Color-Based Object Detection Using Parrot Mambo Drone Camera

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ABSTRACT

Drones have become an essential tool for autonomous navigation, surveillance, and object detection in various applications. In this project, we utilized the Parrot Mambo drone, a lightweight and programmable quadcopter, to detect objects based on their color properties. The primary objective was to identify and track objects of specific colors—Red, Green, Blue, and Yellow—using the drone's onboard camera. To achieve this, we leveraged MATLAB for image processing and object recognition. The drone captured real-time images, which were then processed using color segmentation techniques in MATLAB. The RGB color model was used to filter and isolate objects of the targeted colors, and a thresholding approach was applied to enhance detection accuracy. Additionally, basic morphological operations were implemented to reduce noise and improve the reliability of object identification. Through this approach, we successfully detected and highlighted the desired objects within the drone's field of view. This project demonstrates the potential of computer vision and UAV-based object tracking for applications in robotics, automation, and smart surveillance. Future enhancements could include integrating machine learning algorithms for more robust detection and extending the system for real-world applications like autonomous search-and-rescue missions and industrial inspections.

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1. INTRODUCTION

Drones have gained significant attention in recent years due to their versatility and applications in various fields, including aerial photography, surveillance, and automation. The Parrot Mambo, a compact and beginner-friendly drone, serves as an excellent platform for learning and experimentation. With its downward-facing camera, onboard sensors, and stable flight capabilities, it provides a foundation for developing computer vision algorithms. This project focuses on utilizing the Parrot Mambo drone for color-based object detection, demonstrating its potential for vision-based tasks.

The primary objective of this project is to detect objects of specific colors—Red, Green, Blue, and Yellow—using the Parrot Mambo's camera feed and process the data in MATLAB. By leveraging image processing techniques, we extract meaningful color information from captured images, allowing the drone to recognize and track objects. The combination of color segmentation, thresholding, and morphological operations ensures accurate and efficient object detection.

With its auto takeoff and landing features, FPV mode, and onboard stabilization sensors, the Parrot Mambo drone provides a reliable platform for real-time image processing. The project aims to develop a color detection system using Parrot Mambo drone's camera to identify red, green, blue, and yellow blocks from approximately 3 feet height. Upon successful color detection, the drone should respond by spinning its motors at minimal gain, demonstrating object recognition capabilities.

2. METHOD

In this section, we outline the methodology used to enable the Parrot Mambo Mini drone to detect specific colours—Red, Green, Blue, and Yellow—using MATLAB and Simulink. The process involved multiple steps, including setting up the drone, utilizing MATLAB's Color Thresholding App to create functions for detecting specific colours, and integrating these functions into Simulink's image processing block. Initially, the drone was configured and tested using predefined examples from the MATLAB ofr Parrot Mini Drone documentation. A Simulink template with image processing and flight control blocks was then used to implement a vision-based algorithm. The captured images from the drone camera were processed to develop colour detection functions, which were subsequently integrated into the Simulink model. Finally, the flight controller was modified so that the drone's rotors would activate only upon detecting the specified colour. The following steps provide a detailed breakdown of this process.

2.1 Setting up the Parrot Mambo Mini drone

The drone was initially tested using example scripts from the MATLAB documentation. These scripts ensured proper connectivity and functionality. The Simulink template for the Parrot Mini drone was loaded, which contained predefined blocks for image processing and flight control. Reference: MATLAB Parrot Mambo Documentation

Figure 1. Parrot Mambo mini drone working

2.2 Image Processing and Color Detection Implementation

To begin the process, Simulink was launched, and the Parrot Mini drone template was selected to establish the framework for the Image processing model. Once the template was loaded, the image processing block was thoroughly analyzed to understand its structure and workflow. This step was crucial to ensure that the model was correctly configured for integration with the drone's camera system. Following the guidelines provided in the MATLAB Image Processing Guide, a vision-based algorithm was developed and implemented within the image processing block. The algorithm was designed to detect and process color information from the captured images.

On command we run *openExample('parrot/GettingStartedWithVisionOnPARROTExample')* which opens an example to understand Image Processing and Flight Control functions in Simulink. A video viewer was integrated into the Simulink model, enabling real-time visualization of the processed frames. This feature allowed for immediate feedback and verification of the image processing results. The drone's camera was employed to capture images of red, green, blue, and yellow blocks, which served as test subjects for the color detection algorithm. These images were subsequently used for thresholding, enabling the algorithm to identify and distinguish between the different colors.

