A GPS based Drone for Environmental Conservation

Course Title: Microprocessors, Microcontrollers and Embedded Systems Lab

Course Code:CSE-3524

Section:5CM

Submitted to:

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Introduction

In this microprocessor project, we explore the design and implementation of a drone, highlighting the integration of microprocessor technology in modern robotics. The project involves developing the drone's control system, programming flight algorithms, and interfacing various sensors for real-time data acquisition and processing. Through this project, we aim to demonstrate the crucial role of microprocessors in managing complex tasks, ensuring precise control, and enhancing the overall functionality of unmanned aerial vehicles. This hands-on experience not only reinforces theoretical knowledge but also provides practical skills in embedded systems and automation.

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Objectives:

1. Design and build a functional drone incorporating a microprocessor for control and data processing.
2. Develop and implement flight control algorithms to ensure stable and efficient drone operation.
3. Integrate and interface sensors for real-time data collection and environmental interaction.

4. Enhance understanding of microprocessor-based system design and embedded programming.
5. Demonstrate the application of microprocessors in robotics and automation through practical implementation.

Equipment:

1.3DR Power Module:

Description:

The 3DR Power Module is a compact device designed to supply clean power to a drone's flight controller while providing real-time voltage and current monitoring. It features a built-in 5.3V regulator, ensuring stable power delivery, and includes a 6-position cable for easy connection to compatible flight controllers. The module supports input voltages of up to 30V and can handle a current load of up to 90A, making it suitable for a variety of drone applications.

Working Principle:

The 3DR Power Module operates by connecting to the drone's battery and providing a regulated 5.3V output to power the flight controller. It monitors the battery's voltage and current using built-in sensors. This data is transmitted to the flight controller, enabling real-time monitoring of the power supply. The module ensures stable power delivery while protecting the system from voltage fluctuations and overcurrent conditions.

2.B3 Charger and Battery:

Description:

LiPo Battery: A LiPo (Lithium Polymer) battery is a rechargeable battery commonly used in drones due to its high energy density, lightweight, and flexible shape. It provides a stable voltage and can deliver high current, making it ideal for high-performance applications. LiPo batteries require careful handling and management to ensure safety and longevity.

B3 Charger: The B3 Charger is a compact and user-friendly charger specifically designed for charging 2S and 3S LiPo batteries. It features a simple interface with LED indicators to display the charging status of each cell. The B3 Charger ensures balanced charging, which helps maintain battery health and performance by equalizing the voltage across all cells.

Working Principle:

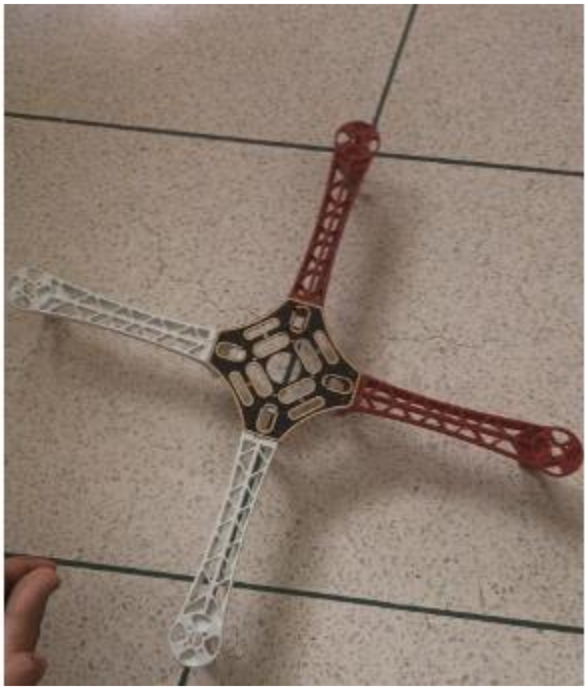
Working Principle of LiPo Battery

A Lithium Polymer (LiPo) battery consists of multiple cells containing a lithium-ion polymer electrolyte. During charging, lithium ions move from the positive electrode (cathode) to the negative electrode (anode) through the electrolyte. During discharging, this process reverses, and lithium ions move back to the cathode, releasing energy to power devices. LiPo batteries are known for their high energy density, lightweight, and ability to provide high discharge rates, making them ideal for applications like drones.

Working Principle of B3 Charger

The B3 charger is a simple and compact balance charger specifically designed for LiPo batteries. It operates by connecting each cell of the LiPo battery to individual charging circuits. The charger ensures that each cell is charged to the same voltage, preventing overcharging or undercharging of any cell. It typically has LED indicators to show the charging status. By balancing the cells, the B3 charger maximizes the battery's lifespan and ensures safe and efficient charging.

