International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 04 | April - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

LIDAR-ENABLED MICRO DRONE WITH PROXIMITY EFFECT

K.Abhinav Sesha Srinivas
Dept of Electrical and Electronics Engineering
RVR&JC COLLEGE OF ENGINEERING
Guntur,India
seshasrinivasa@gmail.com

L.Naveen
Dept of Electrical and Electronics Engineering
RVR&JC COLLEGE OF ENGINEERING
Guntur,India
naveen.linga23@gmail.com

Ch.Mahendra Bhupathi
Dept of Electrical and Electronics Engineering
RVR&JC COLLEGE OF ENGINEERING
Guntur,India
chmahendrabhupathi@gmail.com

Dr.G .V . Prasanna Anjaneyulu
(Associate Professor)
Dept of Electrical and Electronics Engineering
RVR&JC COLLEGE OF ENGINEERING
Guntur,India
gvp.rvrjc@gmail.com

Abstract—Micro drones are increasingly used in various applications such as surveillance, inspection, and research. However, traditional drones are expensive, require large operating space, and are prone to collision risks. This paper presents the design and implementation of a micro drone with proximity alert using LiDAR technology. The system integrates an Arduino Pro Mini, F3 EVO flight controller, LiDAR sensor, buzzer, and LED indicators to detect obstacles in real time. The LiDAR sensor measures distance and alerts the user through varying buzzer frequency and LED blinking based on proximity. The proposed system offers a low-cost, lightweight, and efficient solution for safe navigation in confined environments.

Keywords—Micro drone, LiDAR, proximity alert, obstacle detection, Arduino, UAV

Introduction

Unmanned Aerial Vehicles (UAVs), commonly known as drones, have gained significant importance in modern engineering applications such as surveillance, mapping, inspection, and agriculture. However, traditional drones face several limitations including high cost, large size, noise, and inability to operate effectively in confined or obstacle-rich environments.

Micro drones overcome these challenges by offering compact size, low cost, and flexibility in operation. However, one major limitation of micro drones is the lack of reliable obstacle detection systems, especially in low-cost implementations. Conventional sensing techniques such as ultrasonic and infrared sensors suffer from limited range, lower accuracy, and sensitivity to environmental conditions.

To address these issues, this paper proposes a LiDAR-based proximity alert system integrated into a micro drone. LiDAR provides high accuracy, fast response, and reliable distance measurement using laser-based Time-of-Flight technology. The proposed system enhances navigation safety by providing real-time alerts using buzzer and LED indicators.

Several research works have explored obstacle detection in micro drones:

- Sharma et al. (2023) developed a LiDAR-based micro drone with buzzer alert, but lacked optimization in control response.
- Hasure et al. (2024) proposed a LiDAR drone for environmental monitoring, but the system was relatively expensive and complex.
- Other systems used ultrasonic sensors, which suffer from low precision and limited range.

RESEARCH GAP:

- Lack of low-cost + efficient LiDAR integration
- Limited real-time alert optimization
- Absence of lightweight systems for indoor navigation

CONTRIBUTION OF THIS WORK:

- Cost-effective LiDAR-based micro drone
- Real-time dynamic alert system
- Lightweight and compact design

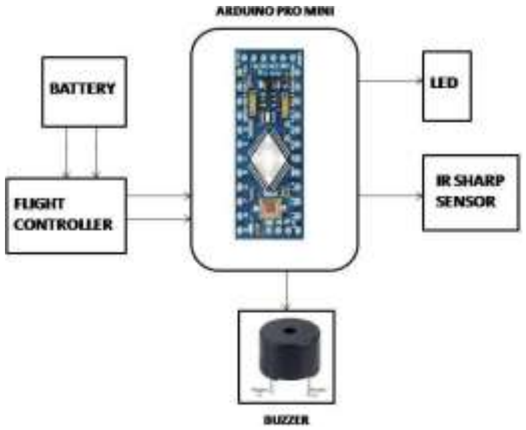
PROPOSED SYSTEM

The proposed system consists of a micro drone integrated with a LiDAR-based proximity alert mechanism.

System Architecture:

- LiDAR sensor → distance measurement
- Arduino Pro Mini → data processing
- F3 EVO controller → flight control
- ESC → motor speed control

- Buzzer & LED → alert system



WORKING PRINCIPLE:

1. LiDAR emits laser pulses and measures reflected time
2. Distance is calculated using ToF principle
3. Arduino processes distance data
4. If distance < threshold:
    - Buzzer frequency increases
    - LED blinking increases
5. Operator adjusts drone direction accordingly

This ensures **real-time obstacle awareness without complex computation**.

