Self-Reconfiguration in Response to Faults in Modular Aerial Systems

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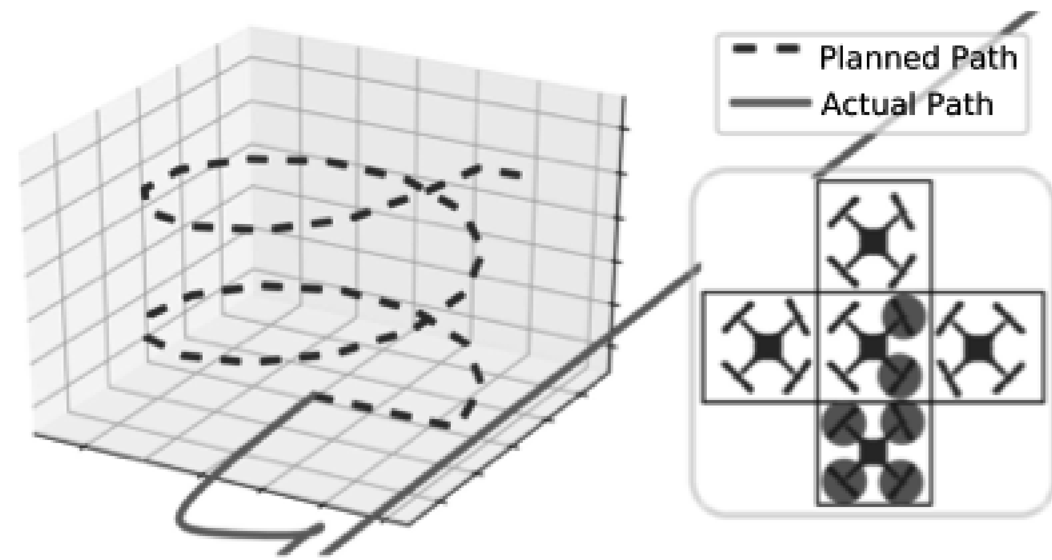
Abstract—**We present a self-reconfiguration technique by which a modular flying platform can mitigate the impact of rotor failures. In this technique, the system adapts its configuration in response to rotor failures to be able to continue its mission while efficiently utilizing resources. A mixed integer linear program determines an optimal module-to-position allocation in the structure based on rotor faults and desired trajectories. We further propose an efficient dynamic programming algorithm that minimizes the number of disassembly and reassembly steps needed for reconfiguration. Evaluation results show that our technique can substantially increase the robustness of the system while utilizing resources efficiently, and that it can scale well with the number of modules.**

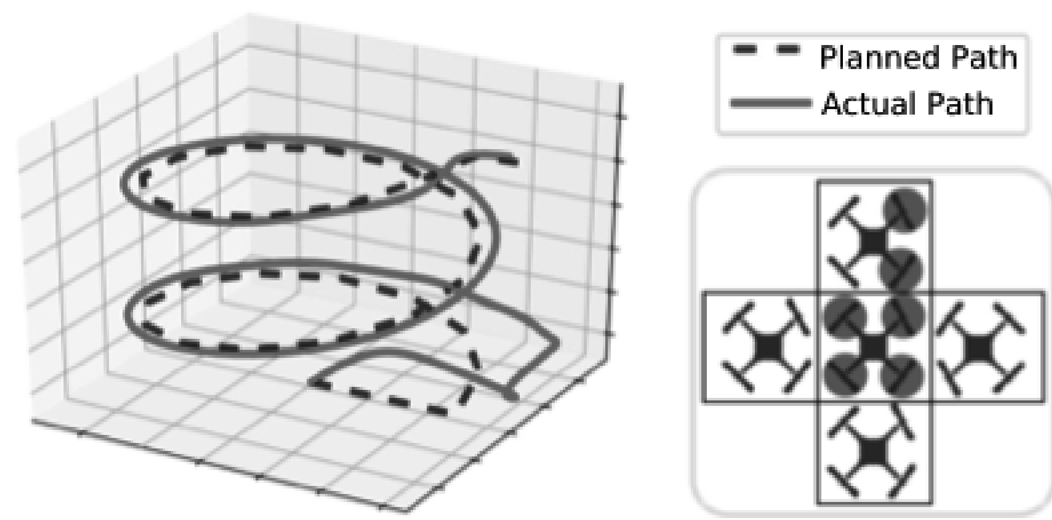
Index Terms—**Cellular and modular robots, aerial systems, applications, failure detection and recovery.**

I. Introduction

TERMITES, bees, and ants are prominent examples of many small units working together to accomplish large undertakings (e.g., a termite mound). Recently, there has been a trend towards replicating such swarm-like behavior in robotic systems to solve complex collective tasks such as exploration [20], construction [13], and transportation [4] [8]. For example, robot swarms have been used to create large structures that are impos-



(a) Non-optimal configuration.



(b) After self-reconfiguration.

Fig. 1. An aerial structure in a plus-shape following a helical trajectory. Illustrations of the structures are shown to the right of each plot. Translucent red disks indicate faulty rotors. (a) Six faulty rotors can be fatal for a structure driving it to undesired locations. (b) The structure can follow the trajectory after