© December 2025 | IJIRT | Volume 12 Issue 7 | ISSN: 2349-6002

LiDAR-Based Microdrone for Obstacle Detection and Live Streaming System

Naik D C[1], Bhoomika D[2], Lokranjan V[3], Rakesh B T[4], Rakshitha H L[5]
[1,2,3,4,5]*Aps College of Engineering*

***Abstract*—The use of drones has increased rapidly in recent years due to their ability to perform tasks such as aerial surveillance, inspection, mapping, and monitoring in areas that are difficult or unsafe for humans to access. However, one of the major limitations in drone applications is the risk of collision with nearby objects during flight. This problem becomes more critical in indoor environments, narrow spaces, or locations with multiple physical obstacles. A collision can damage the drone's hardware, cause loss of control, or result in safety hazards. To overcome this issue, the present project proposes an intelligent obstacle detection and live video streaming system developed using the ESP32-CAM microcontroller and the VL53L0X LiDAR distance sensor. The main objective of this system is to make drone operation safer by alerting the user about possible collisions while simultaneously providing live visual feedback.**

The system is built around the ESP32-CAM, which is a compact and cost-effective microcontroller that supports Wi-Fi connectivity and camera-based video streaming. In this project, the camera module of the ESP32-CAM streams live footage over a Wi-Fi network.

***Index Terms*—Drone, Obstacle Detection, ESP32-CAM, LiDAR Distance Sensor, Collision Avoidance System, Real Time Video Streaming, Wi-Fi Connectivity.**

I. INTRODUCTION

The field of drone technology has been growing very fast, and because of that, there is now a huge need for drones that can detect obstacles quickly and give real-time information to the operator. In many complex places like indoor buildings, factories, warehouses, or areas without GPS signals, a drone needs very reliable sensing to avoid crashing. But normal drones usually depend on simple sensors or just a camera, and these are not always accurate. They may work poorly when the lighting changes, when the space is tight, or when there are small objects around. Because of this, drones sometimes don't react in time, which can lead to accidents. So proper distance measurement and immediate feedback are extremely important for safe drone movement, especially in areas where the chances of hitting something are high. That is why this project focuses on making a system that uses the ESP32CAM and the VL53L0X LiDAR sensor to offer accurate distance detection and live video streaming at the same time. The VL53L0X is a small but powerful time-of-flight (ToF) sensor, and it measures distance using laser pulses with very high accuracy, even up to millimetre level. It constantly checks how far objects are from the drone, and when it notices something getting too close, it immediately triggers an alert to warn the operator. This helps avoid collisions and keeps the drone safe in tight or risky environments.

At the same time, the ESP32-CAM plays two important roles in the system. First, it processes the LiDAR sensor data, and second, it provides live video streaming over Wi-Fi. This gives the operator a clear, real-time view of what the drone sees. Because the ESP32-CAM has built-in Wi-Fi, the data and video can be viewed on a mobile device or a computer browser, which makes monitoring very easy from anywhere nearby. The live footage helps the operator understand the surroundings better, while the sensor readings help judge the distance precisely. The ESP32-CAM is a small and lightweight board, which makes it perfect for drone applications where every gram matters. Since drones have limited space and weight capacity, using compact components like these helps in designing a more efficient system. When both modules work together, they create a complete safety setup video for visuals and LiDAR for accurate measurement.

II. EASE OF USE

The proposed LiDAR-based drone system is designed with a strong focus on user-friendliness, ensuring that even individuals with limited technical knowledge can operate it effectively. The hardware setup uses simple and clearly labeled connections, allowing components such as the LiDAR module, microcontroller, and power system to be assembled with minimal effort. The system includes an automated calibration process, reducing the need for repeated manual adjustments and enabling quick deployment in different environments.

On the software side, the interface is kept intuitive, with clear indicators for distance measurements, obstacle alerts, and system status. Users can monitor drone activity through a basic control dashboard, which requires only essential inputs to start, stop, or adjust the drone's movements. The flight operations are largely automated, making it easier for beginners to control the drone without advanced piloting skills.

