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ANALYSIS THE GYROSCOPE-BASED CONTROL AND STABILIZATION OF UNMANNED AERIAL MINI-V

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ABSTRACT

This system presents an implementation of gyroscope-based control and stabilization systems for unmanned aerial mini-vehicles (mini-UAVs), focusing on the use of a compact gyroscope with three degrees of freedom. The gyroscope serves as the primary reference frame for the UAV's navigation system, enabling precise orientation and attitude control. A control algorithm is developed to generate corrective control moments based on gyroscopic input, which in turn determines the deflection angles of the UAV's control surfaces. This mechanism allows the vehicle to maintain stable flight, respond to disturbances, and perform controlled manoeuvres. A mini autopilot system is integrated to ensure that the UAV's longitudinal axis remains aligned with the gyroscope's reference axis, enhancing flight accuracy and stability. The project also explores both remote and pre-programmed navigation modes, evaluating system performance under various conditions. Furthermore, considerations of structural integrity, response durability, and overall system reliability are addressed, demonstrating the effectiveness of gyroscopic stabilization in improving UAV flight performance, especially in dynamic or unpredictable environments.

Keywords: UAV, Gyroscope, Longitudinal Axis, Autopilot.

1. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), especially mini-UAVs, have rapidly evolved in recent years, becoming crucial tools in various civil, military, and commercial applications. Their compact design, ease of deployment, and ability to access difficult or dangerous areas have made them indispensable in tasks such as surveillance, search and rescue, environmental monitoring, infrastructure inspection, and delivery services. However, the miniaturization of UAVs comes with its own set of technical challenges, primarily related to flight stability and precise control. Due to their lightweight structures and high sensitivity to aerodynamic disturbances like gusts of wind or sudden directional changes, mini-UAVs require sophisticated stabilization mechanisms to maintain accurate flight paths and safe operation.

One of the most effective solutions to enhance UAV stability and control is the use of gyroscopes, particularly those with three degrees of freedom (3-DoF), which can detect angular velocity along three perpendicular axes. This project focuses on the integration of such a mini gyroscope into a control system designed for mini-UAVs. The gyroscope acts as the central reference system that continuously monitors the vehicle's orientation in real-time. Its primary role is to detect deviations from the intended flight attitude and provide critical data that enables the system to generate corrective responses. This feedback loop forms the backbone of the UAV's stability mechanism, ensuring that the aircraft can withstand and recover from external perturbations with minimal deviation.

Key features of mini-UAVs include:

- **Lightweight and portable**: Easy to carry and deploy in the field.
- **Battery-operated**: Usually powered by lithium-polymer (Li-Po) batteries.
- **Short-range**: Operate within a few kilometres of the ground control station.
- **Sensor-equipped**: Fitted with cameras, GPS, gyroscopes, accelerometers, and sometimes thermal or multispectral sensors.
- **Manual or autonomous control**: Can be flown remotely by an

2. LITERATURE SURVEY

2.1 Kumar, G.P., Praveen, B., Nisanth, U.T., & Hemanth, M. (2018). Development of Auto Stabilization Algorithm for UAV Using Gyro Sensor. International journal of engineering research and technology, 5.

Quadcopter plays a vital role in surveying purpose, also used for various other sectors such as in defense, telecommunication, package delivery etc., Normally the quad has four wings. If it is subjected to a windblown at different velocities at variant times, it becomes a hectic task for the user to control the vehicle. Mostly the Quad gets out of control from the user resulting in a collision or in an unstable position. We are not concentrating in the application part rather we are improving its working functionality. Bringing the four wings to a balanced state simultaneously is difficult. This paper deals with an Unmanned Aerial Vehicle(UAV), a Quad copter is engaged here. When an external factor such as wind disturbs the quad, the vehicle becomes unstable. So, they are providing an algorithm to stabilize the UAV during in motion. Controlling the Quad needs an expert advice or prior training. If an unbalanced situation confronts the vehicle, it can be restored to a stable state with the involvement of the algorithm which is fed through Adriano.

