HYBRID GWO-ALGORITHM BASED PID CONTROLLER FOR QUAD COPTERS

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Introduction:

Unmanned Aerial Vehicles (UAVs), commonly referred to as drones or quadcopters, have become important and necessary to numerous applications, ranging from surveillance and logistics to environmental monitoring and disaster response. To meet the demands of advanced control systems and that are capable of high precision movement and robust stablitiy is a need. One of the ways in which these constraints can be improved is through the use of PID optimization and tuning. To achieve this we try to implement PID using Grey Wolf Optimizer and ,look into it's hybrids.

The PID (Proportional-Integral-Derivative)control system combines proportional, derivative, and integral controllers to achieve precise and stable drone flight. It effectively counters disturbances and maintains a steady position at the desired height.

1)proportional controller, also known as a P-controller, is a fundamental component of many control systems. It provides control action proportional to the error between the desired setpoint and the measured process variable.

2)derivative controller, orD-controller, helps in controlling a system by looking at how fast things are changing. It pays attention to how quickly the difference between the desired value and the actual value is changing. It looks at how fast the altitude is changing and calculates the derivative.

3)An integral controller, also known as an I-controller works by accumulating the error signal over time and using this integrated value to make appropriate adjustments to control inputs.

The Grey Wolf Optimization (GWO) algorithm is a population-based meta-heuristic algorithm inspired by the social hierarchy and hunting mechanism of grey wolves.

The hunting process typically involves four stages:

1)Tracking 2)Chasing 3)Encircling 4)Attacking

The GWO algorithm mimics the social hierarchy and hunting mechanism of grey wolves to solve optimization problems

The alpha, beta, and gamma wolves represent the best solutions found so far. The delta wolves represent the worst solutions in the population.

Objectives:

The Development of a GWO and Hybrid-GWO algorithms which will be usable in PID for Drones.
To Increase the efficiency and improve the stability of Quadcopters in case of disbalance and improper positioning due to weather conditions using a genetic Algorithm.
To aim at a reduction in Cost by using open-source software and hardware such as Arduino IDE. Using Low Cost tools to implement custom built code and test it constantly as compared to pre-built coded flight controllers.

Methodology:

Sensing the Errors: Sensors on the drone continuously measure its position, angle, and rotation. This is compared to the desired state.

PID Tuning : In order eliminate the small errors by itself specific PID values are assigned by repeated tuning.

Hybrid GWO algorithm : By continues evaluation of GWO with different algorithm and hybrid algorithm is built.

Comparison : Optimum PID values generated by different hybrid algorithm are tested.

Performance metrics assessment:

Stability: This refers to the drone's ability to maintain its desired position and orientation (roll, pitch, yaw)

Responsiveness: This measures how quickly the drone reacts to changes in control inputs or external disturbances.

Overshoot: This refers to the amount the drone goes beyond its target position or angle after correcting an error.

Conclusion:

An Arduino based Custom drone model capable of quad copter motions and movements has been developed.

PID Tuning is applied and drone is able to demonstrate self- tuning and stability through the PID applied.

Scope for future work:

1. Algorithm Refinement: Continued research can explore further enhancements and refinements to bio-inspired optimization algorithms, seeking to improve convergence rates, solution accuracy, and robustness to environmental variations.

2. Integration with Autonomous Systems: Integration of optimized PID controllers with autonomous navigation and decision-making systems can enable more sophisticated and autonomous UAV operations. Future research can explore the synergies between optimized control algorithms and autonomous flight planning and navigation algorithms.