3.Frame:



Description:

The drone frame is the structural skeleton that supports all the components of the drone, including motors, propellers, batteries, and electronics. Typically constructed from lightweight yet strong materials like carbon fiber or aluminum, the frame is designed to ensure stability and durability during flight. It provides mounting points for the flight controller, power distribution board, and other essential parts, while also maintaining an optimal layout for weight distribution and aerodynamic efficiency. The design of the frame is crucial for the overall performance, agility, and endurance of the drone.

Working Principle:

The frame of a drone serves as the structural backbone, providing support and housing for all the components. It is typically made from lightweight yet strong materials such as carbon fiber, aluminum, or plastic to ensure durability while minimizing weight. The frame's design includes arms that extend to mount the motors and propellers, ensuring balanced thrust distribution. It also features mounting points for the flight controller, battery, and other essential components. By maintaining structural integrity and optimal weight distribution, the frame ensures stability, maneuverability, and efficient flight performance.

4. ArduCopter(APM 2.8):

Description:

The ArduCopter APM 2.8 is an advanced autopilot system designed for multi-rotor aircraft, providing full control and stabilization for drones. It features an Atmel ATMEGA2560 microcontroller, a range of onboard sensors including a gyroscope, accelerometer, magnetometer, and barometer, which enable precise flight control and navigation. The APM 2.8 supports various flight modes such as GPS waypoint navigation, loiter, return-to-home, and altitude hold. It is compatible with the Mission Planner software, allowing users to plan missions, update firmware, and monitor real-time telemetry data. The APM 2.8 is renowned for its versatility, reliability, and ease of use, making it a popular choice for both hobbyists and professionals in the field of unmanned aerial vehicles (UAVs).

Working Principle:

The ArduCopter APM 2.8 is an open-source flight controller that manages and stabilizes a drone's flight. Its working principle involves several key components and processes:

1. **Sensors Integration**: The APM 2.8 integrates various sensors, including gyroscopes, accelerometers, magnetometers, and barometers, to gather real-time flight data. These sensors monitor the drone's orientation, position, and altitude.
2. **Microcontroller Processing**: The onboard microcontroller processes the sensor data and executes flight algorithms. It calculates the necessary adjustments to maintain stability and control based on the input from the pilot or autonomous flight plan.
3. **Motor Control**: The APM 2.8 sends control signals to the Electronic Speed Controllers (ESCs) connected to the motors. By adjusting the speed of each motor, the flight controller manages the drone's movements, such as pitch, roll, yaw, and throttle.
4. **GPS and Navigation**: With an optional GPS module, the APM 2.8 can perform advanced functions like waypoint navigation, return-to-home, and position hold. The GPS provides accurate location data, which the flight controller uses for precise navigation.
5. **Flight Modes**: The APM 2.8 supports various flight modes, including manual, stabilized, altitude hold, and autonomous missions. Pilots can switch between these modes based on their needs and skill level.
6. **Communication**: The flight controller interfaces with the ground control station via telemetry modules, allowing for real-time monitoring, mission planning, and parameter adjustments.

Through these components and processes, the APM 2.8 ensures stable, controlled, and versatile drone operation, supporting both manual piloting and autonomous flight missions.

5. M8N GPS:

Description:

The M8N GPS module is a compact and highly accurate Global Navigation Satellite System (GNSS) receiver. It supports multiple satellite constellations including GPS, GLONASS, Galileo, and BeiDou, providing precise positioning and navigation capabilities. The module features fast acquisition and strong signal reception, making it suitable for applications requiring reliable GPS data, such as drones, UAVs, and other mobile devices.

Working Principle:

The M8N GPS module operates based on signals received from multiple satellite constellations (e.g., GPS, GLONASS, Galileo, BeiDou). Here's how it works:

1. **Satellite Signal Reception**: The module receives signals transmitted by satellites orbiting the Earth. These signals contain timing and positioning information.
2. **Signal Processing**: The M8N GPS module uses a receiver to process the signals received from at least four satellites simultaneously. It calculates the distances to each satellite based on the time it takes for signals to travel from the satellites to the module.
3. **Position Calculation**: Using the distances from multiple satellites, the module calculates its precise latitude, longitude, and altitude. This process is known as trilateration.