Additionally, the system provides real-time feedback, alert notifications, and simple troubleshooting steps that help users identify and resolve issues quickly. The lightweight design and modular structure make maintenance easier, allowing components to be replaced or upgraded without technical complexity. Overall, the system emphasizes simplicity, accessibility, and smooth interaction, ensuring that users can operate the drone confidently and efficiently with minimal learning curve.

III. LITERATURE SURVEY

The reviewed literature shows that drones have become highly useful tools in many fields such as agriculture, wildlife monitoring, environmental studies, conservation, inspection, and mapping. Many researchers focus on improving drone intelligence, safety, and sensing abilities so drones can operate autonomously and handle challenging environments more effectively.

Several studies highlight how LiDAR, stereo vision, and deep learning greatly improve drone perception. LiDAR sensors are widely used because they provide accurate distance measurements and 3D information, which helps drones detect obstacles, measure terrain, and navigate safely. Deep learning models such as CNNs, DC-CNN, and other neural networks enhance the classification of LiDAR point clouds and help drones recognize objects or other drones quickly and accurately. Researchers found that deep learning gives better accuracy and faster feature extraction compared to traditional methods.

Many works show the importance of AI-powered drones in wildlife monitoring. Systems using computer vision and machine learning can automatically detect animals, track their movement, and reduce the need for manual observation. Drones are also being used to control invasive species on islands, monitor bird presence using thermal or AI models, and even track animals in dark or obstructed environments through bio-inspired microphones and sensors.

Agricultural research papers highlight how drones help with crop health monitoring, pest detection, pesticide spraying, and precision farming. They reduce labor, save chemicals, and provide environmentally friendly solutions. Some studies also focus on renewable energy use in farming, showing how solar, biomass, and wind-powered drones can support sustainability.

Several papers examine drone path planning, energy efficiency, and fleet scheduling. Advanced optimization algorithms such as Circo, improved Whale Optimization Algorithm (IWOA), and other hybrid strategies help drones use less energy, reduce flight time, and improve performance in mixed UAV fleets.

Other studies analyze drone applications in areas like hydrological modeling, freight transport safety, and vegetation mapping. UAV-derived photogrammetric models provide high-resolution and low-cost alternatives to traditional surveying. Drones equipped with LiDAR and stereo vision can measure railway freight loading dimensions accurately, improving operational safety.

Some papers compare different software tools used for processing drone imagery such as Agi soft Meta Shape, Pix4D, Correlator3D, and WebODM explaining that each has strengths and weaknesses. They stress that no single tool is best for all projects, so choosing software depends on the required accuracy, speed, and type of environment.

There are also studies on rodent repellent systems using ultrasonic sound and LED light, showing how nonchemical solutions can protect crops and food storage safely. Additional research explains how drones equipped with thermal cameras help track animals at night and monitor hidden species effectively.

Overall, the literature agrees that modern drones, when combined with LiDAR, AI, optimization algorithms, and advanced sensing technologies, provide high accuracy, better automation, and strong potential for future applications. These studies collectively show the growing role of drones in environmental protection, agriculture, safety monitoring, and intelligent autonomous navigation.

IV. COMPONENTS AND DESCRIPTION

4.1 ESP32-CAM Development Board:

Fig 4.1 ESP32-CAM, is basically the "main controller" or the small computer that runs your whole project. It has a built-in camera, Wi-Fi, Bluetooth, and several GPIO pins to connect sensors and other parts. In simple terms, it acts like the brain: it reads inputs, processes data, and gives outputs based on your code. The best part is that it can capture photos, stream live video, and connect to mobile hotspots or Wi-Fi networks, which is why it's perfect for drone or surveillance applications. It uses an ESP32 chip, which is very powerful for its size and consumes low power, making it ideal for battery-based projects. The camera module (OV2640) allows you to view real-time footage of the drone's surroundings. You can also interface sensors like the VL53L0X LiDAR to detect obstacles. The board doesn't have a USB port, so we program it using an FTDI programmer. It has both 3.3V and 5V lines, so you can attach different components safely. Overall, the ESP32-CAM is compact, cheap, powerful, and extremely useful for IoT, robotics, and drone systems. Without this board, your entire project wouldn't be able to think, communicate, or respond to obstacle.

