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Journal of Ergonomics

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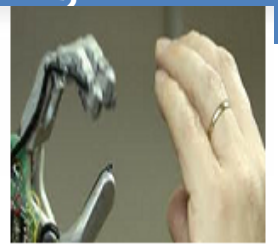
ISSN:2165-7556



RESEARCH IN SCALING TECHNIQUES IN HUMAN MACHINE INTERFACES

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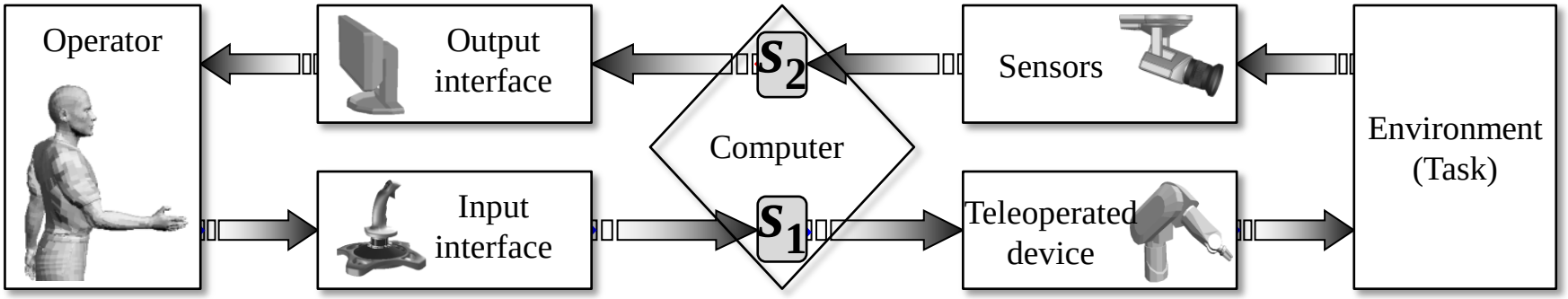
Universitat Politècnica de Catalunya Barcelona Tech.
Barcelona, July 2014.

Departament d'Enginyeria de Sistemes, Automàtica i Informàtica Industrial
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Goals



