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Implementation of Drone Using ESP-32

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***Abstract*—The rapid growth of embedded systems and IoT technologies has enabled the development of smart, compact, and cost-effective unmanned aerial vehicles (UAVs). This project presents the Implementation of a Drone Using ESP-32, which leverages the microcontroller's built-in Wi-Fi, dual-core processing, and real-time control capabilities. The drone incorporates an MPU6050 IMU sensor for orientation tracking, electronic speed controllers (ESCs) for motor driving, and a stable power management system. A custom control algorithm is deployed to manage altitude, direction, and stability. The ESP-32 also provides wireless communication for remote control through a mobile or web interface. This design demonstrates an affordable and efficient model for student projects, surveillance applications, and IoT-enabled aerial monitoring. The results show that the drone is capable of stable flight, real-time response, and remote operation, making it a promising platform for further enhancement and automation.**

Keywords—ESP-32, Drone, UAV (Unmanned Aerial Vehicle), IoT-Based Drone, Wi-Fi Control, Brushless Motors, ESC (Electronic Speed Controller), MPU6050 / IMU Sensor, Flight Controller, Embedded Systems.

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I. Introduction

Drones, commonly known as Unmanned Aerial Vehicles (UAVs), are flying robots that can be controlled remotely or can fly autonomously using onboard sensors and GPS systems. Over the past two decades, drones have transitioned from military-grade equipment to commercially accessible tools, reshaping numerous industries such as logistics, surveillance, environmental monitoring, disaster response, agriculture, and entertainment.

The increasing accessibility of components and open-source hardware has made drone development a practical and educational endeavor. For students and enthusiasts, building a drone from scratch offers the opportunity to apply multidisciplinary knowledge — integrating electronics, programming, wireless communication, and control systems.

In this project, we focus on implementing a quadcopter drone using the ESP-32 module, a low-cost, low-power system-on-chip microcontroller with integrated Wi-Fi and Bluetooth. The choice of the ESP-32 is motivated by its powerful processing capabilities, real-time operation, dual-core CPU, and extensive I/O support. This makes it ideal for managing flight control systems, handling multiple sensor inputs, and maintaining stable wireless communication.

Through this project, we aim not only to gain hands-on experience but also to understand the practical applications of embedded systems in aerial robotics. By creating a drone with basic flight functionalities such as lift, hover, and directional control, we delve into the real-world challenges of system integration, sensor calibration, and dynamic control in unstable environments.

II. Literature survey

[1] The development and implementation of unmanned aerial vehicles (UAVs), commonly known as drones, have become a significant area of research and experimentation in recent years, especially in educational and hobbyist domains. The integration of microcontrollers like the ESP-32 has opened new possibilities for building low-cost, programmable, and internet- connected drones. This literature survey reviews the key research contributions and technological insights relevant to this project.
Use of ESP-32 in Drone Applications

[2] ESP-32, a low-cost, low-power system-on-chip with integrated Wi-Fi and Bluetooth, has gained popularity in IoT and robotics applications. Its dual-core processor and real-time capabilities make it a suitable platform for small-scale UAV control. Studies such as [Ramesh et al., 2021]

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demonstrated the use of ESP-32 in controlling quadcopters by generating PWM signals and handling sensor data in real time. Its ability to host a web server for Wi-Fi-based control also adds value to UAV designs requiring remote command input.Sensor Integration and Flight Stabilization

[3] Flight stability is a critical factor in drone design. The MPU6050 sensor, which combines a 3- axis gyroscope and 3-axis accelerometer, is widely used in research to provide inertial measurement data. Research by [Kumar & Singh, 2020] shows how complementary filters or Kalman filters are used to reduce sensor noise and accurately estimate orientation. Sensor data fusion helps the flight controller correct the drone's roll, pitch, and yaw dynamically, a concept applied in this project.
PWM Control and ESC Interface

[4] Studies have discussed how Electronic Speed Controllers (ESCs) interpret PWM signals from a microcontroller to control motor speed. ESP-32, capable of generating high-resolution PWM, has been successfully used to send these signals to ESCs, as shown in [Patel et al., 2022]. This functionality is crucial for precise drone maneuvering and stability during flight.