Fig 4.1: ESP32-CAM Development Board

4.2 VL53L0X Lidar Distance Sensor:

The VL53L0X shown in fig 4.2, is a tiny but very intelligent sensor that measures distance using a technology called Time-of-Flight (ToF). Instead of normal ultrasonic waves, this sensor uses laser pulses which means the readings are much faster and more accurate. It can detect objects up to around 2 meters, and this is super helpful in projects where you need quick obstacle detection, like drones, robots, or automation systems. When the sensor turns on, it shoots out invisible laser light, and then it waits to see how long the light takes to bounce back. Based on this time, it calculates how far the object is. Because it uses light instead of sound, it doesn't get affected by noise, wind, or material type. In your project, the LiDAR sensor constantly checks the surroundings and sends the distance data to the ESP32-CAM. If something comes too close, the system can trigger the buzzer or take any programmed action. It operates at 3.3V, which is perfect for microcontrollers. It also communicates using I2C, so only two wires are needed. Overall, this sensor gives reliability, accuracy, and speed, making it extremely valuable in any smart safety or collision-avoidance system.

Fig 4.2: VL53L0X LiDAR Distance Sensor

4.3 7V Li-Po Battery:

The fig 4.3 shows the battery rating between 1000 mAh to 2000 mAh tells you how long it can run. For example, a 2000 mAh battery lasts roughly twice as long as a 1000 mAh one under similar load. In drone applications, weight is very important, and Li-Po gives the best balance between power and lightness. This battery powers the ESP32-CAM, LiDAR sensor, and buzzer either directly or through a voltage regulator if needed. But Li-Po batteries must be handled carefully they must not be overcharged or discharged too deeply because it can reduce battery life. Overall, this battery is the heart of your system because without stable power, nothing will work. Its size, power efficiency, low weight, and recharge-ability make it ideal for your hardware project.

Fig 4.3: 7V Li-Po Battery

4.4 Piezoelectric Buzzer:

A piezoelectric buzzer which is shown in fig 4.4, is a small sound producing device used to give alerts, warnings, or notifications. It works using a special material inside that vibrates when voltage is applied, creating sound waves. These waves turn into beeps, alarms, or tones that can be heard clearly. In your project, the buzzer is used as an alert mechanism. When the LiDAR detects an object too close or when the system needs to notify the user about danger or action needed, the ESP32-CAM sends a signal to the buzzer, and it starts beeping. It is lightweight, consumes very little power, and works great with microcontrollers because it only needs one GPIO pin to operate. You can program it to beep fast, slow, long, short, or in patterns based on conditions. Buzzers are commonly used in fire alarms, vehicles, appliances, robots, and drone safety systems. They provide immediate feedback to the user without needing a screen. In our case, the buzzer acts as a simple but effective way to warn about obstacles or issues.

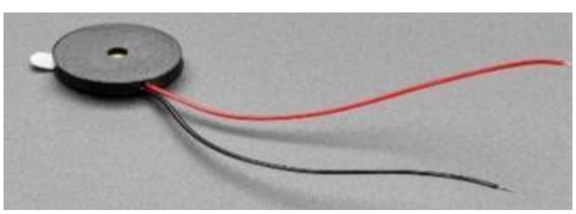

Fig 4.4: PiezoelectricBuzzer

4.5 FTDI Programmer:

In fig 4.5 FTDI programmer is a small USB-to-Serial converter used to upload code to boards like the ESP32-CAM, which do not have built-in USB ports. When you connect the FTDI programmer to your laptop using USB and to the ESP32-CAM using jumper wires, it lets you flash your program directly into the microcontroller. It basically acts as a bridge between your computer and the ESP32CAM. It converts USB signals into serial signals (TX and RX) that the board understands. Without this programmer, you cannot upload code to the ESP32-CAM for the first time. To use it, you connect TX to RX, RX to TX, 5V and GND to power, and also IO0 to GND during uploading. After uploading, you disconnect IO0 so the ESP32-CAM boots normally. FTDI programmers are reliable, cheap, and easy to use. They are essential for many microcontroller boards. Once coding is done, the ESP32-CAM runs independently on the battery without the programmer.