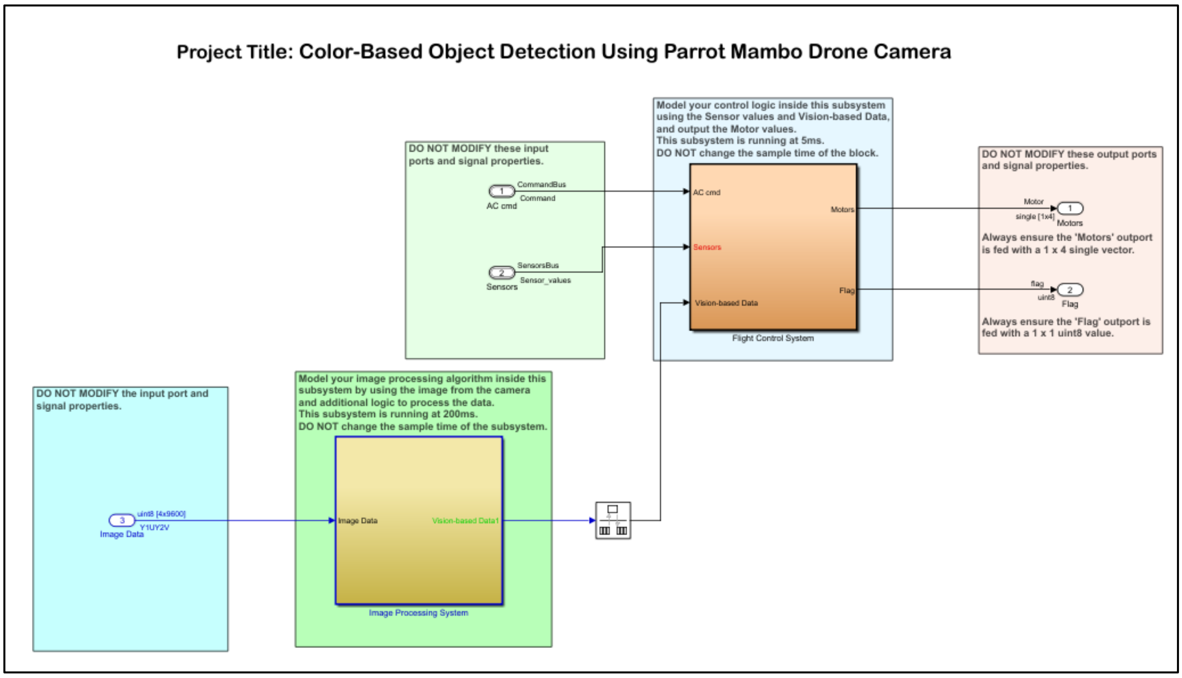

Figure 2. Simulink Mini drone Template for Image Processing

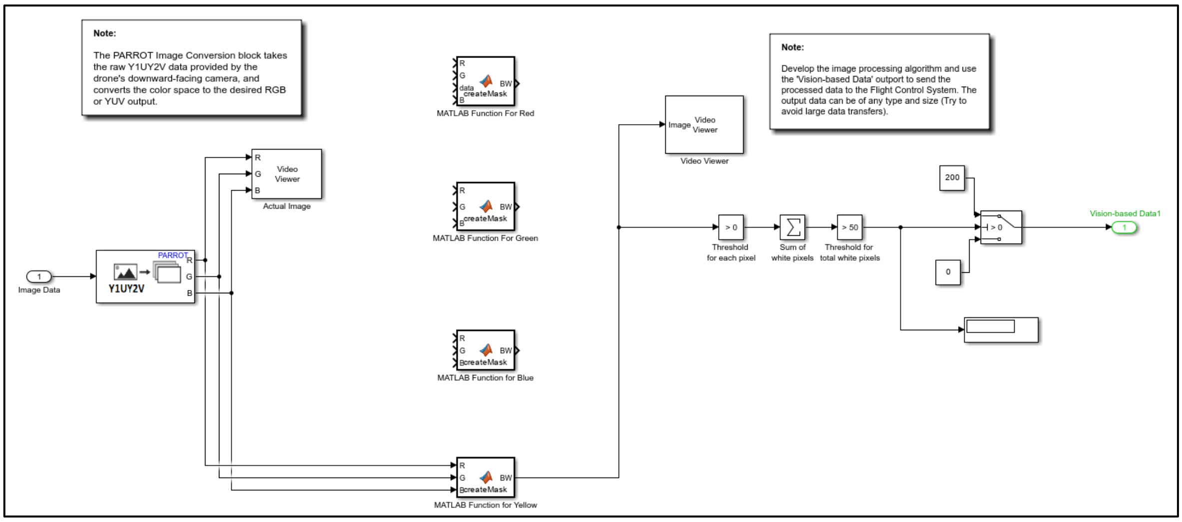

Figure 3. Image processing algorithm created to detect red colour

Figure 4. Test images for creating colour detecting functions

2.3 Developing Color Detection Functions

