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Auto Pilot System for Small Helicopter Type UAV with Three Independent Control Systems

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Abstract

In this paper we have discussed the development of a new approach for small low cost helicopter based UAV in which independency of control system is achieved and other features like power enhancement, development, flight of helicopter at fix altitude of highly cost effective, autonomous reconnaissance UAV, suitable for safe flights in close environments . Our approach is focused on development of reliable flight control system in which constituent subsystem are independent of each other. The constituent subsystems being,

- *Altitude Control Subsystem*
- *Spin Lock Subsystem*
- *Horizontal Drift Control Subsystem*

Auto Pilot, Helicopter, UAV, Independent Control Systems, Fix Altitude, Cost Effective UAV

Keywords: *Auto Pilot, Helicopter, UAV, Independent Control Systems, Fix Altitude, Cost Effective UAV*

1. Introduction

In today world Unmanned Aerial Vehicles (UAVs) have become a essential part of a country's strategic technology. UAVs are commonly used where the risk of sending a human piloted aircraft is unacceptable, or the situation makes using a manned aircraft impractical [1, 2]. Two major types of UAV's are those which resemble either an aero plane or a helicopter [3]. Our proposed design is a UAV which resembles a helicopter [4].

UAVs perform a wide variety of functions. The majority of these functions are some form of remote sensing [5]; this is central to the reconnaissance role most UAVs fulfill. Less common UAV functions include interaction and transport. In this project helicopter is used which gains a fixed height with the help of range sensor and stabilizes itself using an inertial sensor(Rate Gyro) [6, 7]. This UAV will be able to carry a payload and also used in surveillance, transportation, video capturing, physical security *etc*. [8, 9].

2. Development of the Design

The restrictions in the Design Specifications require the UAV to be smaller so could be constructed by using available resources. First we have to check the small helicopter which can fulfill our requirements. Formal projects in this area are categorized into two groups on the basis of design; quad copter and a simple helicopter.

To decide between these designs, we evaluated each based on the factors of speed, complexity of design, and stability in switching between different positions on the helicopter. So we choose a toy helicopter and modify it.

In design specification step we have to consider the following specifications:

- size
- endurance
- weight of avionics
- payload caring capacity
- price

Figure 1. Initial Design of Toy Helicopter

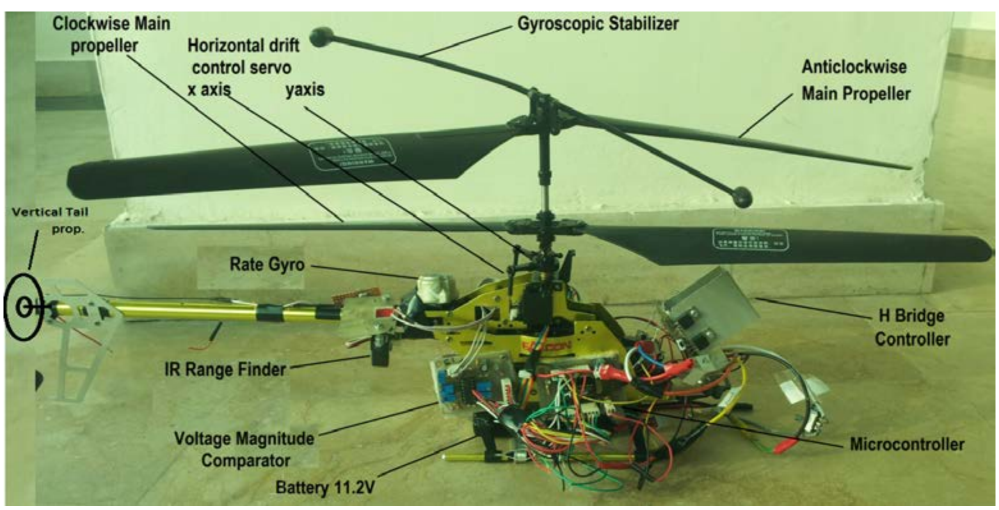

Figure 2. Final Design

Table1. Size of Helicopter

Full length	**1970mm**
Main Rotor Diameter	615mm
Total Height	549mm
Tail Rotor Diameter	212mm

3. Existing Control System for Helicopter Type uav

These systems are build around one high performance microcontroller. In our case low performance distributed controller are being used.

