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Human Multisensory Cybernetics

U.S. ARMY RDECOM

ARL open campus

S&T Campaign: Human Sciences
Human-System Integration

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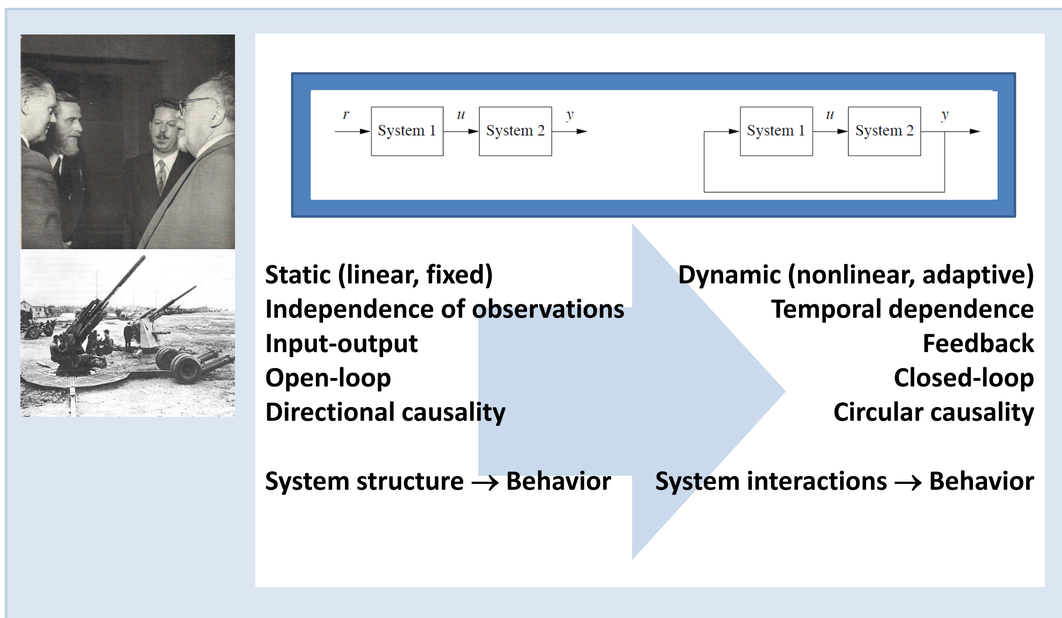
Research Objective

- **Apply the concepts, insights, and methods of *cybernetics* in quantitative and predictive models of human multisensory integration, exploiting the *dynamic* nature of human behavior to enhance human interactions in sociotechnical systems**



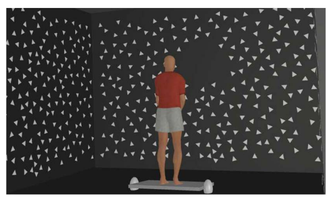
Left: Cybernetic foundations; Right: Paradigm shifting perspectives

Challenges

- **Modeling adaptive mechanisms in human multisensory integration**
- **Developing model-based algorithms for multi-sensory fusion**
- **Fusion of multiple sensory features, including features with different metrics**

USE OF STROBOSCOPIC STIMULATION TO INDUCE FUNCTIONAL ADAPTATIONS IN THE USE OF MULTISENSORY INFORMATION

BACKGROUND:
- Adaptive weighting of sensory inputs to dynamic changes in the environment have been demonstrated in human sensorimotor control.
- Stroboscopic stimulation has been demonstrated to increase performance in skilled visuomotor tasks



APPROACH:
- Utilize stroboscopic stimulation to induce *functional adaptations* in human use of multisensory information in locomotor and skilled motor task performance

OBJECTIVES:
- Identify and characterize functional adaptation in human multisensory integration
- Explore individual differences in multisensory weighting and their impact on sensorimotor, perceptual, and cognitive performance
- Develop proof-of-concept algorithms for adaptive multi-sensor fusion

Current Research Example

ARL Facilities and Capabilities Available to Support Collaborative Research

- **Available Facilities (APG, MD)**
  - **Multisensory augmented reality testbed platform**
    - Wearable, Head-mounted
    - Highly Immersive
    - Flexible, reconfigurablte sensor arrays
    - High-resolution, wide field, stereoscopic visual displays
    - Embedded eye tracking capabilities
    - Depth sensing, including hand and finger tracking
  - **Multi-aspect real-world measurement capabilities**
    - Wearable, Un-tethered Operation
    - Flexible, Fully Customizable User Interface
    - Multiple modalities: EEG, EKG, EDA, respiration, blood pressure, motion, posture, and others
  - **Environment for Auditory Research (EAR)**
    - One-of-a-kind , world-class capabilities
    - Multiple, reconfigurable spaces
    - Unique stimulus arrays, suitable for visual and auditory, as well as tactile displays
- **Unique ARL expertise includes:**
  - Sensory& Perceptual Processes
  - Adaptive Mechanisms in Multisensory Integration & Perception
  - Real-world experimental design and analysis

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- **Additional expertise needed in:**
  - **Computational and statistical modeling of adaptive and neural systems**
  - **Systems and adaptive control theory modeling of human and biological systems behavior**
  - **Algorithm development and software implementation**
- **New research approaches sought in:**
  - **Innovative experimental tasks and paradigms to probe adaptive processes in human multisensory integration**
  - **Novel stimulation modalities to enhance perceptual and motor performance**
  - **Embodied approaches to multi-sensor fusion**

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