MIE 240: Human-centred system design

Controls

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Learning Objectives

- Describe the various types of controls
- Discuss control-task pairings
- Define discrete control activation
- Provide examples of positioning control devices

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Control Design Principles

Perception principles

- Make accessible
- Make discriminable
- Avoid absolute judgment limits
- Exploit redundancy gain

Mental model principles

- Location compatibility
- Movement compatibility

Response selection principles

- Avoid accidental activation
- Hick-Hyman Law
- Decision complexity advantage
- Fitts's Law
- Provide feedback

Controls should be easily recognized

Controls should be easily reached

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Principles of Response Selection

R15. Feedback

- Most controls are associated with some kind of visual feedback
  - Example: Effect of turning steering wheel causes change in direction
- Good controls gives feedback of control state
- Feedback >100msec can be harmful if rapid responses are required (Need skilled operator)

Visual feedback

Lack of haptic feedback in robotic assisted surgery

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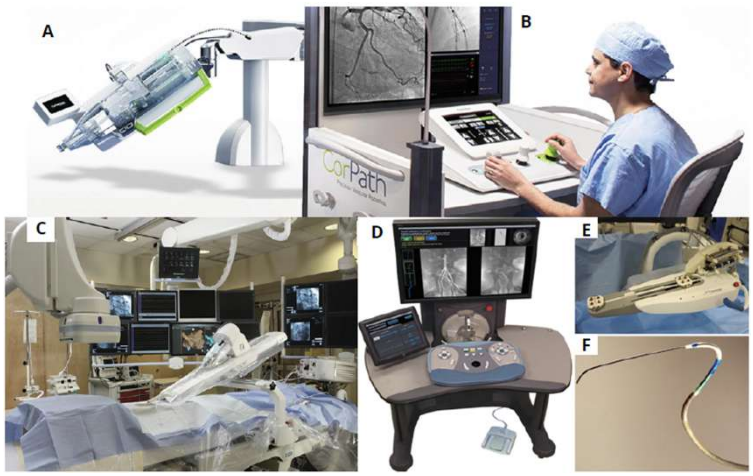
Feedback: Robotic assisted surgery



Thais Baena Network Feasibility Study for Remote Robotic-assisted Neurovascular Procedures

<u>Testing the feasibility of remote RAS</u>

Bandwidth: the maximum rate of data transfer
Latency: the time delay for data packets to cross the network
Jitter: the variation in packet arrival times, can disrupt the precision critical to surgical robotics.
Packet loss: occurs when data packets fail to reach their destination.

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Types of controls and tasks

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Types of controls

Controls and tasks – discrete vs. continuous, number of states (on/off vs 3+), point and select vs. tracking values

Push button

Toggle

Round knob (Dial)

Selector Switch

Voice

Lever

Keyboard

Mouse & joystick

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Table 9.1 Pairing controls and tasks

	Push button	Toggle switch	Lever	Selector switch	Keyboard	Voice	Round knob	Joystick or Mouse
Discrete control task								
Two states (On-Off)	●	◑	●L	○				
Three states		◑	●L	●				
Sequential states				●				
>24 discrete states	●	◑						
Continuous setting			◑				●	
Entering text					●	◑		
Continuous control task								
Point and select								●
Track values (1D)			●				○	◑
Track values (2D)								●

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Discrete controls

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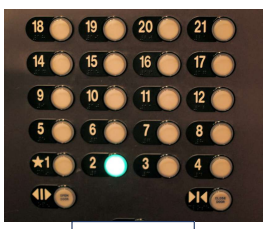
Discrete Control Activation

Many controls in the system are designed primarily for **activating** or **changing** the discrete state of a system

- Only making these controls more visible or salient is not enough
- feedback (visual, auditory, tactile), size, discriminability and labeling



