Lab 3

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ABSTRACT

This lab focuses on implementing an autonomous line-following algorithm for the Parrot Mambo drone. The objective is to enable the drone to take off, track a designated colored line (Red/Green/Blue) using its onboard sensors or an external vision system, and land automatically at the designated finish point.

1. INTRODUCTION

This lab focuses on developing a Simulink-based model that enables the Parrot Mini drone to autonomously detect and follow a colored line while ensuring stable flight. The drone is programmed to track the designated path using its onboard camera and image processing capabilities. Once a circular marker is detected, the drone initiates an automatic landing sequence. The implementation integrates vision-based navigation, state-based control logic, and position override mechanisms to achieve smooth and autonomous flight. This experiment demonstrates fundamental concepts in autonomous UAV control, including sensor integration, state machine logic, and computer vision-based navigation.

2. METHOD

The Parrot Mambo drone is connected to the host computer via Bluetooth, with connectivity verified by pinging the IP address “192.168.3.1.” MATLAB is then launched, and the command “parrotMinidroneKeyboardControl” is executed before starting the Simulink instance. Opening the Flight Control System model and navigating to the Path Planning sub-model reveals critical components such as keyboard control logic, vision-based data processing, and landing enable logic. These modules will be modified to incorporate a state flowchart, enabling the drone to autonomously track and follow a line while overriding manual control inputs. The key objective is to ensure that the drone seamlessly transitions from manual control to autonomous navigation based on vision-based feedback.

2.1 Position Control Logic Override

To enable autonomous flight, the outputs x_{out}, y_{out}, and z_{out} from the state flowchart are fed directly into the keyboard control logic. These signals bypass manual input and are directly sent to the motor control commands, ensuring that the drone moves based on real-time vision-based data rather than user inputs. This override mechanism allows for fully autonomous navigation once the drone detects the colored path.

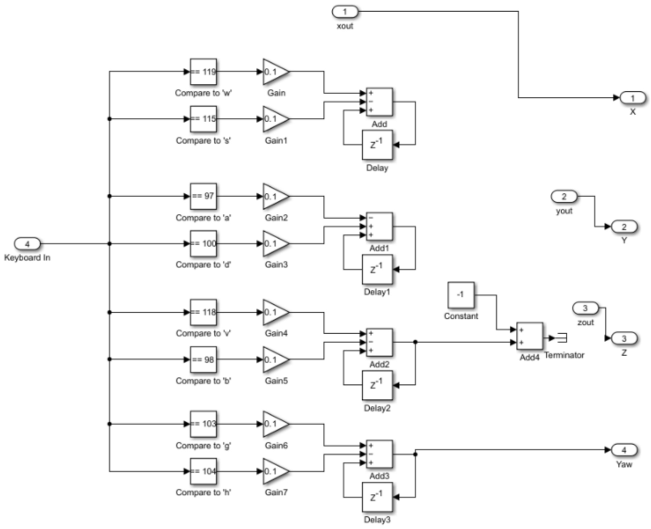

Fig 2.1 Position Control Logic Override Sub System

2.2 Image Processing System

The image processing system is responsible for detecting and tracking the designated colored line using the drone's onboard camera. It consists of functions for image capture, masking, and Boolean output generation, which allow the system to interpret visual data and translate it into navigational commands. A video viewer is implemented to display both RGB and binary (BW) images for validation, ensuring accurate processing of the detected path. The createGreenLineMask MATLAB function processes images from the drone's camera by isolating the green color and converting it into a binary format. Once the number of detected white pixels exceeds a predefined threshold, a control signal is generated, guiding the drone along the path.