3. SYSTEM DESIGN

The block diagram provides a high-level view of the major components involved in the gyroscope-based control and stabilization system for the mini-UAV. The diagram outlines how data flows through the system, from sensor input to final actuator control. Below is a description of the key components and their interactions.

3.1 BLOCK DIAGRAM

The block diagram of the proposed system has been given in Fig 3.1

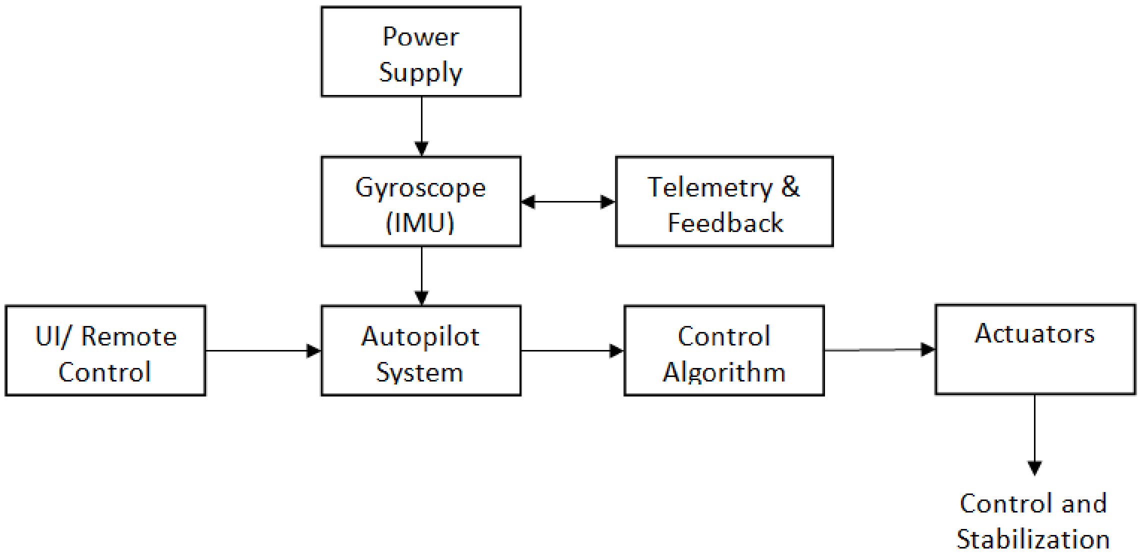

Fig 3.1: Diagram of Proposed System

3.2 SYSTEM ARCHITECTURE

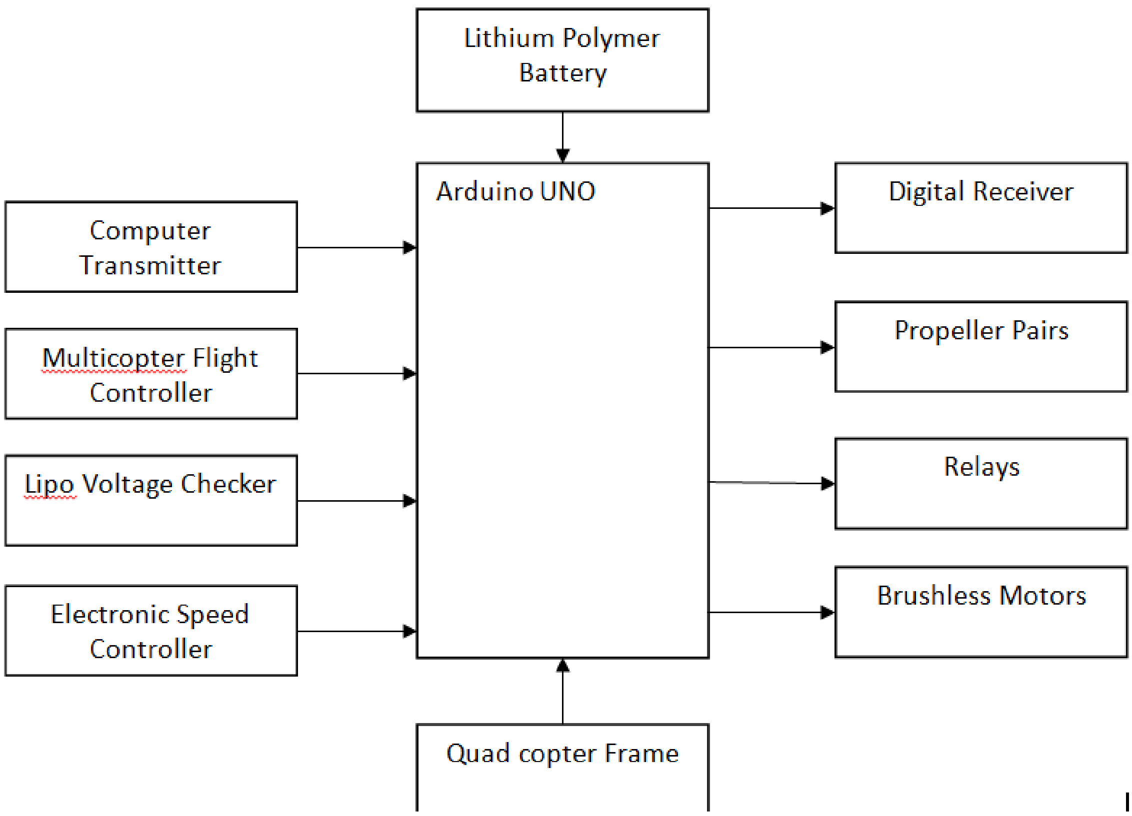

Fig 3.2: System Architecture

4. SYSTEM DESCRIPTION

4.1 HARDWARE DESCRIPTION

System	:	Pentium IV 3.5 GHz or Latest Version.
Hard Disk	:	40 GB.
Monitor	:	14' Color Monitor.
Mouse	:	Optical Mouse.
Ram	:	1 GB.

Features:

1. Super active and passive anti-jamming capabilities.
2. Very low power consumption.
3. High receiving sensitivity.
4. 8 model memory, digital control.
5. We can program by PC with the included software.
6. Full range 2.4GHz 6-channel radio.