Human Machine Interface Modeling

Scale functions characterization

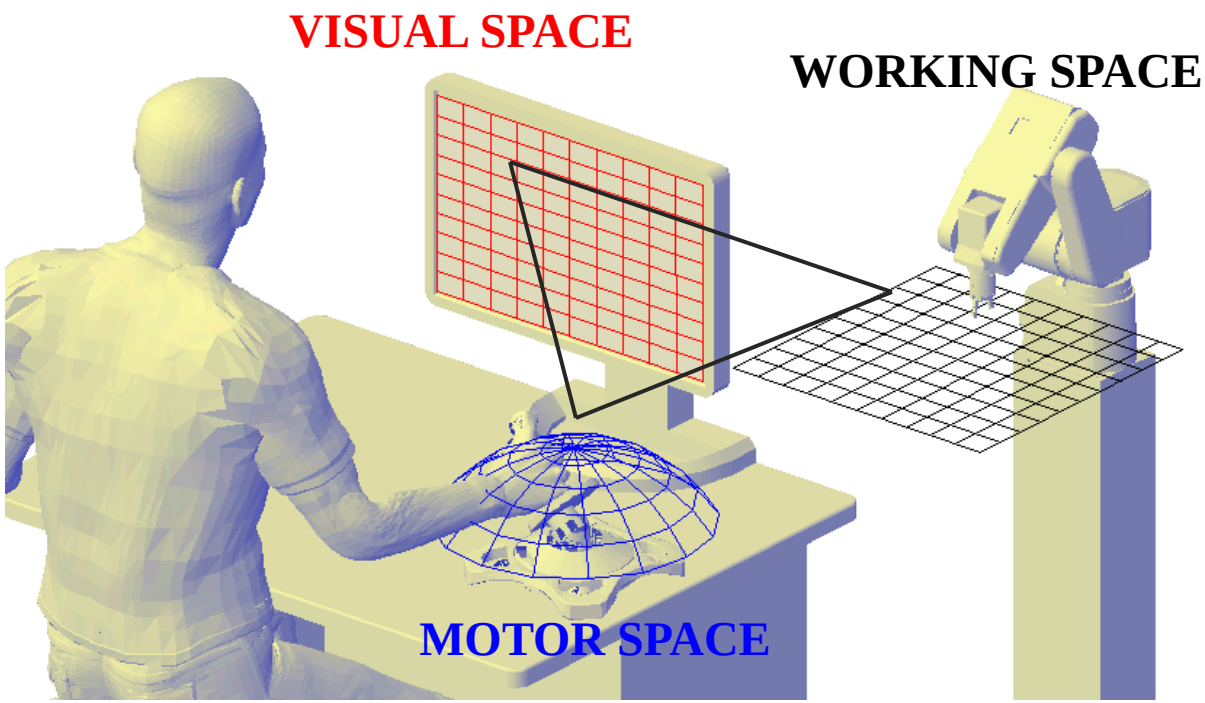
Scaling methodology

Motor behavior modeling

Experimental evaluation

HMI Model

Human-Machine-Interface Triangle

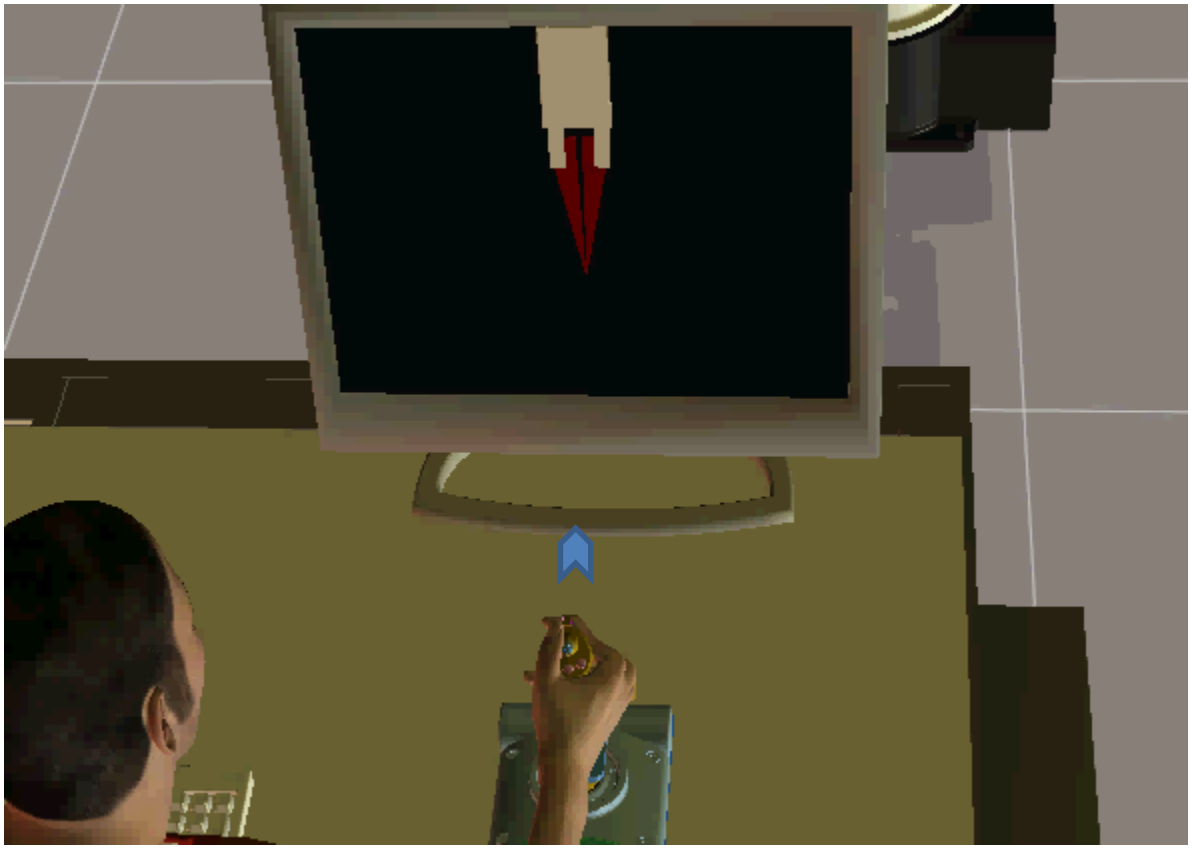


HMI Model

Human-Machine-Interface Triangle: Introducing de scales