METHODOLOGY

HARDWARE DESIGN

The system includes:

- Arduino Pro Mini (ATmega328P)
- LiDAR sensor (TFMini-S)
- F3 EVO Flight Controller
- BLDC Motors with Propellers
- ESC (Electronic Speed Controller)
- LiPo Battery
- Buzzer and LED indicators

Software Design

The system is programmed using embedded C in Arduino IDE.

ALGORITHM:

- Initialize sensor and output devices
- Read analog signal from LiDAR
- Convert voltage to distance
- Compare distance with thresholds
- Generate buzzer and LED signals
- Repeat continuously

SYSTEM COMPONENTS

A. ARDUINO PRO MINI

- The Arduino Pro Mini is a compact microcontroller board based on the ATmega328P, widely used in embedded and robotics applications due to its small size and low power consumption. It features 14 digital input/output pins, of which 6 support Pulse Width Modulation (PWM), and 6 analog input pins.

- In the proposed system, the Arduino Pro Mini acts as the **central processing unit**, receiving distance data from the LiDAR sensor and processing it to generate control signals for the buzzer and LED. Its lightweight design makes it suitable for integration into micro drones where size and weight are critical constraints.

B. F3 EVO FLIGHT CONTROLLER

- The F3 EVO flight controller is a high-performance control unit designed for multirotor drones. It is based on a 32-bit ARM Cortex-M4 processor and includes integrated sensors such as a gyroscope and accelerometer for precise motion control.
- In this system, the flight controller is responsible for stabilizing the drone and managing motor speeds. It processes input signals from the remote controller and adjusts the Electronic Speed Controllers (ESCs) to maintain stable flight. The use of the F3 EVO ensures smooth maneuverability and reliable flight performance.

C. LIDAR SENSOR (TFMINI-S)

- The LiDAR (Light Detection and Ranging) sensor is a key component used for obstacle detection. It operates on the Time-of-Flight (ToF) principle, where laser pulses are emitted and the time taken for reflection is measured to calculate distance.

- The TFMini-S LiDAR sensor used in this project provides accurate distance measurements ranging from approximately 0.1 m to 12 m. It offers high precision, fast response, and reliability compared to conventional ultrasonic sensors.

- In this system, the LiDAR sensor continuously monitors the distance between the drone and nearby obstacles, enabling real-time proximity detection and alert generation.

D. ELECTRONIC SPEED CONTROLLER (ESC)

- The Electronic Speed Controller (ESC) is used to regulate the speed of the drone's motors by controlling the power supplied to them. It converts the DC power from the battery into controlled signals required for motor operation.

- In the proposed system, the ESC receives signals from the flight controller and adjusts motor speeds accordingly to control the drone's movement and stability. It ensures efficient power delivery and smooth motor operation.

E. DRONE MOTORS

- The micro drone uses coreless DC motors, which are lightweight and capable of high-speed operation. These motors provide the necessary thrust for lift and maneuverability.

- Each motor drives a propeller, and the combined thrust generated by all motors allows the drone to take off and maintain stable flight. The speed of the motors is controlled by the ESC based on signals from the flight controller.

F. PROPELLERS

- Propellers are aerodynamic components responsible for generating lift and thrust. They convert the rotational motion of the motors into airflow, enabling the drone to move upward and maneuver in different directions.

- The performance of the drone depends significantly on the size, pitch, and material of the propellers. In this system, lightweight propellers are used to ensure efficient thrust generation and reduced power consumption.

G. LIPO BATTERY

- The Lithium Polymer (LiPo) battery is used as the primary power source for the drone. LiPo batteries are preferred due to their high energy density, lightweight nature, and ability to deliver high current.
- In this project, a 3.7 V battery is used to power the motors, flight controller, and sensor modules. The battery capacity determines the flight time of the drone.

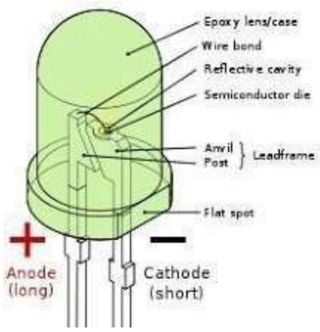
H. BUZZER

- The buzzer is an audio output device used to provide real-time alerts. It generates sound signals based on the proximity of obstacles detected by the LiDAR sensor.

- As the drone approaches an obstacle, the frequency of the buzzer increases, providing intuitive feedback to the operator for avoiding collisions.

I. LED INDICATOR

- The LED is used as a visual alert system. It provides indication of obstacle proximity through varying blinking patterns.
- When the drone is far from obstacles, the LED blinks slowly. As the drone moves closer to an obstacle, the blinking frequency increases. This enhances user awareness and improves safety during operation.



