NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY, ISLAMABAD

SCHOOL OF MECHANICAL & MANUFACTURING ENGINEERING

Topic: Autonomous Navigation Drone: Working Principle

Assignment: 1

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Introduction:

Autonomous navigation drones are unmanned aerial vehicles (UAVs) that can fly and navigate without human intervention. These drones use various sensors and algorithms to perceive their environment, make decisions, and execute actions to reach their destination. This article explains the working principle of an autonomous navigation drone, focusing on its perception, decision-making, and control components.

1. Perception

The perception component of an autonomous navigation drone is responsible for sensing and interpreting the environment. This component typically includes cameras, lidars, ultrasonic sensors, and GPS receivers.

1.1. Vision-based Perception

Vision-based perception is a common approach for autonomous navigation drones. This method uses cameras to capture images of the environment and then processes these images using computer vision algorithms to extract relevant features, such as objects, obstacles, and landmarks.

One example of a vision-based perception algorithm is the You Only Look Once (YOLO) algorithm, which is a real-time object detection system that can detect and classify objects in images. This algorithm can be used to detect obstacles, such as trees, buildings, and other drones, in the environment.

1.2. Lidar-based Perception

Lidar (Light Detection and Ranging) is a remote sensing method that uses laser light to measure distances to objects. Lidar sensors can provide accurate and dense 3D point clouds of the environment, which can be used for obstacle detection, mapping, and localization.

Lidar-based perception algorithms can use point cloud data to segment the environment into different regions, such as free space, obstacles, and unknown areas. These algorithms can also use the point cloud data to create 3D maps of the environment, which can be used for path planning and navigation.

2. Decision-making

The decision-making component of an autonomous navigation drone is responsible for making decisions based on the perceived environment. This component typically includes path planning algorithms and decision-making algorithms.

2.1. Path Planning

Path planning algorithms are used to find a path from the current position of the drone to its destination. These algorithms can use various techniques, such as graph search, sampling-based planning, and optimization-based planning.

One example of a path planning algorithm is the Rapidly-exploring Random Tree (RRT) algorithm, which is a sampling-based planning algorithm that can find a path in complex environments. This algorithm can be used to find a path around obstacles and through narrow passages.

2.2. Decision-making

Decision-making algorithms are used to make decisions based on the current state of the drone and the perceived environment. These algorithms can use various techniques, such as rule-based systems, decision trees, and artificial neural networks.

One example of a decision-making algorithm is the Finite State Machine (FSM) algorithm, which is a rule-based system that can switch between different states based on the current state of the drone and the perceived environment. This algorithm can be used to handle different scenarios, such as obstacle detection, landing, and take off.

3. Control

The control component of an autonomous navigation drone is responsible for executing the decisions made by the decision-making component. This component typically includes motor controllers, flight controllers, and communication systems.

3.1. Motor Controllers

Motor controllers are used to control the motors of the drone. These controllers can use various techniques, such as PID (Proportional-Integral-Derivative) control, to regulate the speed and direction of the motors.

3.2. Flight Controllers

Flight controllers are used to stabilize and control the drone. These controllers can use various techniques, such as sensor fusion and Kalman filtering, to estimate the state of the drone and adjust the motor commands accordingly.

3.3. Communication Systems

Communication systems are used to transmit data between the drone and the ground station. These systems can use various techniques, such as Wi-Fi, Bluetooth, and cellular networks, to transmit data in real-time.

4. Conclusion

Autonomous navigation drones are complex systems that require advanced sensors, algorithms, and control systems. These drones use vision-based and lidar-based perception algorithms to sense and interpret the environment, path planning and decision-making algorithms to make decisions, and motor controllers, flight controllers, and communication systems to execute the decisions. By integrating these components, autonomous navigation drones can fly and navigate without human intervention, enabling various applications, such as inspection, surveillance, and delivery.