ADVERB PALETTE: MULTI-OBJECTIVE PATH PLANNING FOR ROBOTS

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AGENDA

• PROBLEM
• ADVERB PALETTE
• CONSTRUING INTENT
• SELECTION OF PATH
• ONGOING WORK
TRADE-OFFS IN DECISION MAKING

“Naturally, there’s a trade-off for its exceptional fuel economy.”

“Each time we dine out, Jack recalculates his retirement date.”
PROBLEM

• MULTI-OBJECTIVE PATH PLANNING FOR ROBOTS

• WE WANT THE ROBOT TO TAKE A PATH THAT SATISFY MULTIPLE CONSTRAINTS/OBJECTIVES
  • DO NOT COLLIDE WITH BUILDINGS
  • DO NOT RUN INTO ENEMIES
  • REACH THE GOAL AS FAST AS YOU CAN
PROBLEM CONT.

- GRAY PATHS: GENERATED BY MORRF*
  - COMPUTER ALGORITHM THAT GENERATES OPTIMAL PATHS
  - OPTIMAL PATHS:
SOLUTION: ADVERB PALETTE

- METAPHOR OF A PALETTE FOR MIXING OBJECTIVES/ADVERBS
- EACH OBJECTIVE IS A COLOR

A COMMAND: ‘GO QUICKLY AND SAFELY’

- EACH OBJECTIVE IS AN ADVERB

- THREE ADVERBS/OBJECTIVES:
  - QUICKLY
  - STEALTHILY
  - SAFELY
COMMAND INTERFACE

• 4 DESIGNS: DIFFERENT MECHANISMS FOR TRADE-OFFS
• COMMAND (CONSTRUE INTENT) WHAT IS DESIRED
  • PALETTE
  • SLiders
  • PRISM
  • WAYPOINts
• MIX OBJECTIVES SIMILAR TO THE WAY AN ARTISTS MIX COLORS TO GET A DESIRED SHADE

• MIXTURE PROPORTION IN THE PIE CHART/TEXTBOXES

• CORRESPONDING PATH TO THE MIXTURE SHOWS UP IN THE MAP

Example Human intent vector $h(0.333, 0.333, 0.333)$
PATH SELECTION CONT....

• COMPARE CONSTRUED INTENT $h$ WITH EACH OF THE $\text{path\_vector}$

• USE COSINE SIMILARITY FOR COMPARISON

$$\text{CosineSimilarity}(h, p_s) = \frac{h \cdot p_s}{\|h\| \|p_s\|} = \frac{\sum_{k=1}^{K} h_k p_{sk}}{\sqrt{\sum_{k=1}^{K} (h_k)^2} \sqrt{\sum_{k=1}^{K} (p_{sk})^2}}$$

• BEST PATH IS THE ONE THAT MAKES LEAST ANGLE

$$p_{best} = \arg \max \_{s \in S} \text{CosineSimilarity}(h, p_s)$$

Back to school memories:
$\cos 0^\circ = 1$
$\cos 90^\circ = 0$
STRENGTHS AND LIMITATIONS

• MORE NUMBER OF ADVERBS/OBJECTIVES CAN BE TACKLED WITH PALETTE AND SLIDERS

• PRISM CAN DEAL WITH JUST 3 ADVERBS, BUT THE USER CAN HOVER OVER AND DISCOVER PATHS WITHOUT CLICKING
ONGOING WORK

- USER STUDY IS DESIGNED TO MEASURE
  - USER PREFERENCE
  - SUBJECTIVE OVERLOAD
  - TIME TO COMPLETE TASKS
THANK YOU.