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| ESPRC DOCTORAL TRAINING PARTNERSHIP PHD STUDENTSHIP 2020/2021 ENTRY |

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| **Title** |
| Resilient and reconfigurable control for unmanned aerial vehicle |
| **Theme** |
| Exeter Dynamics and Control |
| **Location** |
| University of Exeter, Streatham Campus, Exeter EX4 4QJ |
| **Primary Supervisor** |
| Dr. Halim Alwi, Department of Engineering, College of Engineering, Mathematics and Physical Sciences |
| **Additional Supervisors** |
| Prof. Christopher Edwards, Department of Engineering, College of Engineering, Mathematics and Physical Sciences |

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| **Project description** |
| *Motivation and challenges:*  Commercial and civil applications of small multirotor unmanned aerial vehicles (UAVs) by prominent companies such as Amazon, DHL and Google have been widely covered by the media. The UAVs considered by these companies are for commercial use (e.g. package delivery and drone taxis) and are smaller in size compared to the larger military ‘drones’. Other (non-exhaustive) examples of civil and commercial applications of UAVs include search and rescue, inspection and filming.  Despite the potential and the wide range of applications of small UAVs, there are still technological obstacles to be overcome, which restrict the full utilisation of UAVs for civil and commercial use. One of the main challenges pertains to the issue of safety; especially since these UAVs need to operate autonomously in the absence of pilots.  One of the most popular UAVs is the quadrotor. However, due to the lack of redundant rotors on this four-rotor configuration, quadrotors can only handle rotor faults and cannot even cope with one of its rotors failing completely. This motivates the research proposed in this project.  The resilient/fault tolerant control systems developed here will directly tackle issues and challenges facing UAVs (i.e. safety and technology), in order to promote the safe use of small UAVs in civil and commercial applications.  *Aims and Objectives:*  The project aims to develop flight control systems for small under-actuated unmanned aerial vehicles, which are resilient to faults, for commercial and civil applications.  Research in the area of Fault Tolerant Control (FTC) has received significant attention in the last few decades. However, despite all the advances and maturation in the field, most state-of-the-art FTC schemes assume that there are enough redundant actuators in the system.  In this project, it will be assumed that the system being considered e.g. quadrotor, has no redundant actuators. In the event of total failure of any of the actuators, the system becomes under-actuated, and the flight control system needs to be resilient and maintain some level of performance or at least allow for a safe landing.  *Research Approach:*  It is envisaged that this project will involve the development of a UAV test-bed platform suitable for testing/validating FTC schemes. The project will include the development of mathematical models and novel FTC schemes which will subsequently be implemented and tested on the UAV platform. The resilient control systems considered here will be built based on sliding mode control (SMC) schemes.  The project will develop fault tolerant schemes, which will be initially simulated with realistic faults/failures using simulation. This will be followed by hardware implementation and rigorous evaluation of the fault tolerant schemes on an under-actuated UAV. |