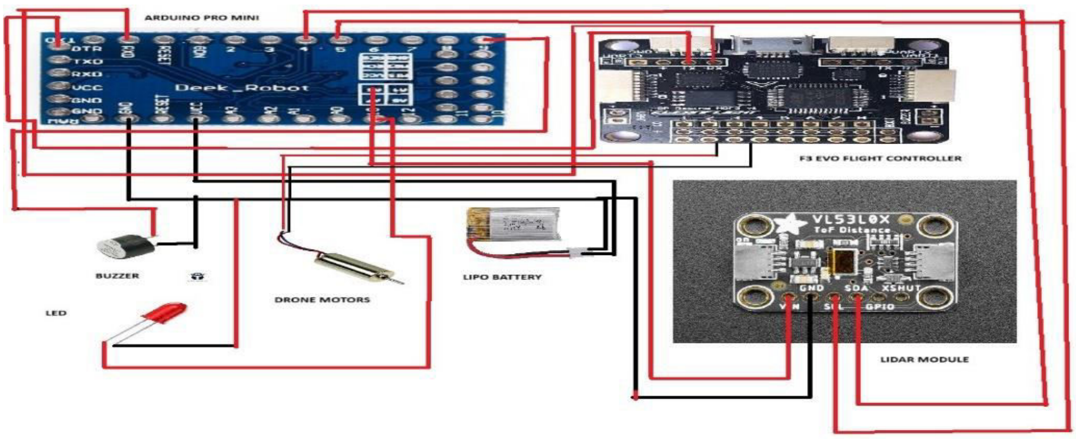

Fig7: Circuit Layout

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IV. RESULTS

The results of the Mini Drone with Proximity Alert project demonstrate significant advancements in drone safety, obstacle avoidance, and autonomous navigation. The ultrasonic sensors and LIDAR module effectively detect obstacles in real-time, with high accuracy and responsiveness. The proximity alerts, including LED indicators and buzzers, successfully notify the system of potential collisions, enhancing flight safety.The integration of the Arduino Pro Mini and F3 EVO flight controller enabled stable and controlled flight, with the drone adjusting its path when obstacles were detected. The proximity detection algorithms processed sensor data accurately, ensuring the drone maintained safe distances from obstacles.

The Li-Po battery provided sufficient power for extended flight times, with the drone demonstrating optimal performance while maintaining a lightweight design. The system's power consumption was effectively managed, ensuring the drone operated efficiently during field tests.
Bluetooth communication enabled seamless integration with a mobile app, allowing users to monitor real-time telemetry, proximity alerts, and battery status. The app's user-friendly interface provided convenient control and monitoring, offering a positive user experience.

In both indoor and outdoor environments, the drone performed reliably in avoiding obstacles, maintaining safe flight paths, and reacting to proximity alerts. The test results indicated the drone's potential for use in surveillance, search-and-rescue operations, and educational purposes.

Testing and feedback from users highlighted the drone's effectiveness in navigating confined and dynamic spaces. Users noted the responsiveness of the proximity alert system and expressed satisfaction with the drone's stability and ease of control.

Overall, the project achieved its goal of creating an autonomous drone with reliable obstacle avoidance and proximity alert capabilities, with potential applications in various fields that require safe and efficient drone operation.

Fig 8 and 9: Drone Prototype

V. CONCLUSION AND FUTURE WORK

The Mini Drone with Proximity Alert project successfully demonstrated a compact, autonomous system capable of detecting and avoiding obstacles in dynamic environments. The integration of ultrasonic sensors, LIDAR, and a well-optimized microcontroller allowed the drone to respond to real-time proximity data, ensuring safe navigation and alerting users to potential collisions. The system's mobile app integration provided a seamless user interface for remote control and telemetry monitoring. In conclusion, the project achieved its goals of enhancing drone safety and providing a reliable, efficient solution for obstacle avoidance. The results indicate the drone's potential for use in various applications such as

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surveillance, search-and-rescue operations, and educational purposes, where safety and reliable navigation are critical. Additionally, improving battery life and reducing the weight of components could extend flight times and make the drone even more versatile. Exploring the integration of GPS for enhanced navigation and geofencing features could open up possibilities for autonomous long-range flights and more precise operational control. Further testing in diverse environments and under different conditions will also help refine the system and ensure its robustness in real-world applications.

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