CPSC 490 Project Description

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Keep on, Keepon

OVERVIEW

Matthew Du Pont is a senior B.A. Computer Science candidate, and Julian Rajeshwar is a B.A. Computer Science / B.A. Economics candidate, both in the class of 2010. They, along with Chris Riederer, collaborated on a final project for CPSC 473: Intelligent Robotics last semester.

During this project, they developed a generalized dancing program for the Keepon platform. The Keepon platform consists of Keepon, a small yellow robot designed for use in autism therapy, and the software used to control Keepon via a connected computer. Previously, Keepon was only able to "dance" if it was completely scripted to appear as if it was reacting to a given song. The project created a program that produces dances for any song (though it was only targeted to look good in songs that have tempo/sound quality one would consider "danceable"), using a high degree of randomness to combine small movements to the beat into, creating emergence into what appears to be a cohesive dance. The project was programmed in the Processing programming language, an open source programming language developed from ideas explored at the MIT Media Lab. The project employed a powerful sound plugin called Minim to capture and process sound, and was an 'on-line' system which processed music as it streamed, rather than in advance.

PROJECT AIMS

The aim of this project is to enhance Keepon's ability to dance. The project produced for Intelligent Robotics had no memory and responded in real time to music. Combined with the high degree of randomness introduced into Keepon's movements, Keepon could hear the same piece of music repeatedly and dance differently each time. While this underlying notion will not change, we plan to add to Keepon's dancing arsenal by making him capable of recognizing and responding predictably to certain musical patterns using both predictive reasoning and memory.

This will liberate Keepon's dancing in several ways. In the past, Keepon was limited and forced to stay 'on-beat' throughout the course of a song because his dancing engine was not calculating a predictable beat (as most songs have) but rather responding in real time to beats as they occurred. Prediction of beats will allow Keepon to execute more complex dance patterns in a rhythmic manner that allows him to return seamlessly to the beat of the song once finished with the pattern. Similarly, Keepon will be able to more fluidly transition between tempo shifts. Adding
musical memory to Keepon's arsenal should allow him to plan entire songs in advance, so that knowing a song in advance yields noticeably better dancing (as it often does with humans).

This project has several interesting impacts. First, it will allow us to re-evaluate the best architecture choice for creating dancing that appears organic. Our past work has indicated that combining disparate movements into emergent systems yields realistic dancing patterns; this project will examine whether or not relying on emergence stands up to an imposition of structure upon the preternaturally whimsical Keepon. Second, this project will allow us to determine to what extent robotic dancing is limited by lack of foreknowledge; in our past work, Keepon's dancing seemed limited by the dance engine's ability to process music and plan moves in real time. Keepon deserves the same chances afforded all humans -- the ability to know Lady GaGa songs by memory. This project will in effect control for the variables introduced by real-time planning. Third, as we noted in our previous work, Keepon's dancing broke down into disjointed and incoherent movements when presented with shifting and ambiguous tempos. Equipping Keepon with the ability to predict and extrapolate tempos and tempo changes will enhance Keepon's ability to create coherent dance regardless of the ineluctable modality of the audible tempo.

We plan to continue our work using the flexible and convenient Processing language and continue to give Keepon the tools to be a fundamentally on-line real-time dancer, with a few extra advantages.

**PROCESS DELIVERABLES**

- Due dates and assessment metrics for the project - as previously described (10/2/09)
- A decision on the precise nature of the dance engine's architecture - while we already have an architecture developed during our Intelligent Robotics project, the more sophisticated nature of this project will require extensive tailoring and revamping of the underlying decision mechanisms it employs (10/14/09)
- A midterm demonstration of Keepon's refined dancing prowess (11/18/09)

**FINAL DELIVERABLES (12/11/09)**

- Video demonstrations of Keepon's dancing ability
- Improved beat detection algorithm and improved matching of dance moves to song
- Specific metrics by which to determine the new dance engine's success, and test results of the program against live demonstrations, using not only predetermined songs to show off Keepon's memory and also new, unknown songs with which to prove Keepon's predictive power
PROJECT ROLES

In general, Julian is responsible for inputs into the precomputation (accurate beat detection, move library) and Matthew is responsible for using those inputs to produce an effective dance.

Julian Rajeshwar

Responsible for beat detection:
ability to dance to more complex rhythms
accuracy of move timing
library of dance moves

Matthew Du Pont

Responsible for song precomputing:
recognition of certain songs (i.e. for song x, include distinctive move/dance pattern y)
improvements over on-the-fly beat detection (longer moves possible because tempo is known in advance, different dance types for radically different tempos/tempo accelerations/crescendos)