MATLAB’s Color Thresholding App was used to generate functions for detecting specific colors. The images captured from the drone camera were used as input to train the thresholding algorithm. Functions were exported to detect red, green, blue, and yellow colors separately.

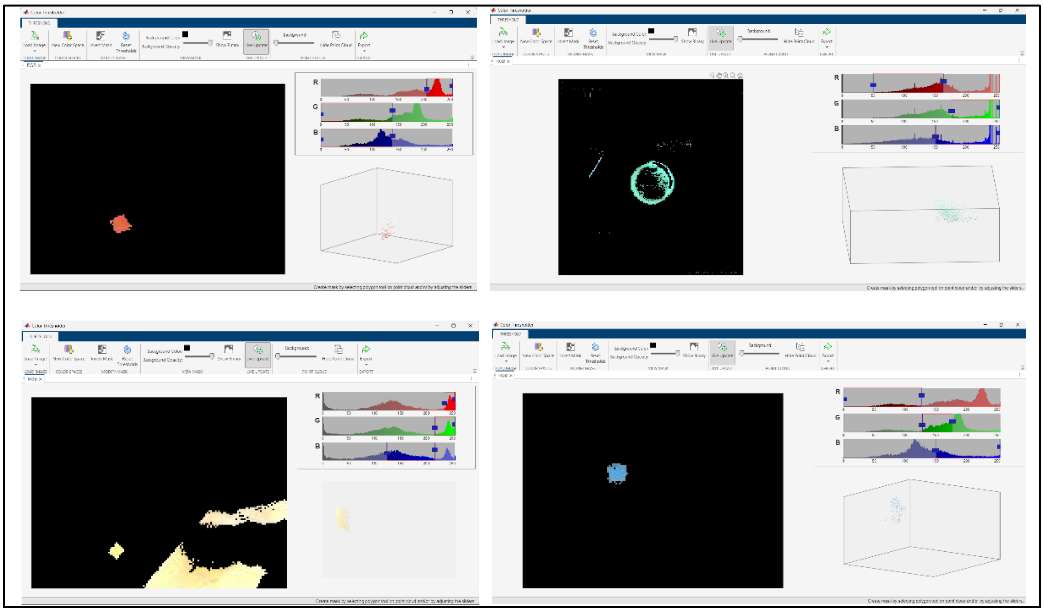

Figure 5. Color Thresholder App tuning to detect Red, Green, Blue and Yellow colour