3.1. Features

1. Three independent control modules.

a) Altitude control module.

b) Spin lock module.

c) Horizontal drift control module.

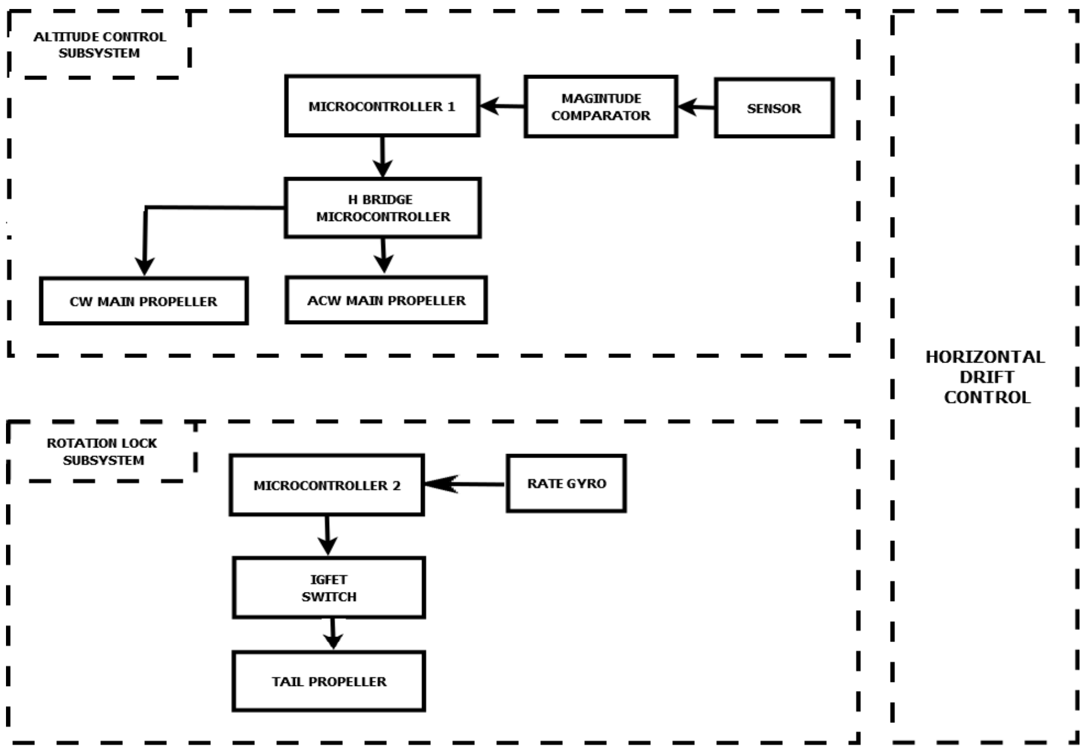

Figure 3. Three Independent Control Modules

2. Autonomous take off and landing.

3. Payload capacity enhancement.

4. Safe flight in closed environment. (Continuing)

4. Design Modification

Based on the findings of the above experiments we decided to introduce the following modifications in the toy helicopter to achieve the desired functionalities.

4.1. Modified Assembly

Following are the components and systems we added in our design. Specially designed small mechanical parts to incorporate several modules on the helicopter's body, Special heat sinks for motors, Introducing the 3 independent microcontroller if one is crashed then other works properly Payload capability enhancing module, height fixing module to fly it at fix altitude.

4.2. Increase Payload Capacity

One of our main objectives was to increase the payload carrying capability of our design. Because initially it was not able to lift any kind of weight. In order to lift weight of motors we had to increase payload capacity to carry our embedded computational boards, motors and sensor. As IRF540 was heating up so we decide to test high capacity IGFET's then we replace it with IRF1404. But we again face same problem as was with IRF540. To solve this problem we add heat sink with them and adjust them under propellers in such a way that thrust (air) coming down from propellers fall on these heat sinks and provide them cooling this help us in reducing maximum heat.Circuit Diagram is shown in Figure 4.