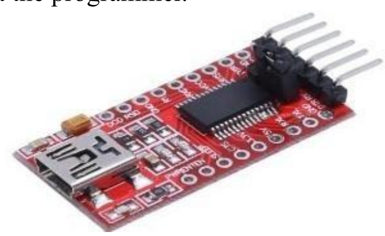

Fig 4.5: FTDI Programmer

4.6 Wi-Fi Antenna for ESP32-CAM:

The Wi-Fi antenna which is in fig 4.6 is an important add-on for the ESP32-CAM because it improves the wireless range and signal strength. The ESP32-CAM already has an internal antenna, but when you need strong connectivity like in drones or long-distance video streaming the external antenna becomes very useful. It helps the device maintain a stable Wi-Fi connection even when it is moving, far away, or facing interference from walls or other signals. This antenna connects to the ESP32-CAM through a small connector (IPEX/U.FL). This is especially important in drone projects because the drone might fly higher or farther from the controller or Wi-Fi hotspot. The antenna itself is lightweight, flexible, and very easy to mount on the drone body. It requires no extra power just plug it into the board and it works. Without a strong antenna, the video stream may break, disconnect, or become very slow. Overall, the Wi-Fi antenna ensures better connectivity, longer range, stable data transfer, and smoother live camera performance. This makes your whole project more reliable and responsive.

Fig 4.6: WiFi Antenna for ESP32-CAM

V. WORKING

5.1 General Approach:

The overall working of the project follows a smooth and logical flow where each component plays its own role to keep the drone safe and provide real-time monitoring. The process starts with powering up the ESP32-CAM using the 3.7V LiPo battery. Once it turns on, the ESP32-CAM connects to WiFi and starts streaming live video. This video can be viewed on any mobile phone or laptop through a normal web browser, so the operator can always see the drone's surroundings while flying.

At the same time, the VL53L0X LiDAR sensor begins measuring the distance between the drone and any object in front of it. It continuously sends laser pulses and receives the reflected light to calculate how far obstacles are. These distance values are given to the ESP32-CAM every millisecond, providing very fast and accurate readings. The ESP32-CAM reads this distance data and checks whether any object is too close or if there is a risk of collision. If the measured distance is lower than the safety limit, the system immediately activates the piezo buzzer. This buzzer gives a loud alert to the operator, helping them react quickly and change the drone's direction.

5.2 Block diagram and its Description:

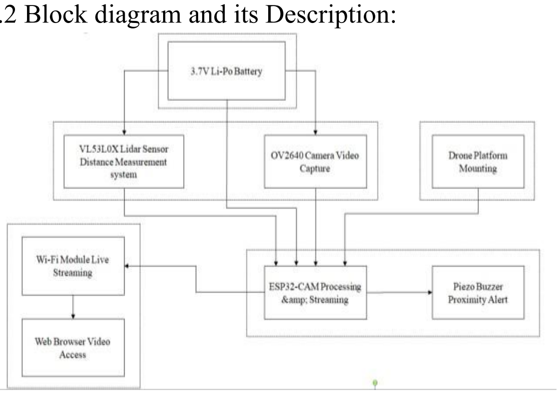

Fig 5.2: Block Diagram of LiDAR based Microdrone for Obstacle.Detection and Live Streaming System

5.3 Block Diagram Description:

The block diagram, fig 5.3 shows how all the important parts of the LiDAR-based microdrone system work together to detect obstacles and stream live video. At the top, the 3.7V Li-Po battery is shown as the main power source. This battery supplies energy to every component, including the LiDAR sensor, the camera module, the ESP32-CAM, and the buzzer. Without this battery, the entire system cannot operate. On one side of the diagram, the VL53L0X LiDAR Sensor is connected. This sensor is used to measure how far an object is from the front of the drone. It continuously sends distance data to the ESP32-CAM so that the system always knows if an obstacle is nearby.

