Combining Moving Targets and Moving Obstacles in a Locomotion Model

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Background

Steering dynamics model has 4 separate components for locomotion:
- Steering to a stationary target [1]
- Avoiding a stationary obstacle [1]
- Intercepting a moving target [2,4,5]
- Avoiding a moving obstacle [3,6]

Research Question

- Can we linearly combine multiple moving components to predict human behavior in complex environments?

- We tested situations with a moving target and:
  1) Moving obstacle
  2) Two moving obstacles

- Conditions were designed to create switches in human behavior around the obstacle(s).
- Does the model predict switching in humans?
- Does the model take similar paths around obstacles as humans?

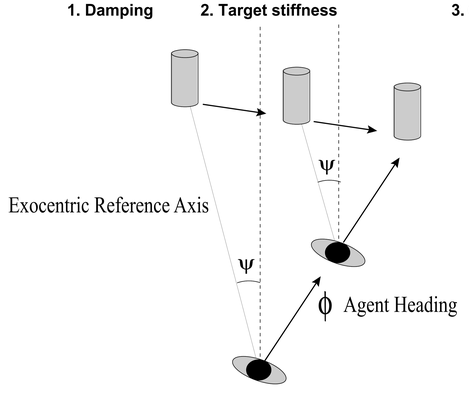
The Model

Damped spring - computes angular acceleration

Targets = attractors of heading
Obstacles = repulsors of heading

Null change in bearing direction to intercept targets.
Avoid null-point to avoid obstacles.

$$\ddot{\phi} = \underbrace{-b\dot{\phi}}_{\text{1. Damping}} \underbrace{- k_t(-\dot{\psi})(c_5 + d_t)}_{\text{2. Target stiffness}} + \underbrace{k_m(-\dot{\psi})(e^{-c_6|-\dot{\psi}|})(e^{-c_7(d_m)})}_{\text{3. Obstacle stiffness}}$$

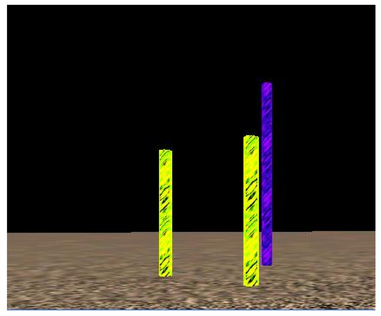


VENLab

12 m x 12 m, free movement
Kaiser HMD (60° x 40°)
Inertial/ultrasonic tracking, ~ 50ms latency

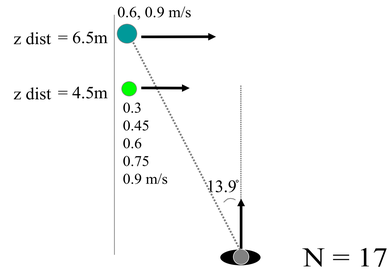
Participants see ground-plane texture
Walk 1 m, targets and obstacles appear

Targets - blue pole
Obstacles - yellow poles

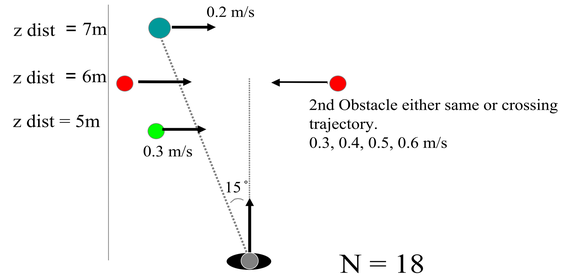


[1] Fajen & Warren (JEP:HPP, 2003)
[2] Fajen & Warren (EBR, submitted)
[3] Warren, Di, & Fajen (VSS, 2003)
[4] Owens & Warren (Psychonomics, 2004)
[5] Bruggeman & Warren (VSS, 2005)
[6] Cohen, Bruggeman, & Warren (VSS, 2005)
NIH EY10923
Special Thanks to VENLab team

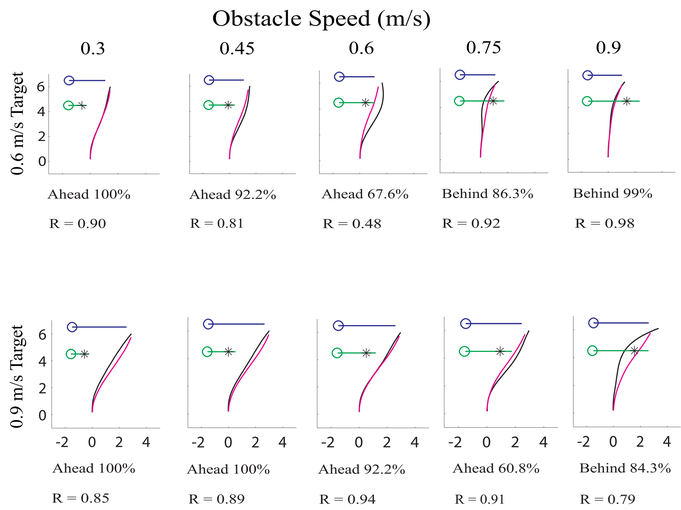
Experiment 1: Methods



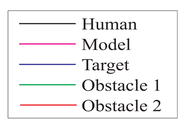
Experiment 2: Methods



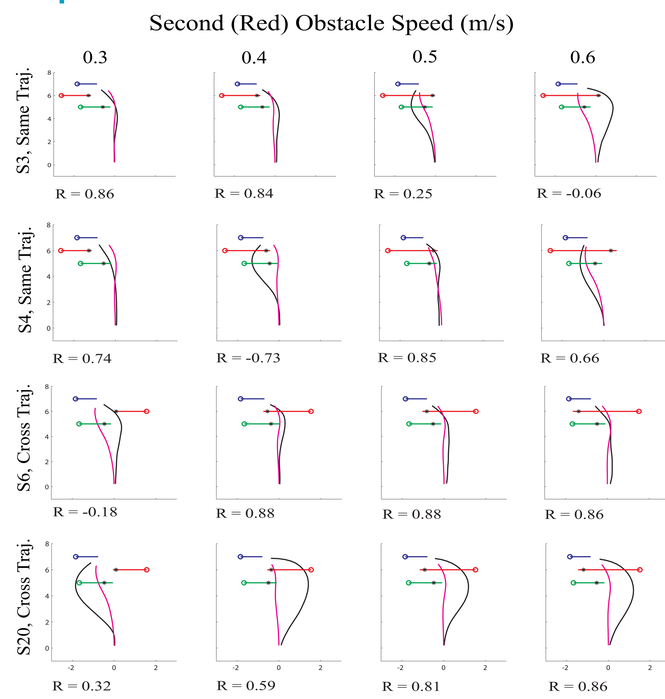
Experiment 1: Results



Correlations in heading (ϕ) between model and Human



Experiment 2: Results



Discussion

- Model predicts human paths with 2 moving objects.
- Trouble with 3 moving objects - more variation in paths.
- Timing with respect to objects becomes more important.
- Suggests that 3+ moving objects may not be linearly combined by the model.

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