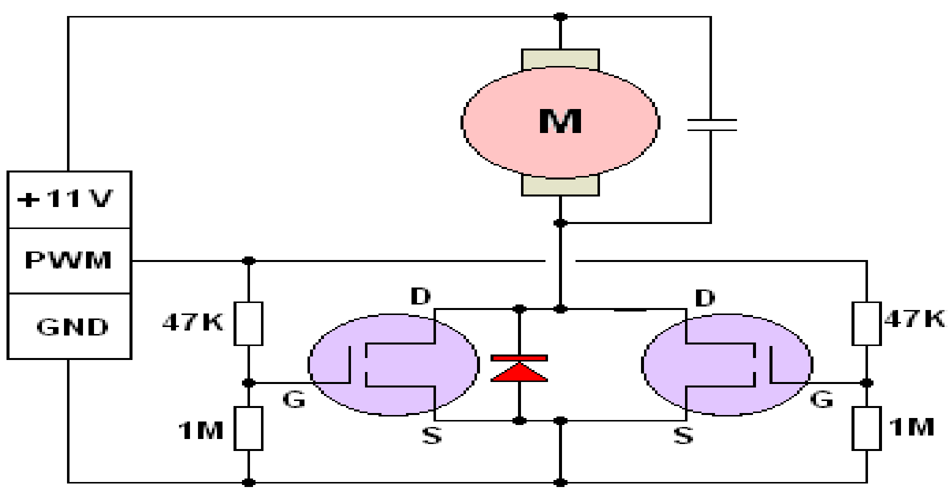

Figure 4. Circuit Diagram of Motor Speed Controller using H-Bridge

5. The Independent Sub-Systems of our Design

a) Altitude control sub system

b) Rotation lock sub system

c) Horizontal drift control sub system

5.1. Altitude Control Sub System

This was one of most interesting feature of helicopter to fly it at fix altitude. In this case an IR sensor was continually looking at ground and giving us information about the height in the form of variable voltage signal. We converted this signal into digital form with the help of ADC circuit and introduced that signal in microcontroller and then with the help of PWM signal we controlled the PWM of main propellers, to keep helicopter at fix height. In our case we fixed it at height of 5.5 feet from ground level. These interesting phenomena helped us in achieving the task of terrain hugging. The flow diagram is shown in Figure 7.