Feedback

Size

Labeling

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Discrete Control Activation

Feedback

- Some controls offer more feedback channel than others
- This can happen due to visual cues, auditory cues (clicks), or even a feel of the control
- Auditory and tactile feedback provide the operator with instant knowledge of the toggle's change in state
- Visual feedback maybe less obvious in case of push buttons

Light on adapters provide feedback

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Discrete Control Activation

Size

- Smaller keys are usually problematic
- 'Typos' happen because the keys are too small and too close to one another
- An error more likely in case of people with bigger fingers or those who are wearing gloves
- Spacing between two keys is equally important as their size

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Discrete Control Activation

Discriminability and Labeling

- Keypress or control activation also occur if the key is not well specified to the novice or the causal user
- More likely to occur when large sets or identically appearing controls or unlabeled or poorly labeled controls
- Labels required when physically displaced from controls

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Continuous control

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Positioning Control Devices

- Most of the human machine interaction require the need to position some entity in space
- Example – moving a cursor to a point on the screen
- These tasks are referred to as pointing or positioning
- A wide range of such control devices are available like mouse, trackpad, stylus, joystick and so on

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Positioning Control Devices

Task performance dependence

- In most critical tasks involved in pointing, direct position controls (touch screen, light pen) are the most preferred
- Mouse tends to be slower but more precise
- Problem in accuracy can be caused by several factors like instability of hand and fingers
- Time lags and delays also impact performance and satisfaction

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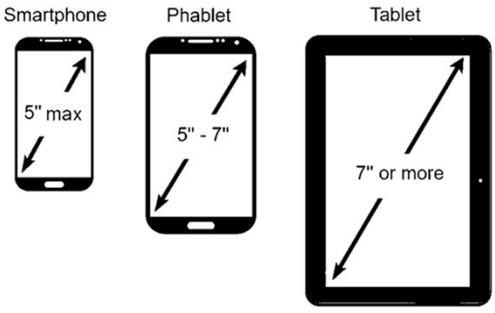
Positioning Control Devices

The work space environment

- Display showing the actual movement after control execution is equally important
- Display size influences device movement effort necessary to access targets
- Physical characteristics of the display also influence usability
- Factors like vibrations in environment can also have impact on controlling



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Benefits of Voice Control

Benefits of voice input

- Naturally efficient linguistic control
- Avoid some competition (dialing a phone in car)
- Support redundancy gain (visual + voice navigation)

Costs of voice input

- Word confusion
- Limited vocabulary size
- Constraints on speed
- Interference of noise and stress
- Compatibility with spatial tasks

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Summary

- Choice of control or input device is task dependent
- Many controls in the system are designed primarily for activating or changing the discrete state of a system
- Positioning control devices - position some entity in space
- Voice input - naturally efficient linguistic control, supports redundancy gain, avoid resource competition

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Control Design Principles

Attention principles
- Proximity compatibility
- Avoid resource competition

Memory principles
- Knowledge in the world
- Be consistent

Perception principles
- Make accessible
- Make discriminable
- Avoid absolute judgment limits
- Exploit redundancy gain

Mental model principles
- Location compatibility
- Movement compatibility

Response selection principles
- Avoid accidental activation
- Hick-Hyman Law
- Decision complexity advantage
- Fitts's Law
- Provide feedback

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Principles of Response Selection

The *difficulty* and *speed of selecting* a response or an action is influenced by several variables:

- **Avoid accidental activation –** four general methods**:** locate and orient, recess and shield, interlock and sequence operations, resist, delay, and confirm (see pg 293)
- **Hick Hyman Law** - Speed with which an action can be selected is strongly influenced by the number of possible actions
- **Decision complexity advantage –** more efficient to require a smaller number of complex decisions than many simple decisions
- **Speed accuracy trade-off/Fitts's Law** - carrying out actions too quickly increase likelihood of errors
- **Feedback** - Good control design gives direct feedback of control state

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Next lecture (Fri., Feb. 7)

Topic: Human-computer interaction
Review: Ch. 10 (Ch 10.1-10.3, 10.4)

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