How Do You Turn This Driving Simulator On?

Tutorial for Traffic Engineering and Roadway Design Research Using Driving Simulation

Sue Chrysler
Linda Ng Boyle
Richard Romano
Agenda

1:30  Introductions
1:45  Hardware Selection and Room Set-up
     Richard Romano
2:05  Research Topics and Scenarios
     Sue Chrysler
2:20  Experimental Design Concepts
     Linda Ng Boyle
2:40  Data Collection Tips
     Sue Chrysler
3:00  Group Exercise
4:00  Discussion and Questions
4:30  Adjourn
Hardware Selection and Room Set-up

Richard Romano
Eye Relief (Display Distance)

- It is important for visuals objects in simulator to be located “behind” the screen.
- Otherwise they look too big and too far away.
Eye Relief

- When screens are too close (inside 4 feet ?)
  - Eye strain from accommodation
- Eye strain is worse than computer work
  - The “virtual” image is further away
  - Fights with accommodation reflexes

Taken from thefarmersdaughter.com
Selecting Cab Size

- Full vehicle is large, expensive, and hard to move into a room
- ½ cab can be effective
- ¼ cab (or desktop) are smallest
  - Eliminates the roof and pillars
  - Can make it difficult to locate your car in the virtual world.

Taken from bransonpianomo.com
Monitors are very close for larger field of view (FOV)
  ◦ Smaller, cheaper monitors
  ◦ Allow displaying interior elements of the vehicle (i.e. dashboard)

Disadvantages
  ◦ Close monitors can cause eye strain
  ◦ No passengers
  ◦ No interior components
Resulting Designs: Quarter Cab

- Bring monitors close to display vehicle mirrors and vehicle exterior in the monitors
- Can include center console
- Disadvantages
  - No passengers
  - Difficult to have a wide FOV
    - Vertical or horizontal
  - Can’t test accommodation time changes from monitor
    - Out the Window to interior (cluster, etc.)
Resulting Designs: Full or Half Cab

- Requires large room
  - Must push screens out beyond the vehicle
- Typically use projectors
- Stop signs on right and cars on left are “inside” screen so they don’t always look correct
  - Complaints that they look too big and too far away
Curved screen has constant distance to the screen (good for accommodation cues)
Head/vehicle motion causes a kink in the horizon on faceted screens
Steering Feedback

- Passive Steering
  - Spring feedback

- Active Steering
  - Motor mounted on steering wheel
  - More expensive
  - Can use tighter on center torque to help drive the car straight when looking away from the road
  - Helps you recover from a skid by turning the road wheels into the direction of travel

Taken from gov.uk
Motion Feedback

- Is important for vehicle controllability
- Pitch and Yaw
  - Important motion cues for simulator sickness
  - Supports our ocular reflexes
- Vision uses position to interpolate velocity
- Acceleration feedback needed
  - From our vestibular system for good vehicle control
- High gain and high tilt rate motion improve controllability but does not feel good
Motion and Sickness (Pitch)

- In real world
  - Vestibular ocular reflex makes it so the car pitches around your eyes.

- In a fixed based simulator
  - Horizon just moves up
  - Issues with the car “pitching” too much

- A pitch motion base can support the reflex properly.
- Or turn off pitch motion in the dynamics.
Vestibular ocular reflex (VOR)

- Allows you to track the road
- Without vestibular feedback (yaw motion) the subject must rely on the Optokinetic Nystagmus (OKN)
- If motion in simulator is scaled, eyes must use both OKN and VOR
- Motion bases can filter motion so the yaw rate is not constant, which makes it even worse

Motion and Sickness (Yaw)

- Lack of yaw motion cues
  - Make driving performance worse at intersections
  - Cause driver induced oscillations
- People complain about steering wheel and vehicle dynamics
- Simulator users tend to minimize many turns at intersections
- The only real fix is an unlimited motion yaw ring.

Taken from forcedynamics.com
Room Requirements

- No need to paint room black
  - But windows need to be close to light tight

- Power
  - May need several dedicated 120 V circuits
  - 600 W Computer $\rightarrow$ 5 Amps $\rightarrow$ 2000 BTU

- Air conditioning
  - 10000 BTU for multi channel desktop to 50000 BTU for larger systems).

- Need cool air flow past the driver

- Need a place for the computers

- Need a place for the experimenters
  - Tasks lights (desk lights) are a good
Work Flow

- Driver’s enter and exit from the left side
- Sit so you can see the driver but they can’t see you
- Enter from the back of the room if possible
- How about observers?
What Have You Done?

- What changes can/have you made to improve your room?
  - Air conditioning/lighting?

- What changes can/have you made to improve your simulator?
  - Different monitors/projectors?
  - Different control layout?
  - Changes to the cab?
  - Other accessories?