J. REMOTE CONTROL SYSTEM

- The remote control system is used to operate the drone wirelessly. It consists of a transmitter and receiver that communicate using radio frequency signals, typically in the 2.4 GHz range.
- The transmitter sends control commands such as throttle, pitch, roll, and yaw to the receiver mounted on the drone. The flight controller interprets these signals and adjusts motor speeds accordingly to control the drone's movement.

MATHEMATICAL ANALYSIS

A. THRUST REQUIREMENT ANALYSIS

For stable flight, total thrust generated by all motors must satisfy:

Ttotal≥W=mg

Where:

- Ttotal= Total thrust (N)
- m = Mass of drone (kg)
- g = Acceleration due to gravity (9.81 m/s²)

Taken:

Mass of drone m=0.054kg

W=0.054×9.81=0.5297N

Trequired=2.5×W=2.5×0.5297=1.324N

Thrust per Motor (4 motors):

Tmotor= Trequired/4 =1.324/4 = 0.331N

This is the minimum thrust each motor must generate

B. PROPELLER THRUST MODEL

Thrust generated by a propeller is given by:

$$T = C_T \rho n^2 D^4$$

Where:

- C_T = Thrust coefficient
- ρ = Air density (1.225 kg/m³)
- n = Rotations per second (RPS)
- D = Propeller diameter (m)

Taken:

- RPM = 55000
- $n = \frac{55000}{60}$ = 916.67 RPS
- D=45mm=0.045m

Calculation:

$$T \approx 0.1 \cdot 1.225 \cdot (916.67)^2 \cdot (0.045)^4$$

$$T \approx 0.0421\ N$$

Available thrust per motor = 0.421 N
Required thrust per motor = 0.331 N

C. POWER CONSUMPTION ANALYSIS

Electrical power is given by: P=V×I

Motor Power:
Voltage V=3.7V
Current per motor ≈ 0.5A

Pmotor=3.7×0.5=1.85W

For 4 motors:

Pmotors=4×1.85=7.4W

Other Components:

Arduino ≈ 0.05W
LiDAR ≈ 0.185W

To ensure stable and controllable flight, a thrust-to-weight ratio of 2 to 3 is typically used.

$P_{total}=7.4+0.05+0.185=7.635W$

CIRCUIT DIAGRAM AND CONNECTIONS

- The circuit diagram of the proposed micro drone system illustrates the interconnection of all major components including the Arduino Pro Mini, LiDAR sensor, F3 EVO flight controller, Electronic Speed Controllers (ESCs), motors, buzzer, LED, and power supply.

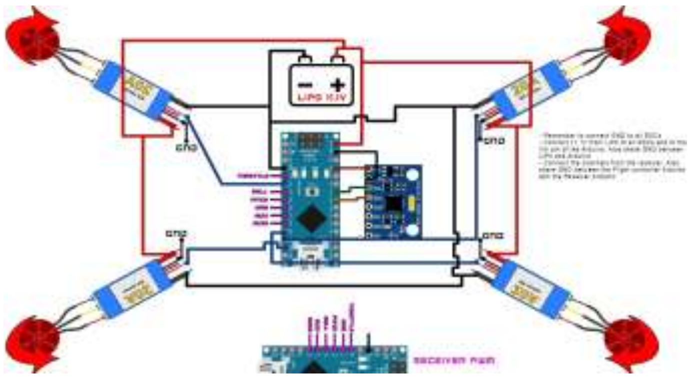
- The LiDAR sensor is interfaced with the Arduino Pro Mini to provide real-time distance measurements. The sensor continuously transmits distance data, which is processed by the microcontroller to determine the proximity of obstacles. Based on the measured distance, control signals are generated to activate the buzzer and LED indicators.

- The buzzer and LED are connected to the digital output pins of the Arduino. These components act as alert systems, where the buzzer produces sound and the LED blinks with varying frequency depending on the distance from obstacles.

- The F3 EVO flight controller is connected to the ESCs, which in turn are connected to the drone motors. The flight controller receives control signals from the remote receiver and adjusts the motor speeds accordingly to maintain stability and control of the drone.

- The LiPo battery serves as the main power source and supplies power to all components, including the flight controller, Arduino, LiDAR sensor, and motors through the ESCs. Proper voltage regulation is ensured to protect sensitive components.

- The overall circuit ensures efficient communication between sensing, processing, and actuation units, enabling real-time obstacle detection and alert generation while maintaining stable flight operation.

