

**PROPOSAL:
HUMAN GUIDED ITERATIVE TRAINING OF
DYNAMIC MOTOR SKILLS**

A Thesis Proposal
Presented to
The Academic Faculty

by

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**PROPOSAL:
HUMAN GUIDED ITERATIVE TRAINING OF
DYNAMIC MOTOR SKILLS**

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SUMMARY

We propose a human-in-the-loop (HITL) system to develop dynamic controllers for virtual characters under the guidance of a human coach. The user only needs to provide a primitive initial controller and high-level, human-readable instructions as if coaching a human trainee. The virtual character interprets the provided instructions, accumulate the knowledge from the human coach, and iteratively improves its motor skills by optimizing control parameters. To facilitate the mapping between high-level instructions and control variables, we introduce a new representation of motor skills, the “motor tree” which hierarchically organizes the skills from the low-level motions to the complex ones. The hierarchical structure enables flexible re-assembly and efficient re-optimization by preserving the invariant features of motor skills. Further, the optimization process is accelerated by several techniques such as utilizing the failed previous trials or exploiting the idling time of optimizer. With the propose framework, the human coach can design complex dynamic controller for virtual characters intuitively and interactively.

CHAPTER I

INTRODUCTION

Learning a dynamic motor skill, such as a precision jump in Parkour or a flip in gymnastics usually requires an iterative training process with interactive coaching and repetitive practices. Even though details of the learning process remain unknown, Pitts and Posner [1] hypothesize the three stages of the skill acquisition process: the cognitive stage, the associative stage, and the autonomous stage. The cognitive stage is when the trainee gathers information about the new skill or receives the feedback on the existing skills from the coach via instructions. In the associative stage, the learner translates the declarative knowledge to functional movements after an unspecified amount of practice and few mistakes. In the autonomous stage, the skill has become almost automatic or habitual so that it can be executed with minimal amount of efforts. A key of this hypothesis is an iterative process between cognitive learning and physical training. With this intuition, we propose a human-in-the-loop optimization framework to design dynamic controllers for virtual characters, which consists of the “coaching” stage for receiving user instructions and the “practicing” stage for optimizing control parameters.

In fact, the iterative training system can greatly simplify the design process of dynamic controllers by exploiting the same mechanism as human. Moreover, since our system incrementally develops the controller by accumulating human knowledge, the existing controllers can be easily adapted, extended, or concatenated for new situations. However, several new research questions arise when we formalize the elusive principles of human learning into mathematical models for designing physics-based controllers, such as mapping the human instruction to low-level control variables

or representing the accumulated knowledge on motor skills. To resolve the issues, we introduce a new hierarchical representation of motor skills, the “motor tree”, to simulate the phenomenon of skill abstraction and accumulation. To increase the responsiveness, the motor tree is optimized at interactive rates by exploiting the previous failure history or idle time of the system.

CHAPTER II

ITERATIVE CONTROLLER DESIGN

Resembles learning by demonstration,

2.1 System Overview

coaching and training

2.2 Controller

Our controller produces a torque

2.3 Instruction

our instruction are following:

CHAPTER III

TIMELINE FOR PROPOSED RESEARCH

- 2014, Apr: present proposal to committee
- 2014, Apr - May: setup a virtual/real robot
- 2014, May - Aug: internship @ Disney Research
- 2014, Sep: submit the first part to ICRA
- 2014, Sep - Oct: re-formulate the research problem
- 2015, Feb: submit the second part to IROS
- 2015, Feb - May : write thesis
- 2015, May: defense thesis

REFERENCES

- [1] FITTS, P. M. and POSNER, M. I., “Human performance.,” 1967.