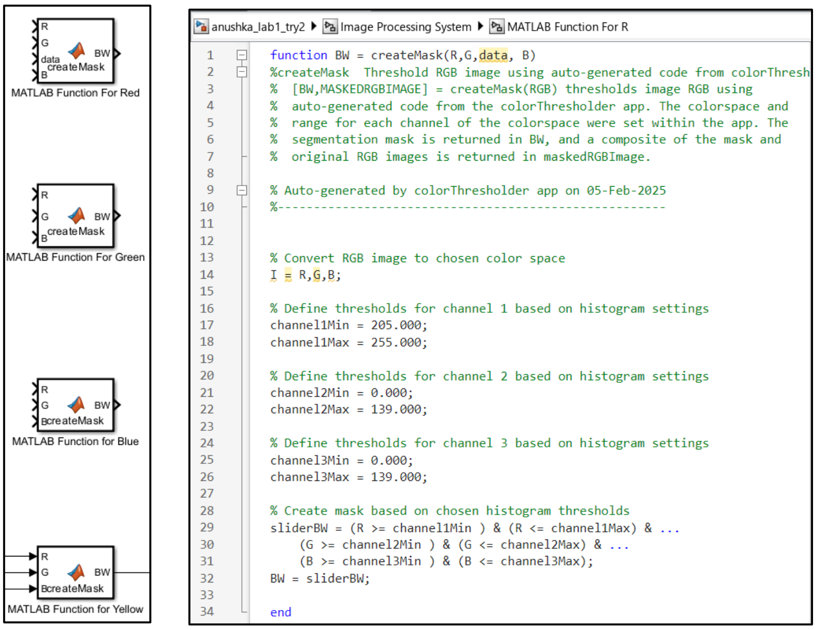

Figure 6. Function block with code for each Colour in Image Processing Block

2.4 Integrating Color Detection into Simulink

The image processing block was updated to incorporate the generated functions for color detection. This integration allowed the system to process color information from the captured images. Due to system constraints, only one-color detection function could be active at any given time. Therefore, manual selection was required to switch between functions for detecting different colors, such as red, green, blue, or yellow.

A reference image is provided below to illustrate the setup of the integrated color detection system within the Simulink model.

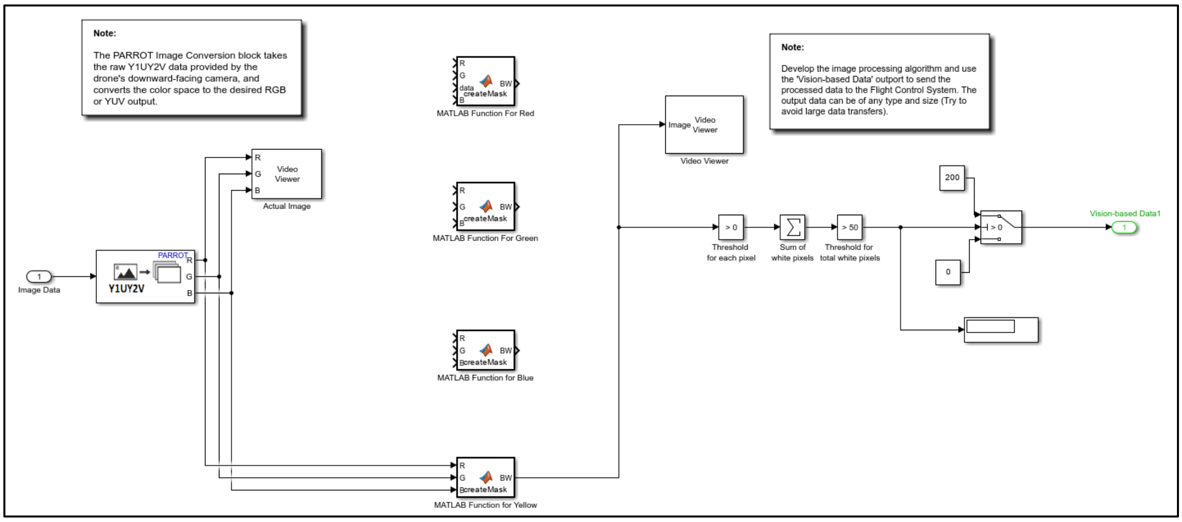

Figure 7. Final colour detection system under Image Processing subfunction

2.5 Modifying Flight Controller for Autonomous Operation

The flight control logic was modified to ensure that the drone’s rotors would only activate when a specific color was detected by the camera. This modification was essential for enabling color-based autonomous operation. For example, when the blue detection function was activated, the drone would initiate movement only upon identifying a blue block. This logic ensured that the drone responded appropriately to the color cues. The modified control logic enhanced the precision of the drone’s operation by ensuring it only responded to the desired color. This refinement reduced unnecessary movement, improving the overall efficiency and accuracy of the autonomous system.