7. 4 Types (Airplane, Heli90, Heli120, Heli140).
8. Use a linear spread of fine paragraph by an excess antenna.
9. It covers the entire bandwidth of the antenna bandwidth range.
10. High quality and stability.

Specifications:

Item Type:	Receiver, Transmitter
No. of Channels:	6
Frequency (GHz):	2.4
Modulation Type:	GFSK
Sensitivity (dBm):	1024
Code Type	Digital
Band-Range (GHz)	2.40 ~ 2.48
Bandwidth (KHz)	500
DSC Port	Yes (3.5mm:output:PPM)
Charging Port (Y/N)	Yes
Default Operating Mode	Mode 2 (Left-Hand Throttle)
Color:	Black
Low Voltage Warning	Yes(at less than 9V)
Operating Voltage (VDC):	12
RF Power	Less Than 20 dbm

Features:

1. Needle: straight.
2. Power supply: LP2985-3.3.
3. Max voltage: 16V.
4. Add a 47uF tantalum capacitor.
5. Port: MUX (UART0, UART2, mnnI2, and OSD are optional, OSD is the defaulted output).
6. Arduino Compatible!
7. Includes 3-axis gyro, accelerometer, along with a high-performance barometer
8. Onboard 4 MegaByteDataflash chip for automatic data logging.

