

# Preface

Several years ago, we started thinking about what it means for a robot to move in a particular “style of motion.” This question arose out of a desire to be able to make robotic movements more meaningful and relatable to humans and a curiosity about what distinguishes different genres of movement. It quickly became clear that this line of inquiry required a whole new set of tools for understanding motion generation in particular, and control design in general—tools that related to our perception of human motion and to the performing arts.

In conjunction with the technical development of style-based motions, we began searching for a community of researchers who were interested in questions pertaining to “Controls and Art.” This search resulted in two Invited Sessions at the American Control Conference (2011 in San Francisco and 2012 in Montreal), with the second one being co-organized with Naomi Leonard. We were pleasantly surprised by the strong interest in these sessions, and by the many creative and interesting approaches to using control-theoretic frameworks to investigate, bolster, and create art. This book is a logical extension of the two invited sessions, where a large subset of our authors contributed papers.

The different chapters in this book fall into one or more of three main camps, namely research that (1) uses artistic ideas for the purpose of control design and analysis, (2) uses control theoretic ideas to understand and analyze art, and (3) uses control theory as a generator of artistic expressions. It is, however, not our ambition to paint the complete picture of the research that can be found in the intersection between Controls and Art, or to imply that this field is close to maturity. Instead, we hope that this book will inspire new research in this exciting line of inquiry.

The marriage between control theory and art is challenging because it requires a union between subjective and objective analysis. In fact, while control theory thrives under well-defined performance specifications and clear metrics of success, art thrives on multiple interpretations and evaluations of a single work. As such, when embarking on an endeavor connecting the two, a shift in perspective is needed. This book represents such a shift: the list of authors includes artists and engineers and the list of topics includes dancing robots, swarming dancers, automated puppetry, reactive museum installments, salsa dancing, intricate geometric patterns, aerial quadrotor ballets, music generated from math, and amorphous blobs that dance the Bhangra. More importantly, we ask our readers to

consider the matters that arise for putting together what may seem like kitschy combos: How do dancers communicate to execute such highly coordinated movements? What does it mean for a robot to dance? What do viewers watching movement notice most? Can we augment human capabilities with technology? What makes a composition of curves aesthetic? How do people interact with curated spaces? And what do the answers to these questions teach us about human creativity?

To answer these questions, the chapters in this book are arranged around different themes, with the first theme investigating fundamental questions such as *How is movement perceived?* (Kingston et al. [Chap. 1](#)), *What do performers actually do?* (Leonard et al. [Chap. 2](#)), and *What is in a dance?* (Baillieul and Ozcimder, [Chap. 3](#)). The next theme involves the construction of control laws based on artistic principles, including aerial robots (Schoellig et al. [Chap. 4](#)), robot puppets (Jochum et al. [Chap. 5](#)), and teams of mobile robots (Tsiotras and Castro, [Chap. 6](#)). The last theme turns the relationship between Controls and Art around by asking how Controls tools can be used in the Arts themselves, including algorithmic composition using swarm theory (Huepe et al. [Chap. 7](#)), automation for enhancing museum installations (Godbehre and Goldberg, [Chap. 8](#)), and the incorporation of robots in performance (LaViers et al. [Chap. 9](#)).

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Controls and Art

Inquiries at the Intersection of the Subjective and the  
Objective

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