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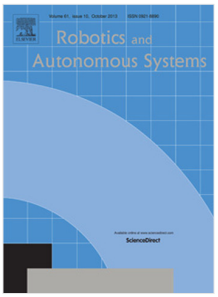

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Monitoring a Robot Swarm Using a Data-Driven Fault Detection Approach

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Abstract

Using swarm robotics system, with one or more faulty robots, to accomplish specific tasks may lead to degradation in performances complying with the target requirements. In such circumstances, robot swarms require continuous monitoring to detect abnormal events and to sustain normal operations. In this paper, an innovative exogenous fault detection method for monitoring robots swarm is presented. The method merges the flexibility of principal component analysis (PCA) models and the greater sensitivity of the exponentially-weighted moving average (EWMA) and cumulative sum (CUSUM) control charts to insidious changes. The method is tested and evaluated on a swarm of simulated foot-bot robots performing a circle formation task, via the viscoelastic control model. We illustrate through simulated data collected from the ARGoS simulator that a significant improvement in fault detection can be obtained by using the proposed method where compared to the conventional PCA-based methods (i.e., T^2 and Q).

Keywords: Exogenous fault detection, swarm robotics, viscoelastic control model, data-driven approaches, statistical monitoring schemes.

1. Introduction

1.1. The state of the art

Swarm intelligence techniques in multi-robotics systems are among the fast growing areas in the field of robotics [1, 2, 3]. The philosophy behind the swarm robotics field is inspired by the societies of animals such as birds, ants and bees. Indeed, the limited capability of a single robot to perform complex tasks can be enhanced by using a robotic swarm [4, 5]. Furthermore, a group of robots, which is able to cooperate to perform complex tasks is important in process industries to enhance productivity, efficiency, and safety, and to increase the flexibility of the whole swarm system. Moreover, swarm robotics is very useful for several applications, such as the collective detection of bombs, cooperative search and exploration, managing