9. Optional off-board GPS, a uBlox LEA-6H module with Compass.

Specifications:

Item Type:	Flight Controller
Power Supply	LP2985-3.3.
Port	MUX (UART0, UART2, mnnI2, and OSD are optional, OSD is the defaulted output).
Input Voltage (V):	12~16 VDC
Sensor	3-Axis Gyrometer, Accelerometer, High-performance Barometer
Processor	ATMEGA2560 and ATMEGA32U-2
Micro SD Card Slot (Y/N):	No

Features:

1. Input: 2-8S
2. Battery type: Lipo/LiFe/Li-ion
3. Cell Voltage Display Range: 0.5v-4.5v
4. Total Voltage Display Range: 3.7-36v
5. Alarm set values: Off or 2.7-3.8v

Specifications:

Item Type:	Battery Testing Equipment
Model Type:	Battery Checker/Tester
Compatibility:	LiPo
Additional Specs.:	Alarm set range (V): 2.7-3.8
Battery Input	1S-8S Battery
Battery Type	LiPO/LiFe/Li-Ion/LiMn
Cell Volt. Display (V):	0.5-4.5
Height (mm):	12
Length (mm):	40
Pack Volt. Display (V):	3.7-36

Features:

1. KV: 1000
2. MAX Efficiency: 80%
3. MAX Efficiency Current: 4-10A (>75%)
4. Current Capacity: 12A / 60s
5. No Load Current: 10 V : 0.5 A

Specifications:

Motor KV (RPM/V):	1000
Motor Type:	Brushless Motor
Compatible LiPO Batteries:	2S to 3S
Model No.:	A2212 10T 13T
Shaft Diameter (mm):	3.17
Current Capacity (A)	12
No-Load Current (mA)	500
Max. Efficiency Current (A)	4 ~ 10
Maximum Efficiency	0.8

Features:

1. Current: 30-40 A
2. Constant Current: 30 A Maximum (40A for maximum 10sec)
3. BEC: 3 A
4. Good Speed Control
5. Excellent Stability Control

Specifications:

Item Type:	Brushless ESC
Model Name	SIMONK 30A
Burst Current (A)	40
Constant Current (A)	30
BEC (Y/N):	(5V/2A), Yes
Compatible LiPO Batteries:	2 to 3S
Color:	Red
Application	BLDC Motors, Multirotors, Rc Planes etc.
Length (mm):	54
Width (mm):	24
Height (mm):	9

Features:

1. Model No: ORANGE 3300/3S-25C
2. Weight : 260 g
3. Voltage : 11.1V
4. Dimensions : 140 x 43 x 20(mm)
5. Balance Plug : JST-XH
6. Discharge Plug : XT-60

Specifications:

Weight (g):	215
Output Voltage (V):	11.1
Charge Rate (C)	1 ~ 3
Discharge Plug	XT-60
Balance Plug	JST-XH
Length (mm):	136
Width (mm):	43
Height (mm):	17
Max. Burst Discharge (C)	30C (10Sec)
Max. Charge Rate	5 C
Max. Continuous Discharge	60C(180.0A)

Q450 Quadcopter Frame – PCB Version Frame Kit with Integrated PCB

Every quadcopter or other multirotor aircraft needs a frame to house all the other components. Things to consider here are weight, size, and materials. This Q450 QUADCOPTER FRAME is a well thought out 450mm quad frame built from quality materials.

Features:

1. Materials: glass fiber + polyamide nylon
2. Frame Weight: 280g.

3. Height: 55mm
4. Colored arms for orientation to keep you flying in the right direction.
5. Power distribution board included in this item(inbuilt PCB).
6. Pre-threaded brass sleeves for all frame bolts.
7. Large mounting tabs on main frame bottom plate for easy camera mounting.