Next to it, the OV2640 Camera Module is shown. This camera captures live video from the drone's surroundings. The video is sent to the ESP32-CAM for processing and streaming. At the center, the ESP32-CAM Processing & Streaming Unit is the main controller. It takes the distance readings from the LiDAR sensor and the video from the camera. It then sends the live video to a web browser and checks if the drone is close to any obstacle.

If an object is too close, the ESP32-CAM activates the Piezo Buzzer, which gives a loud warning sound to alert the user. On the left side, the Wi-Fi module block shows that the ESP32-CAM streams video through Wi-Fi. The user can open any normal web browser to see the live video feed from the drone. Finally, the Drone Platform Mounting block shows that all these components are attached to the drone frame so it can carry them during flight.

VI. RESULTS

The LiDAR-based drone system is expected to navigate safely and autonomously by detecting obstacles and measuring distances in real-time. In Fig 6.1 will demonstrate accurate obstacle avoidance, even in complex or cluttered environments, reducing the risk of collisions. The integration of sensors, microcontrollers, and LiDAR will allow efficient data collection for mapping or environmental monitoring. The project aims to showcase that compact drones can operate intelligently without human intervention, improving reliability and efficiency. Ultimately, this system will provide a foundation for future applications like automated deliveries, surveillance, and smart environmental technology.

Fig 6.1: LiDAR based Microdrone for Obstacle Detection and Live Streaming.

VII. CONCLUSION & FUTURE SCOPE

This project clearly shows how combining LiDAR-based obstacle detection with live video streaming can make drone operation much safer and more reliable. The entire system works together to give both real-time visual monitoring and immediate awareness of obstacles around the drone. The VL53L0X LiDAR sensor continuously measures the distance in front of the drone using laser technology, which makes the readings much more accurate and faster compared to basic sensors. Because of this, the drone can detect objects early and take necessary action before a collision can happen. Along with the sensor, the ESP32-CAM plays a major role by capturing live video and streaming it directly to any device through Wi-Fi.

This allows the operator to see exactly what the drone sees in real time without lag. This feature is extremely useful during navigation, especially in narrow spaces, indoors, or areas with obstacles. The video feed can be accessed through normal web browsers, which means the system does not require any expensive or difficult software. Anyone with a smartphone or laptop can operate it easily. The addition of a small buzzer makes the system even more practical.

Whenever the lidar detects an object coming too close, the buzzer immediately alerts the user. The current lidar-based obstacle detection and live-streaming drone system can be expanded in many useful and exciting directions. One major future improvement is adding autonomous navigation, where the drone can not only detect obstacles but also decide how to avoid them automatically without needing the operator's control. By combining the LiDAR readings with algorithms like SLAM (Simultaneous Localization and Mapping), the drone could create a live map of its surroundings and fly intelligently even in unknown areas. Another important enhancement is integrating AI and computer vision.

The ESP32-CAM or a more powerful processor can be used to detect humans, objects, pathways, or danger zones. This can make the drone suitable for search-and-rescue missions, indoor inspections, agricultural monitoring, and security applications. Adding machine-learning models can also help the drone understand patterns, follow specific targets, or recognize obstacles more accurately. The system can also be extended by using multiple sensors, such as ultrasonic sensors, thermal cameras, GPS modules, or advanced LiDAR units with longer range.

REFERENCES

[1] Kuangyu Zheng, Zimo Ma, Mingyu Zhao, "Joint Efficient UAV Trajectory and Velocity Optimization for IoT Data Collection Using a New Projection Algorithm", Multidisciplinary Digital Publishing Institute, Vol 6, Issue 12, PP 376, (Nov 2022).

[2] Hao Gu, Jie Yang, Chenhan Hu, "Deep Complex Valued Convolutional Neural Network for Drone Recognition Based on RF Fingerprinting", Multidisciplinary Digital Publishing Institute, Vol 6, Issue 12, PP 374, (Nov 2022).