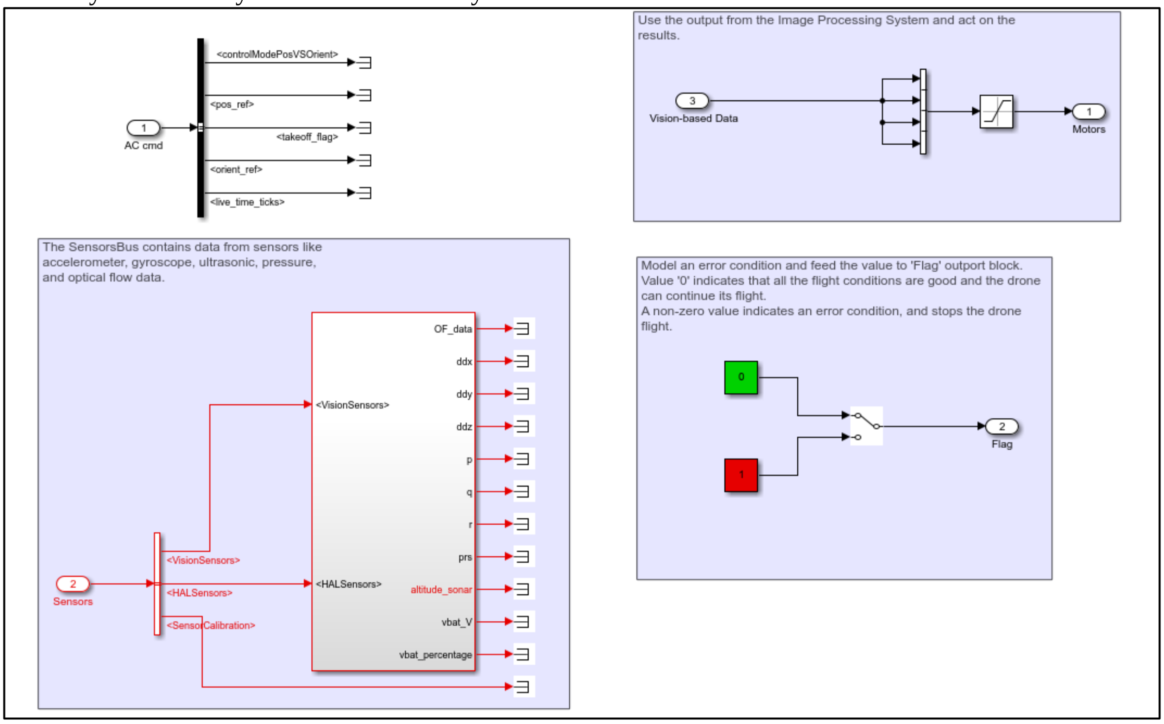

Figure 8. Modified Flight Controller system

3. RESULTS AND DISCUSSION (10 PT)

The implementation and testing of the color detection system on the Parrot Mambo drone yielded comprehensive data across multiple development stages. Our testing focused on three key areas: the image processing model's accuracy in color detection, the drone's flight control system responsiveness, and real-world performance during actual drone flights. The results demonstrate both the capabilities and limitations of using RGB-based color detection on a compact drone platform operating at a fixed height of 3 feet.

3.1. Image Processing Model- Development and Testing

The The development of the color detection algorithm was implemented using RGB color space through MATLAB's Color Thresholder App. Testing was performed first on static test images before moving to real-time video processing. The RGB thresholds were calibrated for each color with the following parameters:

1. Red: R(205-255), G(0-140), B(0-140)
2. Green: R(50-160), G(177-255), B(151-255)
3. Blue: R(0-127), G(128-177), B(150-255)
4. Yellow: R(235-255), G(216-255), B(124-216)

