Navigation

- Movement in an environment
- Two complementary components
  - Travel
    - Motoric: Actions involved in getting from one place to another, typically translating/rotating the camera
  - Wayfinding
    - Cognitive: Thinking, planning, and decision making that lead to motion through understanding the environment
- Travel and wayfinding can interact
  - Can be combined together
  - Techniques used for one can affect the other
Navigation Tasks

- **Exploration** (also cited as basic visualization task)
  - Undirected “browsing” to get the “big picture” and develop an understanding of the environment
  - Need freedom to deviate from path
  - Should impose minimal cognitive load to allow user to concentrate on understanding environment

- **Search** (also cited as basic visualization task)
  - Directed travel to a specific goal/location
    - **Naïve search**: user doesn’t know path/position in advance
    - **Primed search**: user has advance knowledge of path/position
  - May benefit from system guiding the user to the destination

- **Comparison** (also cited as basic visualization task)
  - Inspection to understand the difference between multiple objects/locations/routes
  - Could guide user in comparing locations or routes (e.g., through multiple displays or structured travel)

- **Maneuvering**
  - Small precise movements to position/orient the user better to inspect or manipulate
  - Key issue is ease and precision of control
Travel Task Parameters

- For physical and virtual worlds
- Distance to travel
  - Tracker technology and range of physical movement (e.g., size of tracked environment)
    - May constrain how user can move, making it impossible to map real to virtual one-to-one
  - Fatigue/time constraints
    - May suggest not using direct isomorphic approaches for greater distances
- Curvature/turns in path
  - More complexity makes isomorphic body motion more difficult/tiring
- Target visibility
  - Affects applicability of gaze-directed techniques
- DOF of movement
  - Constraints (e.g., surface travel over a landscape)
    - Make it possible to limit DOF of user control, but,…
    - May sacrifice understanding of environment in return for ease of control
Travel Task Parameters

- Accuracy/freedom of movement in space and time
  - If less accuracy/freedom required, then techniques that use scaled-down models may work well
- Relation to other tasks
  - Is travel the primary task or a secondary task?

Classification of Travel Tasks Along Active–Passive Continuum

- Active
  - User controls movement directly
  - Especially useful in active exploration
- Passive
  - System controls movement
    - “Guided tour”
  - Allows user to concentrate on other tasks
  - May be restricted by design or technology
    - E.g., user may control only orientation within a remotely controlled vehicle
- Route planning
  - User plans route in advance, and system executes it
Classification of Travel Tasks
Along Physical–Virtual Continuum

- Physical
  - User physically translates/rotates to translate/rotate viewpoint
    - E.g., through 6DOF head/body tracking
- Virtual
  - User moves viewpoint virtually
    - E.g., through joystick or pointing
- Hybrid
  - Based on distance
    - Physical travel for short distances, virtual travel for long distances
  - Based on type of DOF
    - Physical orientation (for naturalness), virtual translation (to save time/effort)

Classification of Travel Tasks
By Subtask Decomposition

- Direction / target selection
  - Control of how / where to move
- Velocity / acceleration selection
  - Control of how fast to move
- Input condition determination
  - Control of how travel is
    - Initiated
    - Sustained
    - Terminated
Classification of Travel Tasks
By Temporal Decomposition

- Start moving
- Indicate position
  - Specify position
    - Discrete target specification
    - One-time route specification
    - Continuous specification
  - Specify velocity
  - Specify acceleration
- Indicate orientation
- Stop moving

Note: Indication of position/orientation can occur before/during motion, discretely/continuously

Classification of Travel Tasks
By Interaction Metaphor

- Physical locomotion
- Steering
- Route planning
- Target selection
- Manual manipulation
- Scaling
- ...

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