Fig. 1) observed were because faulty behavior became indistinguishable from normal ones (e.g., flocking agents moving in a straight line). It may be argued that the faults may not be a hindrance, if they do not disrupt the behavior of the swarm. However, this needs to be explored further with a quantitative analysis of swarm behaviors.

In our study, we assume the CRM of all the agents function normally. This is a critical consideration, since abnormalities may not only be restricted to the sensor, motor devices, and control software of the agent, but may also affect the proper execution of the CRM. Consequently, it is worth exploring the impact of perturbations on the CRM itself, as they could drive anomalous behaviors akin to "autoimmunity". It may be expected that communication of virtual T-cells from "healthy" neighboring agents, and a consensus amongst neighboring agents in the decision to mount an immune response, may dampen the effects of such perturbations. However, this needs further investigation.

6. CONCLUSIONS AND FUTURE WORK

In this study, we proposed an approach inspired by the capability of the adaptive immune system, to detect agents behaving abnormally due to faults, in MAS. We examined the validity of our approach using a collection of typical swarm behaviors, while introducing behaviors simulating common faults encountered by robots due to malfunctions in their sensors, motors and control software. Our approach to fault detection utilizes relatively few agents, and may therefore compliment the existing centralized approaches used in traditional MRS. Moreover, because of the inherent distributed nature of fault detection, our approach may also be applicable to swarm robotic systems, where centralized approaches may not always be feasible.

The results of our study encourage us to explore more realistic scenarios involving MRS exhibiting different behaviors depending on environmental contingencies, wherein the capability of our immune system model to maintain a history of robot behaviors may be used to characterize normality in more complex tasks. Furthermore, a detailed comparative investigation of the results of our immune system model with other fault detection algorithms used in MRS, is also underway.

Supplemental Data: Movies of MAS simulations are available online at `www.isr.ist.utl.pt/~dtarapore/AAMAS2013/videos`.

Acknowledgment: This study was supported by the FCT grant PTDC/EEACRO/104658/2008.

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