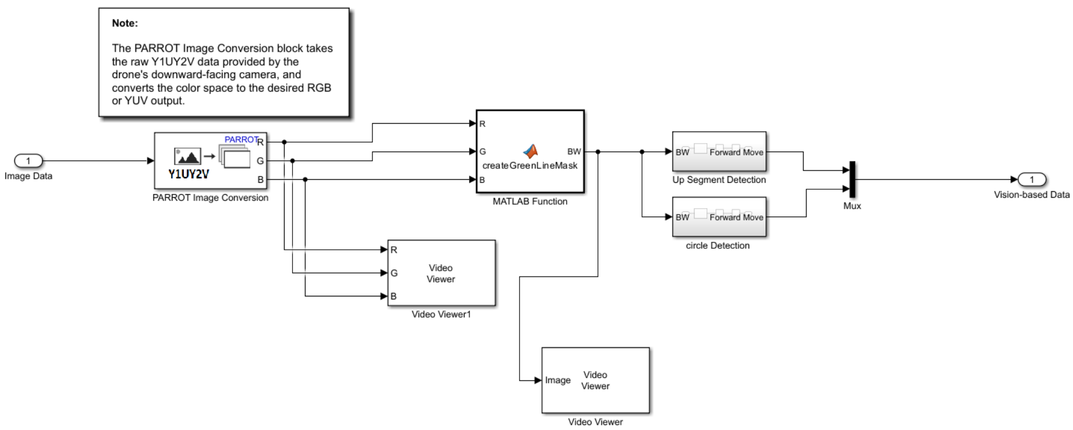

Fig 2.2 Image Processing System

2.3 Landing Enable

The landing enable logic is designed to trigger a landing flag within the Parrot Mambo drone's flight control system. The Boolean output from the image processing system is integrated into the OR block of the landing sub-model, which has been modified to accept three input ports. During execution, the drone initially follows keyboard commands for manual control. However, once it detects the designated colored block or circular marker, the system automatically transitions to autonomous mode, triggering the landing flag. This ensures that the drone autonomously identifies and lands at the predefined endpoint without user intervention.

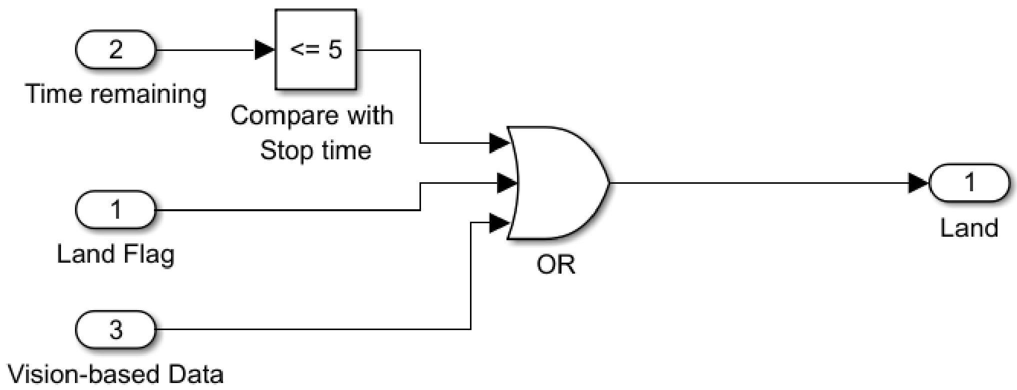

Fig 2.3 Landing Enable Logic

2.4 State Flowchart for Drone movement

The state flowchart defines the sequential decision-making process that enables the Parrot Mambo drone to autonomously follow a colored line and land upon detecting a circular marker. The system consists of three primary states:

- Takeoff State – Commands the drone to hover at a stable height of 1.1 meters, ensuring a steady starting position for navigation.
- Move Forward State – Propels the drone forward along the detected colored line while continuously adjusting its trajectory based on real-time visual feedback.
- Land State – Initiates the landing flag, signaling the drone to safely descend and land upon detecting the predefined circular marker.

By implementing this state-based control system, the drone can operate autonomously with minimal external input, demonstrating key principles of robotic perception, navigation, and control.

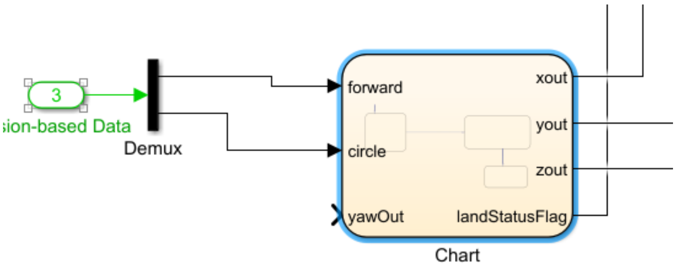

Fig 2.4 State Flow Chart Overlay

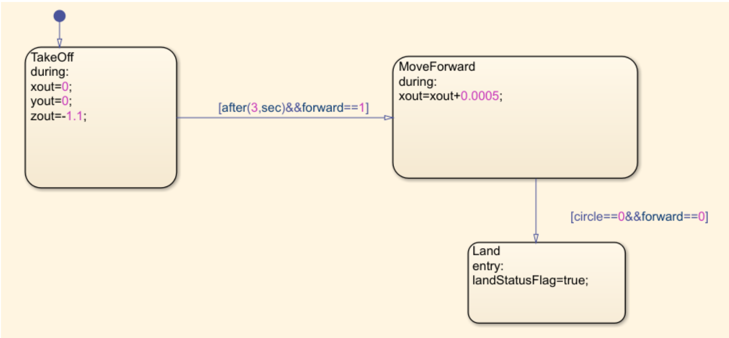

Fig 2.5 State Flow Chart Logic

3. RESULTS

Upon successfully loading the program onto the drone and starting the flight control system, the drone autonomously tracks the designated colored line, continuously adjusting its position based on real-time visual feedback. When the circular marker is detected, the landing logic is triggered, and the drone executes a smooth and precise landing. The results confirm that the implemented vision-based navigation and state control logic allow the drone to effectively track a path, override manual controls, and land autonomously.