Switching Behavior in Moving Obstacle Avoidance

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Main Questions

How do people avoid a moving obstacle?

What makes a person switch from moving ahead to behind the obstacle?

Goal of the Model (Warren, Sun, Fajen, 2003)

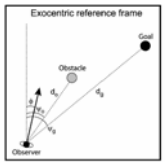
•Null change in target-heading angle = target interception.
•Keep turning rate above zero = obstacle avoidance.

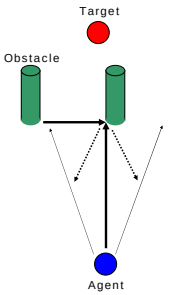
$$\ddot{\phi} = -b\dot{\phi} - k_g(\phi - \psi_g)\left(e^{-c_1 d_g} + c_2\right) + k_m\left(\dot{\beta}\right)e^{-c_7|\dot{\beta}|}\left(e^{-c_8 d_m}\right)$$

Angular Acceleration | Damping Term[1] | Target Stiffness Term[2] | Obstacle Stiffness Term[3]

1. Damping term: Frictional force that resists oscillation of the heading about the goal (i.e. straightens the path)
   *b: rate of damping of body's moment of inertia
2. Target Stiffness Term: Acts to increase angular acceleration linearly with the target heading angle.
   *kg: ratio of stiffness to amount of inertia
   *c1: determines decay rate with distance
   *c2: minimum value so that the acceleration ≠ 0
3. Obstacle Stiffness Term: Acts to keep turning rate around the obstacle more than zero.
   *c7: determines repelling property based on heading
   *c8: determines repelling property based on distance to obstacle

Note: b, kg, c1, c2, c7, c8 are parameters; for this study, we used previously obtained values (Warren, Di, Fajen, VSS, 2003) of: [b=7, kg=.17, c1=.013, c2=.45, c7=.1, c8=.002]





Current Study

Test model in new obstacle conditions
–Can it predict Ahead vs. Behind paths?
–Can the model fit each path?

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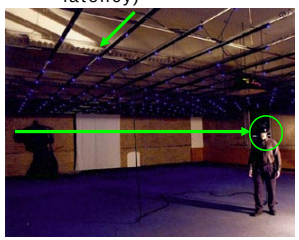
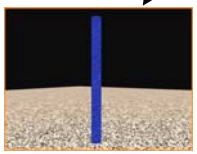
VENLab

•12 x 12 m Virtual Environments
•Large space provides free movement

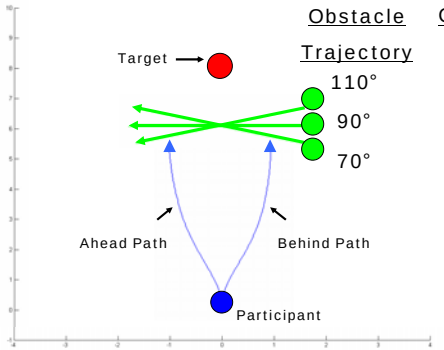
Dual sonic/inertial tracking system (50 ms latency)



Kaiser HMD (60°H x 40°V FOV)



Methods & Design

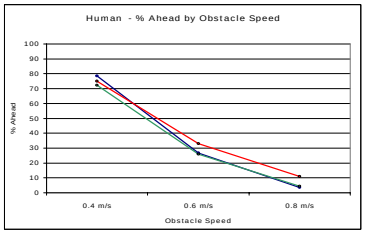


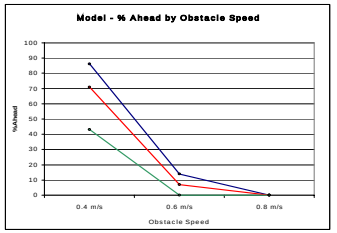
Obstacle Trajectory	Obstacle Speed
110°	.4 m/s
90°	.6 m/s
70°	.8 m/s

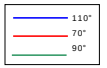
9 conditions x 8 trials = 72 trials

N = 14

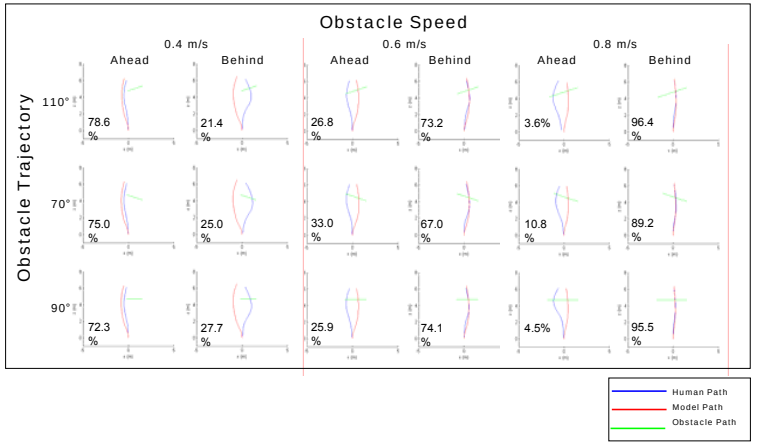
Results







Mean Normalized Paths



Conclusions

The model predicted the dominant human paths. Where differences occurred, the model did not display an overall bias towards Ahead or Behind Paths. Instead, model predictions were related to Obstacle Speed.

Future Directions

- Simulate individual trials, based on human speed.
- Can the model predict behavior for complex environments?
  - Introduce a moving target
  - Increase number of obstacles

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