By continuously receiving and processing satellite signals, the M8N GPS module provides reliable and accurate positioning information essential for navigation, mapping, and autonomous operation in various applications

6.845 Propeller:

Description:

The "845" propeller typically refers to its dimensions, where "8" denotes the diameter in inches and "4.5" signifies the pitch or the distance the propeller would theoretically move forward in one revolution if there were no slippage. Propellers of this size are commonly used in smaller drones and RC aircraft where efficiency and maneuverability are essential. They are designed to provide a balance between thrust, efficiency, and stability during flight, making them suitable for a wide range of aerial applications.

Working Principle:

The working principle of an "845" propeller revolves around aerodynamic principles and its interaction with the surrounding air. Here’s how it works:

1. **Thrust Generation**: When the propeller rotates, its angled blades create a pressure difference between the front and back surfaces of each blade. This pressure difference generates thrust, propelling the drone forward (or upward, depending on orientation).
2. **Pitch and RPM**: The "4.5" pitch means that in one full revolution, the propeller theoretically moves forward 4.5 inches in ideal conditions (without considering slip). The actual movement depends on the RPM (revolutions per minute) of the propeller.
3. **Efficiency and Load**: The efficiency of the propeller depends on its design, material, and the power provided by the motors. The propeller must be balanced to minimize vibrations and maximize efficiency. It also needs to withstand the aerodynamic forces and loads during flight.

In summary, the "845" propeller transforms the rotational energy from the drone's motors into thrust through aerodynamic principles, enabling controlled flight and maneuverability. Its design and dimensions are crucial factors in determining the overall performance and efficiency of the drone.

7.Microzone 6C Transmitter:

Description:

The Microzone 6C transmitter is a compact and versatile radio controller designed for remote operation of RC (Radio Control) vehicles, including drones, airplanes, and cars. Key features typically include:

1. **Channels and Controls**: It offers multiple channels for precise control of various functions, such as throttle, pitch, roll, yaw, and auxiliary controls.
2. **Frequency and Range**: Operates on a specific frequency band (often 2.4GHz) to ensure reliable communication with the receiver in the RC vehicle. Provides a stable control range suitable for various applications.
3. **Ergonomic Design**: Designed for comfort and ease of use during prolonged operation, featuring ergonomic grips and intuitive button layout for quick access to essential controls.
4. **Battery**: Powered by replaceable batteries or rechargeable packs, providing extended operation time depending on usage and battery capacity.

The Microzone 6C transmitter serves as a reliable and user-friendly interface between the operator and their RC vehicle, offering precise control and flexibility for hobbyists and enthusiasts alike.

Working Principle:

The Microzone 6C transmitter operates on the principle of radio frequency (RF) communication to wirelessly control RC vehicles. Here's how it works:

1. **Radio Frequency Transmission**: The transmitter emits radio waves on a specific frequency band (typically 2.4GHz) that are received by the receiver unit installed in the RC vehicle.
2. **Channel Assignment**: The transmitter assigns different channels to control various functions of the RC vehicle, such as throttle, steering, and auxiliary controls. Each channel corresponds to a specific control input (e.g., joystick, switch) on the transmitter.
3. **Signal Encoding**: The transmitter encodes control inputs into digital signals, ensuring accurate and reliable transmission to the receiver unit. This encoding method prevents interference and ensures that commands are correctly interpreted by the RC vehicle.
4. **Range and Stability**: The transmitter and receiver maintain a stable communication link within a specified range, allowing operators to control their RC vehicles effectively without signal dropout or latency issues.

In essence, the Microzone 6C transmitter enables precise and responsive control over RC vehicles through reliable RF communication, providing hobbyists and enthusiasts with a versatile tool for enjoying and mastering their remote-controlled adventures

8.FPV Setup:

Description:

An FPV (First Person View) setup is a configuration used in remote-controlled vehicles, especially drones and RC cars, to provide a real-time video feed from the vehicle's perspective to the operator. Here's a description of an FPV setup:

1. **Camera**: A small, lightweight camera mounted on the vehicle captures live video footage. FPV cameras are designed for low latency and high resolution to provide a clear view of the surroundings.
2. **Transmitter**: The FPV camera sends the video signal wirelessly to a video transmitter (VTX) onboard the vehicle. The transmitter broadcasts the video signal on a specific frequency (e.g., 5.8GHz) to avoid interference with other devices.
3. **Receiver**: On the ground, a video receiver (VRX) receives the transmitted signal. The receiver is connected to FPV goggles or a monitor used by the operator to view the live video feed.
4. **Antennas**: Both the transmitter and receiver use antennas to improve signal transmission and reception. Circular polarized antennas are commonly used for their efficiency in reducing signal loss and interference.
5. **Battery and Power Supply**: The FPV setup requires power sources for both the vehicle's transmitter and camera, as well as for the receiver and display device used by the operator.
6. **Control Integration**: FPV setups are integrated with the RC transmitter used for controlling the vehicle. Operators use the same controls to maneuver the vehicle while simultaneously viewing the live video feed.