Specifications:

Item Type:	Frame, Kit
Model Type:	Quadcopter Frame
Material:	Glass Fiber, Polyamide Nylon
Wheelbase (mm)	450
Arm Size (L x W) mm	220 x 40
Motor Mount Hole Dia. (mm)	3

Features:

1. Weight (1 pair) : 22 gm.
2. Shaft diameter(mm): 7-(Flat Side) and 8-(Round Side)
3. Total length : 10 inch (254 mm)
4. ABS Material
5. Very strong and lightweight.

SOFTWARE DESCRIPTION

Operating system	:	Windows 10
Coding Language	:	Embedded C Programming
Tools used	:	Arduino IDE

5. CONCLUSION

The implementation of a gyroscope-based control and stabilization system for a mini-Unmanned Aerial Vehicle (mini-UAV) represents a significant advancement in autonomous flight technology. By leveraging the capabilities of a 3-degree-of-freedom (3-DoF) gyroscope in conjunction with an Inertial Measurement Unit (IMU), the system ensures real-time monitoring and correction of the UAV's orientation. This not only enhances the stability and responsiveness of the UAV but also allows for more precise control during both manual and autonomous operations.The integration of a reliable control algorithm, such as PID, enables the UAV to correct deviations in its flight path effectively, maintaining its intended trajectory even in the presence of environmental disturbances like wind or sudden movement. Coupled with an intelligent autopilot system and efficient actuators, the UAV is capable of making smooth, automated adjustments that ensure safe and stable flight. Additionally, the inclusion of telemetry systems and a user-friendly interface allows for real-time monitoring, mission flexibility, and operator intervention when needed. The proposed system offers a compact, cost-effective, and technically robust solution for enhancing the performance of mini-UAVs. It opens doors for a wide range of applications including aerial surveillance, environmental monitoring, search and rescue, and more. This project not only demonstrates the practical utility of gyroscopic stabilization in modern UAV systems but also lays the groundwork for future innovations in small-scale autonomous aerial vehicles.

5.1 FUTURE WORK

One promising direction for future work is the integration of machine learning algorithms into the UAV's control system to enable adaptive flight behavior in dynamic environments. By training the system on various flight scenarios, environmental conditions, and disturbance patterns, the UAV could learn to predict and respond to changes more intelligently—enhancing stability and performance beyond what traditional PID controllers can offer. This would allow the mini-UAV to operate more autonomously in complex, GPS-denied, or cluttered environments such as forests, urban areas, or indoors. Additionally, incorporating real-time obstacle avoidance using computer vision and sensor fusion could further expand the UAV's capabilities, making it suitable for advanced missions like autonomous delivery, precision agriculture, or disaster response.

6. REFERENCES

[1] Kumar, G.P., Praveen, B., Nisanth, U.T., & Hemanth, M. (2018). Development of Auto Stabilization Algorithm for Uav Using Gyro Sensor. International journal of engineering research and technology, 5.

[2] Hu, C. Attitude stability control of UAV gyroscope based on neutral statistics for smart cities. Int J Syst Assur Eng Manag 13 (Suppl 1), 281–290 (2022). https://doi.org/10.1007/s13198-021-01391-6

[3] Rauf, M.N., Khan, R.A., Shah, S.I.A. et al. Design and analysis of stability and control for a small unmanned aerial vehicle. Int. J. Dynam. Control 12, 1801–1816 (2024). https://doi.org/10.1007/s40435-023-01322-2

[4] Y. Dubey, M. Shinde, R. Sheikh, P. Upadhye, H. Hulke and D. Suneja, "Stabilization of Flight Controller for Unmanned Aerial Vehicle," 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS), Coimbatore, India, 2021, pp. 1279-1283, doi: 10.1109/ICAIS50930.2021.9395856.

[5] D. M. Malyutin, "Miniature gyroscopic orientation system for unmanned aerial vehicle," 2018 25th Saint Petersburg International Conference on Integrated Navigation Systems (ICINS), St. Petersburg, Russia, 2018, pp. 1-4, doi: 10.23919/ICINS.2018.8405916.