Generating Spatial Paths to Express Attentional Attitudes

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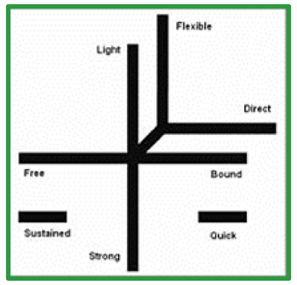
Introduction

How can path shape or manipulations of robot spatial orientations help to convey a robot's inner state? Our research aims to use theatrical concepts of movement to map different spatial trajectories to the different attentional attitudes that a human might perceive in a robot approaching an object of interest.

Motivation

In the field of human-robot interaction, much focus has been put into creating legible motion that will help people understand a robot's intentions. Creating expressive motion, however, can help people understand a robot's inner state, resulting in more fluid communication, empathy and/or acceptance.

Laban Effort States



The Laban Effort system covers four different aspects of movement (Space, Time, Weight, and Flow). This research focuses on Space, with spatial manipulation falling along a scale from Indirect to Direct motion.

Direct motion is characterized by:
- single focus, high attention

Indirect/flexible motion is characterized by:
- multi focus, low attention

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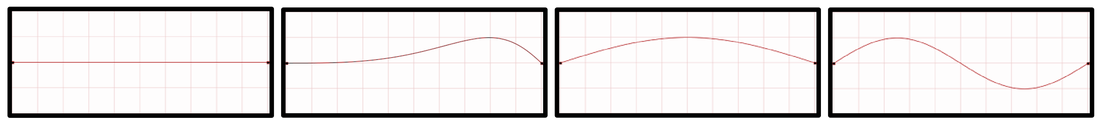
Path Generation

We deconstruct our approach paths to a target into several spatial features, namely path shape, orientation along the path, and linearity. We therefore implemented the ability for CoBot to follow approach paths with parameterization of each of these individual features.

Path Shape:

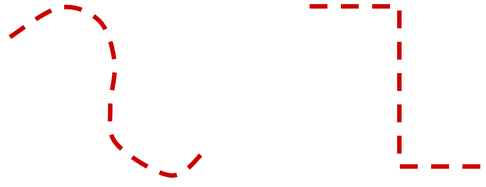


Line (y=0) | Hook (y=sin(x²)) | Curve (y=sin(x)) | Sine (y=2sin(x))

Path Orientation:

Goal-oriented | Path-oriented

Linearity:



Curvilinear | Rectilinear

Other key features of goal-directed movement include stopping orientation and relative distance from the goal. However, these were set at constants to isolate exploration of path characteristics.

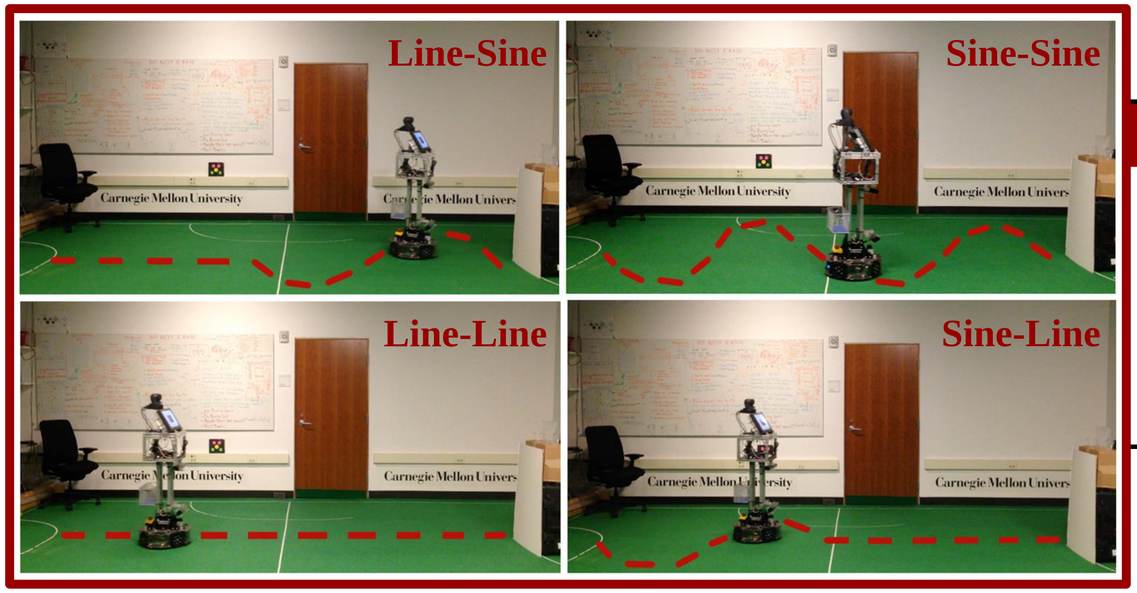


Figure 2. Compound gestures allow the possibility of evaluating the implications of path shape within a contrasting context. Here CoBot is shown executing four of the basic path combinations.

Preliminary Study

A preliminary pilot was conducted to assess the directness/indirectness of the different path shapes and orientations shown to the left. Indirect ratings were highest for sine paths with path-orientations, and Direct ratings were highest for linear paths and goal-orientations.

Attitude-relevant participant observations:

Linear path:
- "It was most **focused** on the straight path."

Goal-oriented orientation:
- "When it stayed facing toward the goal it seemed like it was **paying more attention**."

Goal-oriented non-linear paths:
- "Perhaps it was **wary** of the goal and was approaching it indirectly while **keeping an eye on it**."
- "Looking at the goal but not going straight to it made the robot look **evasive**."

Path-oriented non-linear paths:
- "The robot seemed like it might be **thinking or making decisions** about what to do next when it was looking around more.
- "It was looking all over the place, it looked **drunk**."

Pending Study

Our currently pending study focuses on the contrast between indirect path shape and direct path shape within filmed compound paths to a goal (Figure 2).

Amplitude variation was also featured to explore the range of path directness.

References

1. H. Knight and R. SImmons, "Expressive Motion with X, Y and Theta: Laban Effort Features for Mobile Robots," in *Proceedings of International Symposium Robot and Human Interactive Communication*, Edinburgh Scotland, August 2014.