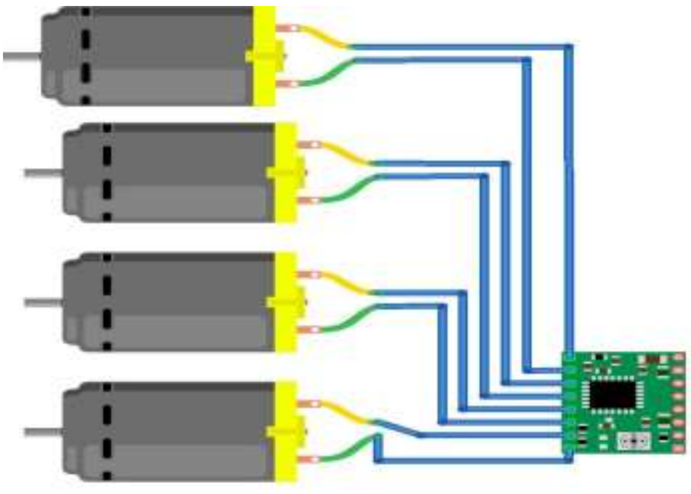


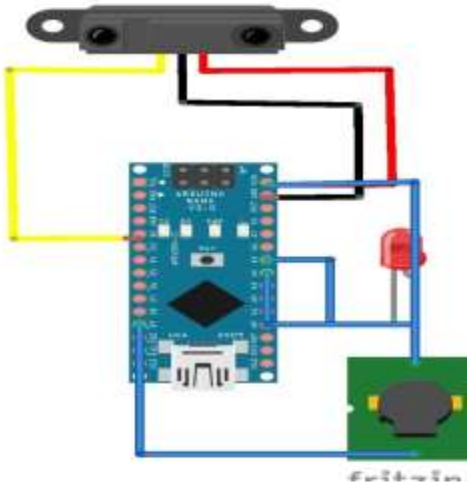
ADVANTAGES

- The proposed system offers several advantages including low cost, lightweight design, and real-time obstacle detection. The use of LiDAR provides higher accuracy compared to conventional ultrasonic sensors. The system is easy to implement and suitable for indoor navigation. Additionally, the alert mechanism using buzzer and LED enhances user awareness and improves operational safety.

APPLICATIONS:

- The developed micro drone can be used in various applications such as indoor surveillance, search and rescue operations, agricultural monitoring, and industrial inspection. It is particularly useful in confined environments where obstacle detection is critical. The system can also be used for educational and research purposes in robotics and UAV development.





CONCLUSION

This paper presented the design and implementation of a micro drone integrated with a LiDAR-based proximity alert system. The proposed system successfully detects obstacles in real time and provides immediate audio-visual feedback using a buzzer and LED, thereby improving operational safety.

The use of LiDAR technology offers higher accuracy and faster response compared to conventional sensing methods, making the system suitable for indoor and obstacle-rich environments. The lightweight design and low-cost components further enhance its practicality for small-scale applications.

Experimental analysis confirms that the developed system achieves stable flight performance and reliable proximity detection within the intended range. Although the system currently provides alert-based navigation, it establishes a strong foundation for future advancements such as autonomous obstacle avoidance and intelligent flight control.

Overall, the proposed micro drone demonstrates an effective and economical solution for safe navigation in confined environments, with potential applications in surveillance, inspection, and research domains.

REFERENCES

1. "Obstacle Detection and Avoidance for Miniature Flying Robots" by Michael M. Hutter, published in the Journal of Intelligent and Robotic Systems (2016). This paper presents a system for obstacle detection and avoidance using a miniature laser rangefinder on a micro drone.
2. "A Robust and Efficient Miniature MAV for Autonomous Indoor Flight" by Dario Floreano et al., published in the IEEE Transactions on Robotics and Automation (2009). This paper presents a design for a micro drone with obstacle detection and avoidance using a stereo vision system.
3. "Development of a Quadcopter for Collision-Free Flight" by K. Satyam et al., published in the International Journal of Advanced Research in Computer and Communication Engineering (2015). This paper presents a micro drone with a proximity sensor for obstacle detection and avoidance.
4. "Miniature Quad rotor UAVs with Vision-Based Obstacle Avoidance" by L. Meier et al., published in the Proceedings of the IEEE International Conference on Robotics and Automation (2008). This paper presents a system for obstacle detection and avoidance using a monocular vision system on a micro drone.
5. "Design of a Quadcopter for Autonomous Obstacle Avoidance" by R. Patil et al., published in the International Journal of Innovative Research in Science, Engineering and Technology (2016). This paper presents a micro drone with an ultrasonic sensor for obstacle detection and avoidance.