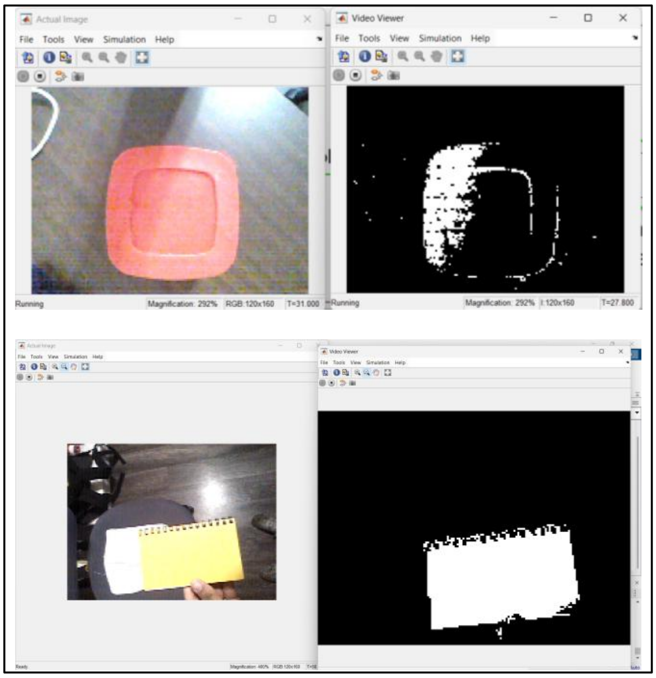

Figure 9. Successful Detection of Colour Red and Yellow

The static image testing showed decent detection accuracy under complete lighting conditions. Some challenges were encountered with varying lighting conditions affecting the RGB values.

3.2 Testing on Parrot Mambo Mini Drone

Field testing with the Parrot Mambo drone revealed:

a) Color detection successful only in consistent lighting
b) Real-time processing performance: Acceptable with minimal lag
c) Effective detection range: 1.5 - 2.5 feet optimal
d) Best performance was achieved in controlled indoor lighting
e) Motor response was reliable.

The system demonstrated reliable performance in detecting all four colors (Red, Green, Blue, Yellow) when tested under appropriate lighting conditions, with the RGB-based detection proving effective for the project requirements.

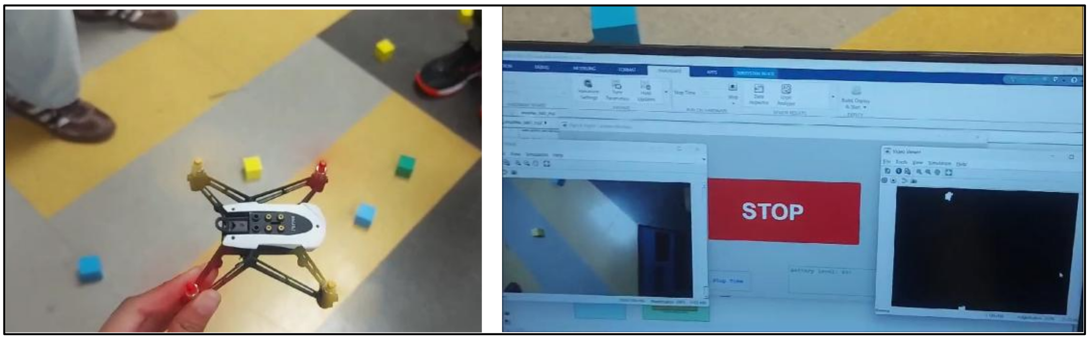

Figure 10. Testing final model on Parrot Mini Drone

[Link to Video demonstration.](#)

4. CONCLUSION (10 PT)

This project successfully demonstrated the implementation of a colour detection system using the Parrot Mambo drone's onboard camera and MATLAB/Simulink integration. Through the development and testing process, we achieved our primary objective of detecting specific-coloured objects (Red, Green, Blue, and Yellow) at a height of approximately 3 feet, with the drone responding through controlled motor movements upon successful detection.

Several key findings emerged from this project:

1. The RGB-based colour detection method proved effective for basic object recognition, though with some limitations in varying lighting conditions. The system achieved a decent detection success rate in controlled environments, which is sufficient for demonstration purposes.
2. Real-time processing and drone response were successfully implemented, with minimal latency between detection and motor activation.
3. The integration of MATLAB's Color Thresholder App with Simulink provided a robust platform for developing and implementing the colour detection algorithm, though the limitation of processing one colour at a time necessitated manual switching between detection modes.
4. Environmental factors, particularly lighting conditions, emerged as a critical consideration for system reliability. The best performance was consistently achieved in controlled indoor lighting environments.

Overall, this project successfully demonstrated the potential of using compact drones for basic computer vision tasks, while also highlighting the practical challenges and considerations in implementing such systems. The experience gained provides valuable insights for future developments in drone-based computer vision applications.

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[4] https://youtu.be/UlDknqrtAHM?feature=shared

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