

# Designing a Fault Tolerance Control Strategy for a Fire-rescue UAV with Tilting Rotors and Deformable Arms

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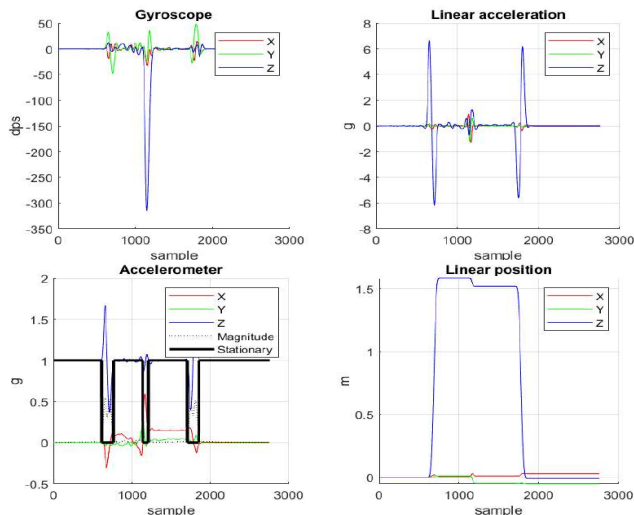


## Introduction

In the past ten years, the supply and demand of multi-rotor UAVs have increased sharply in modern lives, which promoted the optimization of multi-rotor UAV control algorithms and structures. Currently, the main consideration for boosting the UAV's usage is whether the drone can be reliable enough not to be a hazard to the working environment when accidents happen. Despite breakthroughs in fault-tolerant algorithms, it is rare to see fault-tolerant multi-rotor UAVs used in practice. Although fault-tolerant control of multi-rotors has successful cases, those studies are not suitable enough to be put into common use.

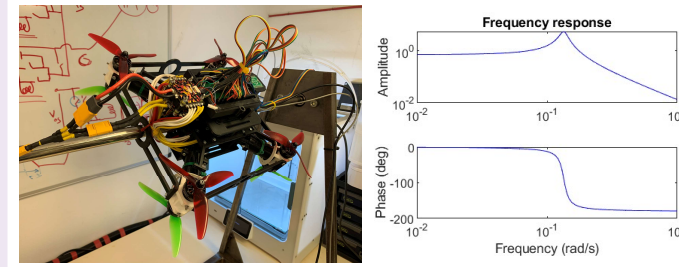
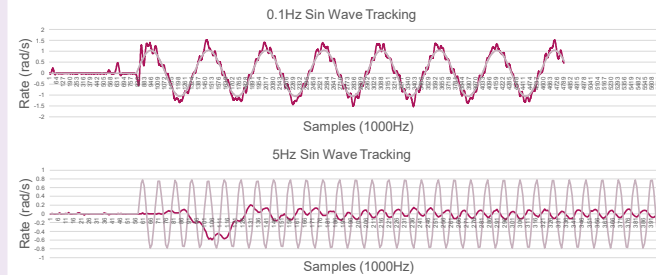
## Accelerometer Dead Reckoning

Several flying process simulations of a quadrotor shows an accelerometer with proper filtering can overcome the integral drift to increase the accuracy of the system.

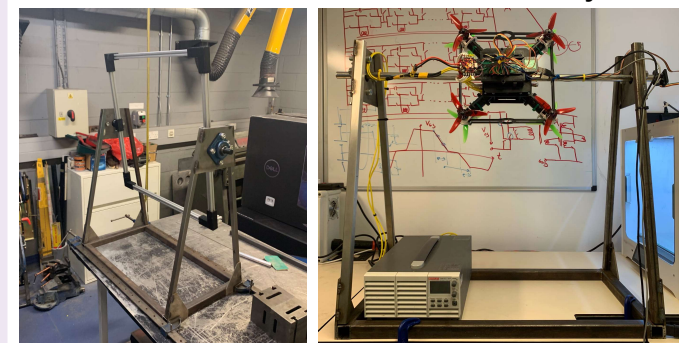


## Closed Loop System Identification

For better performance of the controller, system identification has been processed with different frequency of sine waves (frequency sweep).

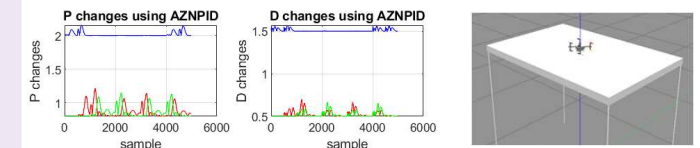


## Controller Test Bench and All 3D-Printed Body



## Augmented Ziegler-Nichols PID (AZNPID)

An optimization to adjust PID parameters is implemented on the prototype to minimize the error between simulation and experimental tests.

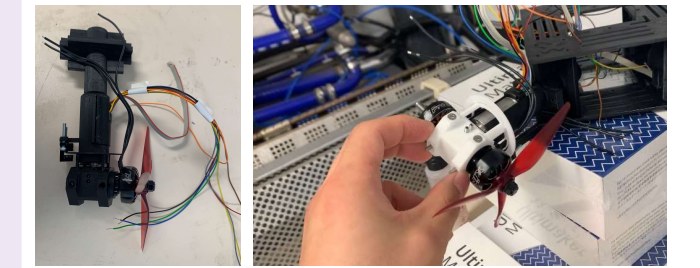


## Gazebo Simulation

As part of the future work, Gazebo simulation will be done after simulating the fault-tolerant controller before its implementation.

## Tiltable Rotor Unit

A tiltable rotor unit is introduced to stop the endless rotation in the fault tolerance mode and transform the drone into a tri-rotor.



## Conclusion and Future Work

- The tilting motor units bring more flexibility and robustness to the drone system.
- The future work includes design a proper fault-tolerant controller and a strategy to quickly stop the endless rotation with the help of rotating the motor units when the drone working in a fault-tolerant mode.

