Dancing robots: form, environment and context in human-robot interaction

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Most dancing robots to date have used patterns of preprogrammed motions or hard-coded interaction rules to produce this behaviour. In a departure from this approach, recently we used a form of embodied chaotic itinerancy (Ikegami, 2007, J. Consc. Studies, 14, p.111; Kaneko et al., 2003, Chaos, 13(3), p. 926) to generate motor movements for a robot in real time. We used the robot's sensors to analyse audio input, processing it at regular time intervals to find the appropriate tempo, and used this information to send input pulses to a FitzHugh-Nagumo neural network model (Aucouturier et al., 2007, Proc. of the 14th ICONIP, Springer-Verlag). The dynamic properties of these neurons allow for interesting chaotic behaviour, as some inputs will produce entrained periodic states, while others produce chaotic or aperiodic responses.

The output neurons of this network drove the motors of our chosen robotics platform Miuro, a simple two-wheeled vehicle robot manufactured by ZMP (Tokyo, Japan). Despite the deterministic nature of the mechanisms driving Miuro, the resultant motions are heavily dependent on the music being played, and thus the robot displays complex transitions between quasiperiodic states of motion. The robot is able to demonstrate both synchronization and autonomy in its reactions to the music.

Currently we are organizing a workshop together with art students to invent a new type of environment for robots. In particular, we are aiming to generate "natural" sound environments in which mobile robots can generate complex and interesting dancing patterns. The workshop will also investigate the role of physical form in driving interaction between autonomous robots and human observers. The robot will interact with human observers in the same method as above, through sound, but our investigation of radical and novel physical forms for the robot will allow us to investigate new varieties of agent-environment couplings.

Ikegami and colleague Keiichiro Shibuya have started a series of sound installations, each of which uses ideas of Artificial Life and complex systems science to make unique soundscapes (http://sacral.c.u-tokyo.ac.jp/index.php?Third%20Term%20Music). Using robots, we can further develop this enlightening cooperation between science and art, which we think is a promising future avenue of artificial life study. Our collaboration with people from Art University will also encompass this issue, examining the concept of open-endedness in artificial life studies and developing new methods for generating sound arts.

In both cases, our future work hinges on developing a new understanding of the robot-environment-human relationship. Through analysis of our work thus far, and discussion of the multitude of conceptual issues we have investigated with the artistic community, we will demonstrate new ways in which to examine these relationships. The interplay between form and function, between observer and performer, and between context and action will all influence the development of both the robot's morphology and its control structure.