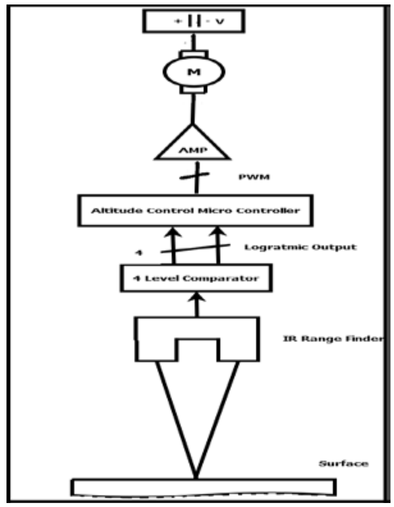

Figure 6. Block Diagram of Altitude Control of Helicopter

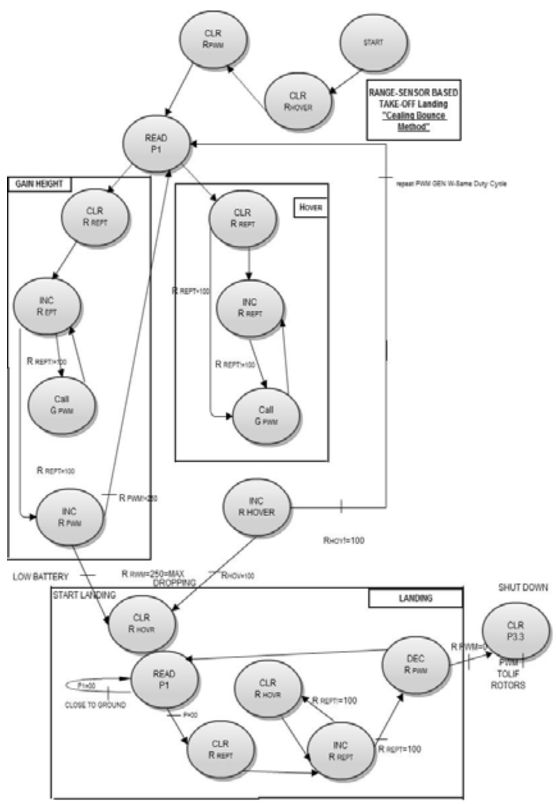

Figure 5. Flow Diagram of Altitude Control of Helicopter

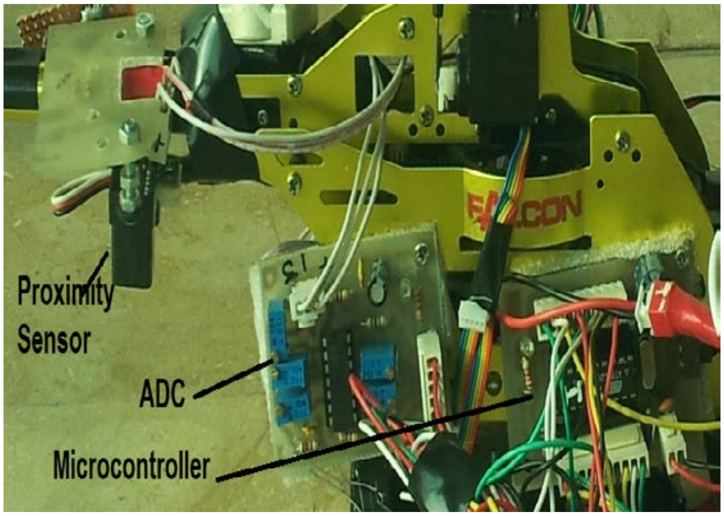

Figure 7. Altitude Control Subsystem

5.2. Rotation Lock Sub System

This sub system controls the rotation of the tail. Rate gyro reads the readings and sends it to microcontroller. After getting input, microcontroller sends signal to IGFET based switch which starts or stop tail propeller. In this way rotation is controlled.

