TOWARDS AN ENABLING MULTIMODAL INTERFACE FOR AN ASSISTIVE ROBOT

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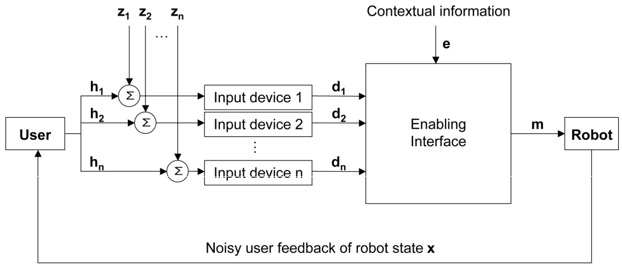
MOTIVATION

- The development of assistive robots for elderly and disabled people is currently an active field of research in the robotics community.
- The integration of multimodal interfaces is a key point to this respect.
- In this work we study how to analyze, implement, and test an "enabling" multimodal interface for the ASIBOT assistive robot.

PROBLEM STATEMENT

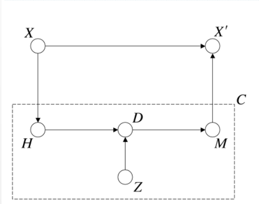


The problem statement

- The user and the robot are operating in a closed loop and both are potentially capable of adapting to each other.
- The intended user commands (*h*) are assumed to be subject to noise (*z*), representing the disabilities of the user.
- The interface will use the noisy signals (*d*) from *n* input devices, and information on the context of operation (*e*), to generate the robot commands (*m*).

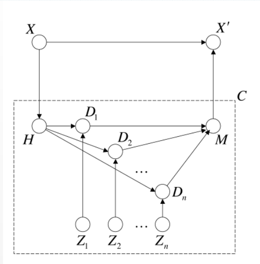
ANALYSIS

- Analysis based on Information Theory and its application to control systems is being investigated.
- A mentally healthy, but physically disabled user controlling an assistive robot: A source rich in information, but acting over a human-machine channel with a limited channel capacity.



The human-machine system as a directed acyclic graph

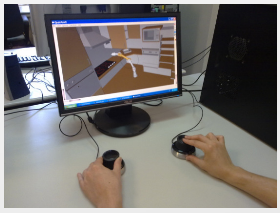
- Current state (*X*)
- Future state (*X'*)
- Controller (*C*):
  - User (*H*)
  - Robot (*M*)
  - Input device (*D*)
  - Disability (*Z*)



- Goal: Maximize flow of useful information between the user and the assistive robot.
- Multimodality can help to achieve this.

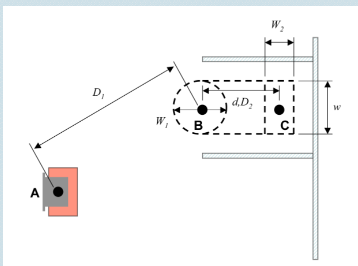
Requirements for implementation

- Allow for multimodal interaction
- Make use of contextual information
- Learn and adapt to user, online and offline
- Be easily adjusted to different users
- Be experimentally verifiable



EXPERIMENTAL VERIFICATION

- Assistive robots are typically intended for use in a user's daily environment.
- This environment can be difficult to specify at design time, which makes it hard to come up with a representative set of tasks for a quantitative evaluation of the performance.
- One solution might be to represent complex tasks as a set of movement primitives for which there exist good models (e.g. *A-B* and *B-C*).
- For example, Fitts' law (targeted movement of distance *D*, with end-point tolerance *W*) and the steering law (trajectory of distance *d*, with tolerance *w*).



Task example: placing a can in a cabinet

OPEN ISSUES

- What type of multimodal interaction should be used?
  - Simultaneous or sequential commands?
  - Redundant or complementary information?
- How can reinforcement learning be used to adapt to user?
- How can contextual information be included?

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