[3] Zixuan Liu, Wei Han, Yu Wu, "Automated Sortie Scheduling Optimization for Fixed-Wing Unmanned Carrier Aircraft and

[4] Unmanned Carrier Helicopter Mixed Fleet Based on Offshore Platform", Multidisciplinary Digital Publishing Institute, Vol 6, Issue 12, PP 375 (Nov 2022).

[5] Jiale Li, Wei Zhou, "Lidar-Assisted UAV Stereo Vision Detection in Railway Freight Transport Measurement", Multidisciplinary Digital Publishing Institute, Vol 6, Issue 11, PP 367, (Nov 2022).

[6] Joseph P. Hupy, Cyril O. Wilson, "Modeling Streamflow and Sediment Loads with a

Photogrammetrically Derived UAS Digital Terrain

[7] Model: Empirical Evaluation from a Fluvial Aggregate Excavation Operation", Multidisciplinary Digital Publishing Institute, Vol 5, Issue 1, PP 20, (Mar 2021).

[8] Arnold Chi Kedia, Christopher Updike, Amy E. Frazier, "An Integrated Spectral–Structural Workflow for Invasive Vegetation Mapping in an Arid Region Using Drones", Multidisciplinary Digital Publishing Institute, Vol 5, Issue 1, PP 19, (Feb 2021).

[9] Alberto Sigala, Brent Langhals: Applications of Unmanned Aerial Systems (UAS), A Delphi Study Projecting Future UAS Missions and Relevant Challenges, Vol 4, Issue 1, PP 8, (Mar 2020).

[10] Faiyaz Ahmed, J. C. Mohanta, Pankaj Singh Yadav, "Recent Advances in Unmanned Aerial Vehicles: A Review", Multidisciplinary Digital Publishing Institute, Springer Link, Vol 5, Issue 47, PP 7963 - 7984 (Apr 2022).

[11] Taleatha Pell, Joan Y. Q. Li, Karen E. Joyce, "Demystifying the Differences between Structure-from-Motion Software Packages for Pre-Processing Drone Data" Multidisciplinary Digital Publishing Institute, Vol 6, Issue 1, PP 24, (Jan 2022).

[12] Mohamed S, & Othman M.F, "Rodent repellent system using ultrasonic and LED light", International Journal of Engineering and Technology, 7(3), PP 123–127, (2018).

[13] Claire Burler, Maisie Rashman, Serge Wich, Andy Symons, Cobus Theron, Steve Long More, "Optimizing observing strategies for monitoring animals using drone mounted thermal infrared cameras", arXiv preprint, (2018).

[14] Perea-Moreno A.J, Hernandez-Escobedo Q & García M.T, "Renewable energy in agriculture", A bibliometric overview, Sustainability, 11(2), PP 595, (2019).

[15] Ma L, Liu Y, Zhang X, Ye Y, Yin G, & Johnson B.A, "Deep learning in remote sensing applications", A meta-analysis and review, ISPRS Journal of Photogrammetry and Remote Sensing, 152, PP 166–177, (2019).

[16] Li S, Su Y, & Li M, "Lidar point cloud classification using deep learning", Sensors 20(5), PP 1259, (2020).

[17] Rojas C.A, & Nielsen M.A, "Autonomous drones and real-time animal monitoring using AI", IEEE Access, 8, PP 189233–189245, (2020).

[18] WirÉD, "Rats Took Over This Pacific Island", Now Drones Are Leading the Fightback, Wired Magazine, (2021).

[19] Zheng Y, & Ge Y, "Smart agricultural drones in pest management", A review Agricultural Sciences,12(6), PP 743–753, (2021).

[20] PLOS Computational Biology, "A Bio-Mimetic Miniature Drone for Real-Time Audio-Backed Short-Range Tracking", (2022).

[21] Coluccia A, Fascista A, Manca D & Dinou A, "Bird detection using deep learning and drones", Sensors,22(3), PP 891, (2022).

[22] Cantu de Leija, M.R.E, Mazzotti, M, Kendall M, D'Ascanio E, Mueller D & Cawlik D, "A meta-analysis of disturbance caused by drones on nesting birds", Journal of Field Ornithology, (2023).