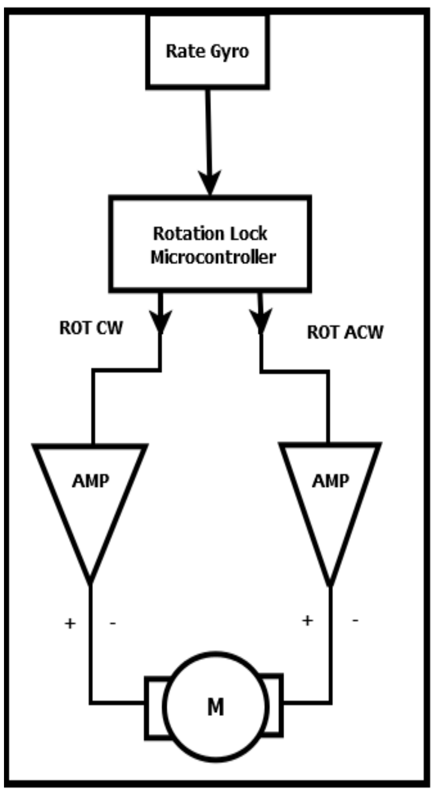

Figure 9. Block Diagram of Rotation Lock Subsystem

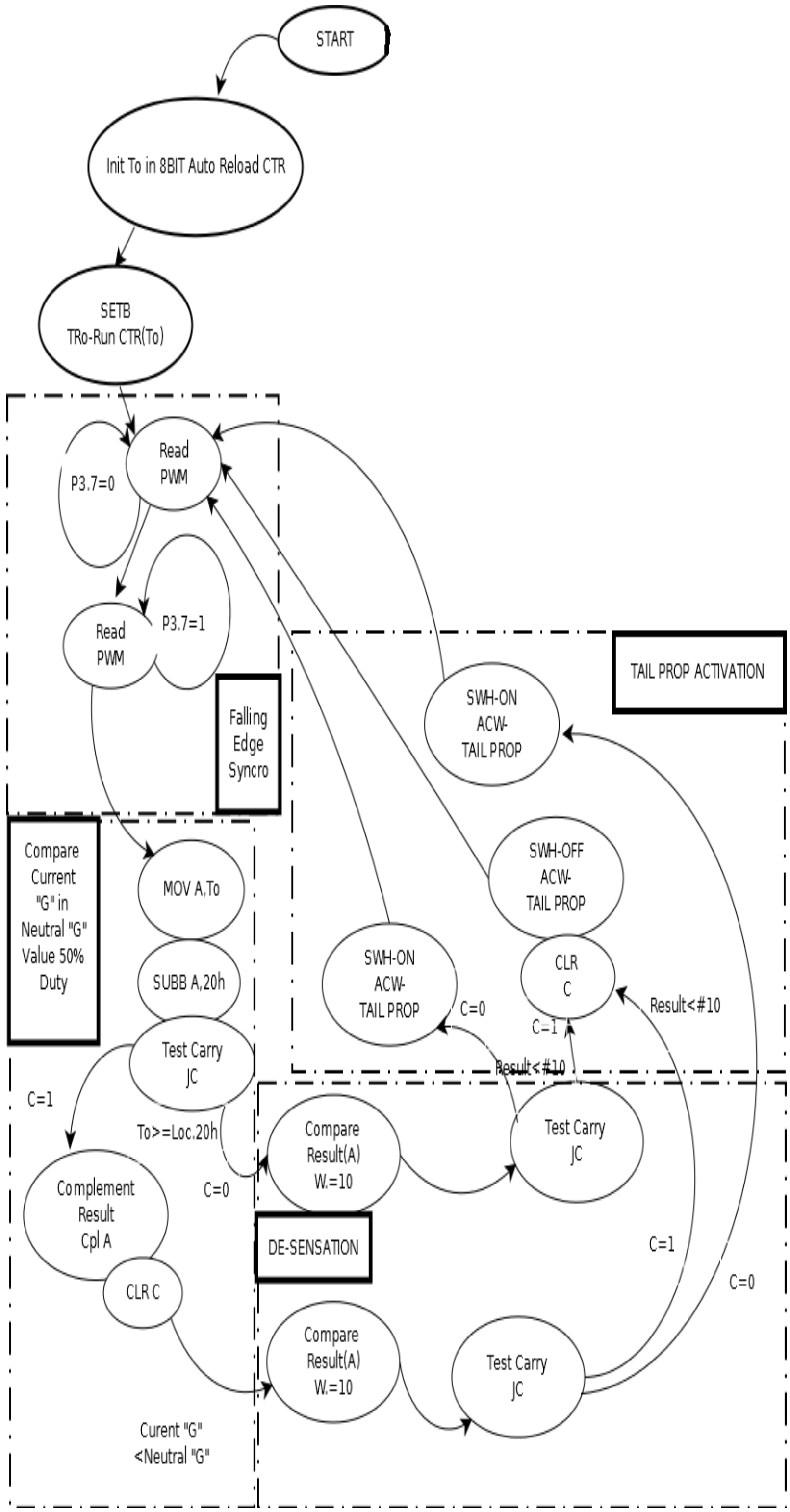

Figure 8. Flow Diagram of Rotation Control Subsystem

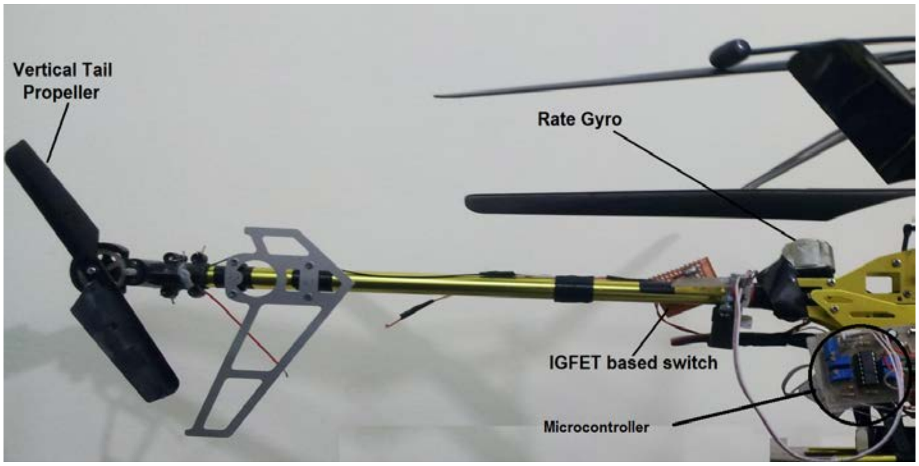

Figure 11. Rotation Lock Sub-System

6. Horizontal Drift Control Subsystem

Horizontal drift is controlled by the two servo motors and slip rings assembly. Drift is controlled along x-axis and along y-axis. Servo motors are being controlled with the help of microcontroller. Microcontroller is getting input from external environment with the help of range finder sensors. When an object is detected servo motor starts moving and helicopter moves towards other side. This sub system is important to avoid collision in closed environment.