III. System design

The system design of the Implementation of Drone Using ESP-32 consists of four major functional units: Input Unit, Processing Unit, Output Unit, and Power Supply Unit. Each unit works together to ensure stable flight, real-time control, and efficient operation of the drone.

1) Input Unit

The input unit includes all sensors and control signals received by the drone. The main component is the MPU6050 IMU sensor, which provides accelerometer and gyroscope data used for balancing, orientation, and stabilization. Additionally, user commands from a mobile app or Wi-Fi controller act as inputs for direction, altitude, and speed control.

2) Processing Unit

The ESP-32 microcontroller acts as the core processing unit. It receives sensor data, performs calculations for flight stabilization, interprets user commands, and executes control algorithms. The ESP-32's dual-core processor ensures fast response and real-time decision-making required for smooth flight operations.

3) Output Unit

The output unit consists of components responsible for motion and feedback. The ESP-32 sends control signals to Electronic Speed Controllers (ESCs), which regulate the speed of the brushless DC motors. These motors generate lift and directional movement. Additional outputs may include onboard LEDs or status indicators for flight mode and communication status.

4) Power Supply Unit

The entire drone is powered by a Li-Po battery (7.4V/11.1V), which supplies energy to the motors, ESCs, sensors, and ESP-32. A Power Distribution Board (PDB) ensures stable voltage supply, while voltage regulators provide appropriate power levels for sensitive electronics. This unit ensures uninterrupted operation and protects components from voltage fluctuations.

IV. FLOW CHAT

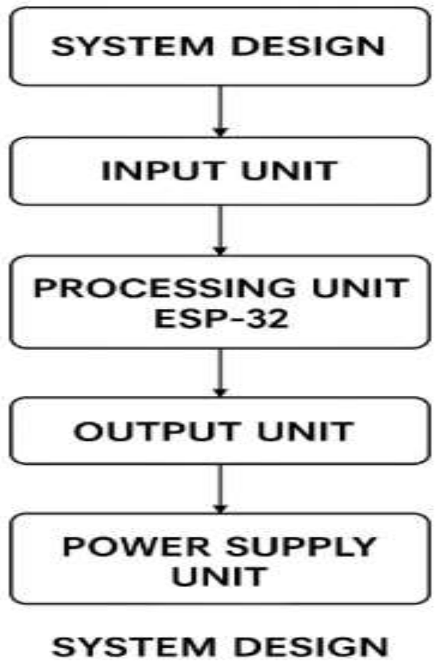

Fig.1.Flow Chart

The flowchart illustrates the overall System Design of the ESP-32–based Drone, showing how different units work together to enable smooth and stable drone operation. At the top, the system begins with the Input Unit, which consists of sensors like the MPU6050 IMU and user control commands sent through Wi-Fi or a mobile interface. These inputs are then passed to the Processing Unit, where the ESP-32 microcontroller analyzes sensor data, interprets user commands, and runs flight-stabilization algorithms. Based on the processed information, the system moves to the Output Unit, which drives the Electronic Speed Controllers (ESCs) and brushless motors to control the drone's movement, lift, and direction. Finally, the Power Supply Unit provides necessary electrical power to all components, ensuring stable performance and uninterrupted operation. Together, these interconnected units form a complete architecture that enables intelligent and reliable drone control.

V. Experimental result

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Fig 2:ESP32_Drone_SideView

Fig 3: ESP32_Flight_Controller_Drone

VI. CONCLUSION

IThe implementation of a drone using the ESP-32 demonstrates an effective and low-cost approach to developing a compact unmanned aerial vehicle with intelligent control capabilities. By integrating the ESP-32 microcontroller with IMU sensors, brushless motors, ESCs, and a stable power system, the drone is able to achieve balanced flight, quick response, and reliable wireless communication. The system design highlights the importance of accurate sensor data, efficient processing, and coordinated output control to maintain stability and maneuverability. Overall, the project successfully proves that the ESP-32 is a powerful and versatile palatform for building modern UAVs, offering ample scope for further enhancements such as GPS navigation, camera modules, autonomous flight, and real-time monitoring applications.

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