FPV setups enhance the remote control experience by providing a real-time visual perspective, allowing operators to navigate with precision and enjoy immersive, thrilling flights or drives from the vehicle's viewpoint.

Working Principle:

The working principle of an FPV (First Person View) setup involves:

1. **Camera**: A small camera mounted on the vehicle captures live video.
2. **Transmitter**: The camera's video signal is wirelessly transmitted to a ground receiver.
3. **Receiver**: The ground receiver receives the video signal and sends it to FPV goggles or a monitor.

4. **Display**: FPV goggles or a monitor displays the live video feed, providing the operator with a real-time view from the vehicle's perspective.
5. **Control Integration**: Operators use an RC transmitter to control the vehicle while viewing the live video feed, enabling immersive and precise remote operation.

Discussion:

Caution:

1.Safety Concerns:

- Ensure all drone operations adhere to safety regulations to prevent accidents.
- Implement fail-safes to handle loss of control or signal to prevent crashes.

2. Legal Compliance:
- Obtain necessary permissions for drone flights and comply with local aviation laws.
- Respect privacy laws to avoid unauthorized surveillance or data collection.

3. Environmental Factors:
- Be cautious of weather conditions that may affect drone stability and performance.
- Avoid flying near restricted areas such as airports or military zones.

Findings:

1. Performance:
- The microprocessor efficiently handles real-time flight control and navigation tasks.
- Sensor integration (e.g., GPS, accelerometers) provides accurate positioning and stability.

2. Battery Life:
- Power consumption by the microprocessor and other components affects the overall flight duration.
- Optimizations can be made to extend battery life without compromising performance.

3. Autonomy:

- Implementing autonomous navigation algorithms enables the drone to perform complex tasks without manual intervention.
- AI-based obstacle detection and avoidance significantly improve operational safety.

Output:

1. Flight Stability:
- The drone maintains stable flight under various conditions, demonstrating effective control by the microprocessor.

2. Data Collection:
- Successfully captures high-quality data (e.g., aerial photos, videos) using onboard sensors and cameras.
- Real-time data transmission to a ground station for monitoring and analysis.

3. User Interface:
- Development of an intuitive interface for controlling and monitoring the drone enhances user experience.
- Real-time feedback on drone status and environmental conditions.

Back draws:

1. Range:
- Limited communication range between the drone and the control station restricts operational distance.

2. Processing Power:
- The microprocessor might struggle with advanced image processing or AI tasks due to limited computational capabilities.

3. Environmental Adaptation:
- Challenges in adapting to extreme weather conditions or varying terrains.

4. Battery Efficiency:
- The current power management system may not be optimized for prolonged flight times.

Improvements:

1. Enhanced Communication:

- Implement longer-range communication modules to extend the operational range of the drone.
- Utilize advanced protocols for more reliable data transmission.

2. Processing Upgrades:
- Integrate more powerful microprocessors or co-processors to handle intensive computational tasks.
- Offload complex processing tasks to edge computing devices or cloud-based services.

3. Power Management:
- Optimize power consumption strategies, including better battery technology and energy-efficient components.
- Explore renewable energy sources such as solar panels for extended flight capabilities.

4. Advanced Sensors:
- Integrate additional sensors (e.g., LiDAR, thermal cameras) for improved environmental awareness and versatility.
- Implement sensor fusion techniques to enhance data accuracy and reliability.

5. Autonomous Capabilities:
- Develop and integrate more sophisticated AI algorithms for fully autonomous navigation and decision-making.
- Improve obstacle detection and avoidance systems using machine learning techniques.

6. Modular Design:
- Create a modular design to easily swap out or upgrade components as technology advances.
- Allow customization based on specific mission requirements (e.g., payload capacity, sensor types).

Conclusion:

The drone project utilizing a microprocessor demonstrates significant potential in terms of performance, data collection, and user experience. However, there are areas needing improvement, such as communication range, processing power, and battery efficiency. By addressing these limitations and incorporating advanced technologies, the project can achieve enhanced functionality, autonomy, and broader applicability in various fields, such as surveillance, agriculture, and delivery services.