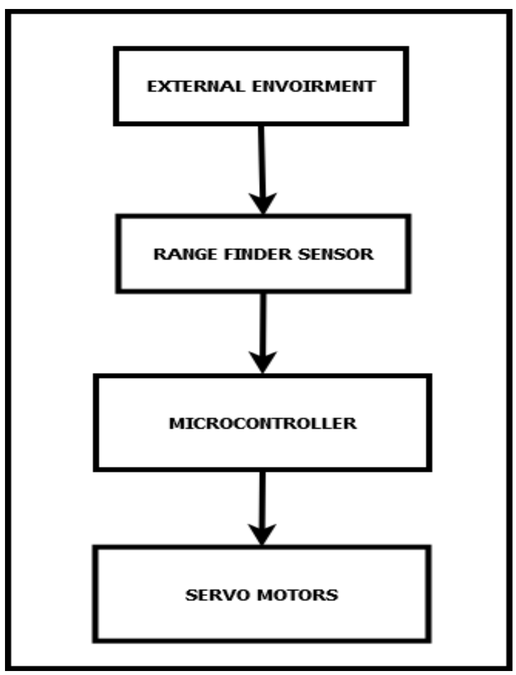

Figure 12. Block Diagram of Horizontal Drift Control System

Figure 13. Horizontal Drift Control System

7. Future Work

In future we can work on horizontal drift control system and improving the design and model. There is possibility that we can use good resolution cameras which can capture video and process video.

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We dedicate our project to our dear parents, who are sacrificing their present for our future. Without their prayers, support and efforts of teachers and parents our dream to become engineer could have never come true

References

[1] G. Cai, K. Peng, B. M. Chen and T. H. Lee, "Design and Assembling of a UAVHelicopter System", 2005 International Conference on Control and Automation.
[2] S. A. Borough, "The University of Toronto RC helicopter: a test bed for nonlinear control", Proceedings of the 1999 IEEE International.
[3] Aeroscout **(2009)**: Scout B2-120, Autonomous Industrial Unmanned Helicopter. URLhttp:// www. aeroscout. ch/downloads/Aeroscout_Scout_B2-120_Brochure.pdf (Abruf am04.02.2009)
[4] M. Ishfaq Javed, S. Afghani, S. Irshad Ali and M. Farhan Baluch, "Skill Free Tele-operation of Terrain Hugging UAV using an Advance Technique of Supervisory Command Optimization", International Journal of Advances in Engineering & Technology, ©IJAET, **(2012)** May.
[5] P. Doherty, "The WITAS unmanned aerial vehicle project", In Proc. of the 14th European Conf. of Arti_cial Intelligence, 2000. Project URL: http://www.liu.se/ext/witas.
[6] P. McKerrow, "Modelling the Dragan yer four-rotor helicopter", Proceedings of ICRA'04, 2004 IEEEInternational Conference on Robotics and Automation, New Orleans, **(2004)**, pp. 3596-3601.
[7] K. Nordberg, P. Dohertyy, G. Farneb¨ack, P.-E. Forss_en, G. Granlund, A. Moe and J. Wiklund, "Vision for a UAV helicopter", Computer Vision Laboratory, Department of Electrical Engineering, Link¨oping University, Sweden y Knowledge Processing Laboratory, Department of Computer Science, Link¨oping University, Sweden.
[8] Dr. K. C. Wong, "UAV Design Activities in a University Environment", School of Aerospace, Mechanical and Mechatronics Engineering, University of Sydney, NSW, **(2006)**.

[9] G. Cai, M. Dong, B. M. Chen and T. H. Lee, "Design and Implementation of a Hardware-in-the-loop Simulation System for Small scale UAV Helicopters", International Conference on Automation and Logistics, Qingdao, China, **(2008)**.

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