HMI Model

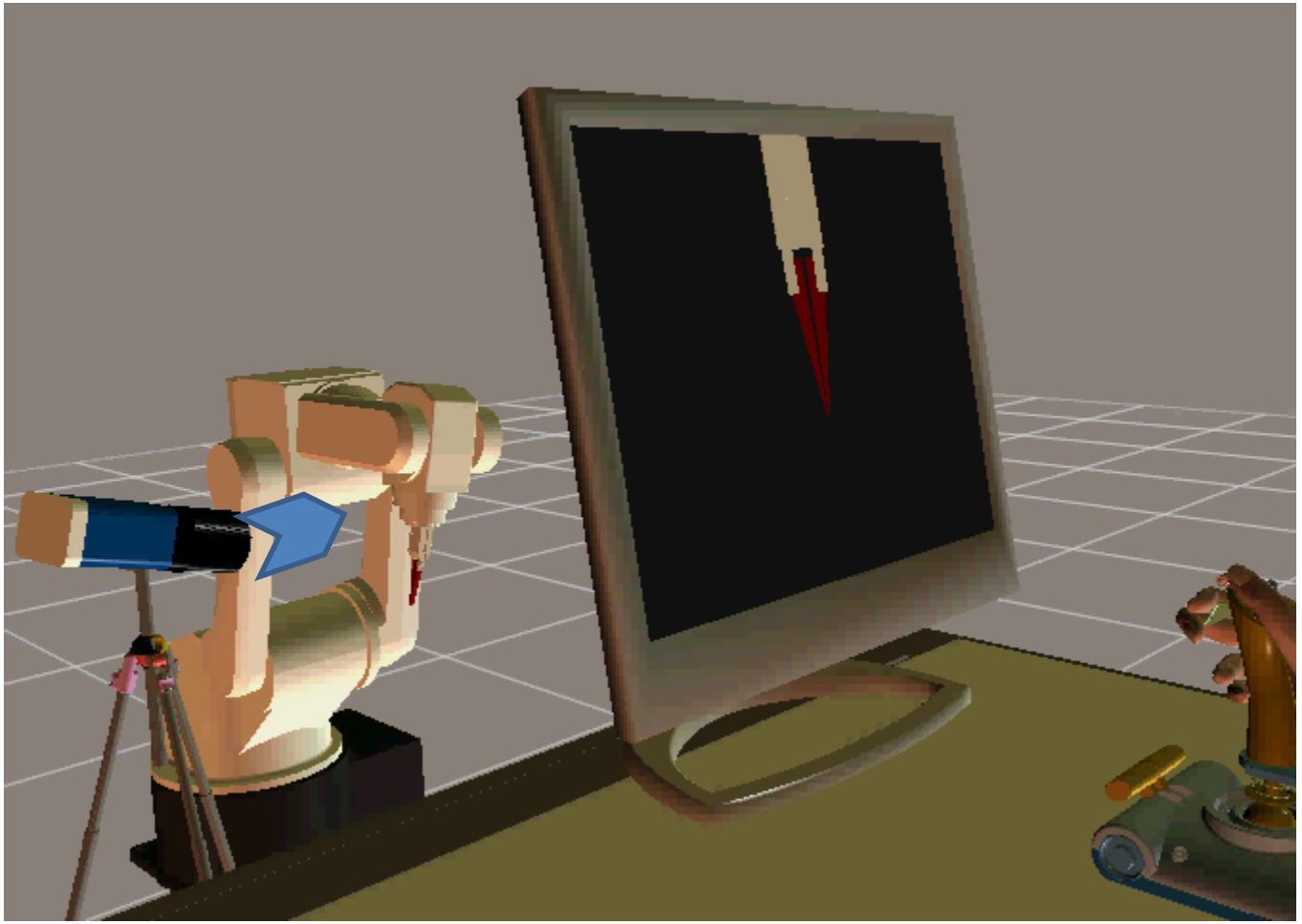
Human-Machine-Interface Triangle: Motor scale



$$\dot{X}_V = \dot{X}_M S_1$$

HMI Model

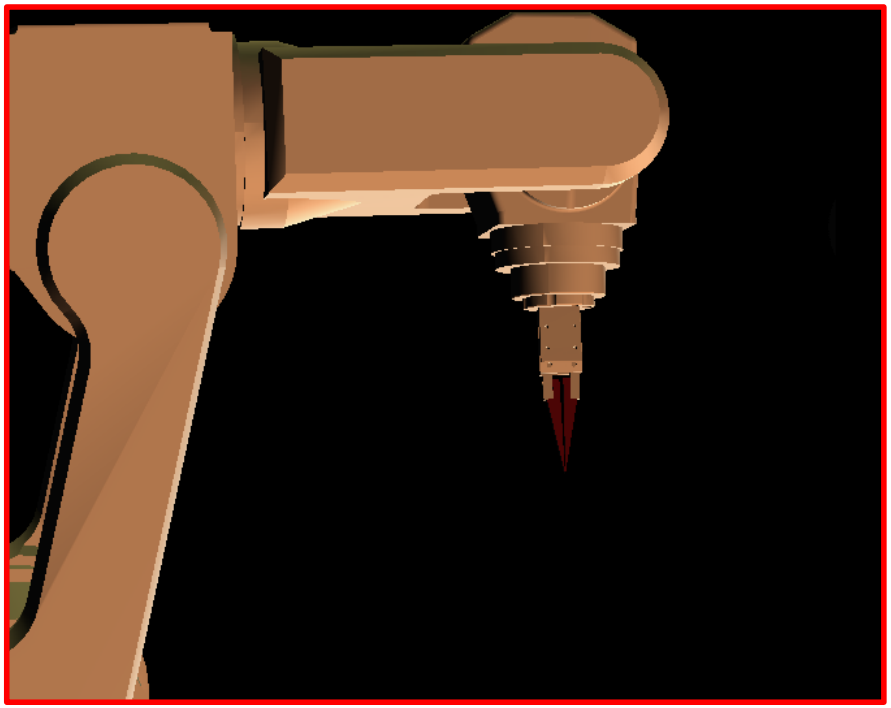
Human-Machine-Interface Triangle: Visual scale

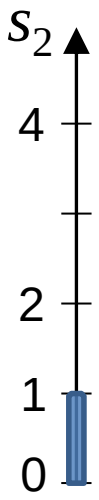


$$\dot{\boldsymbol{X}}_V = \dot{\boldsymbol{X}}_W s_2$$

HMI Model

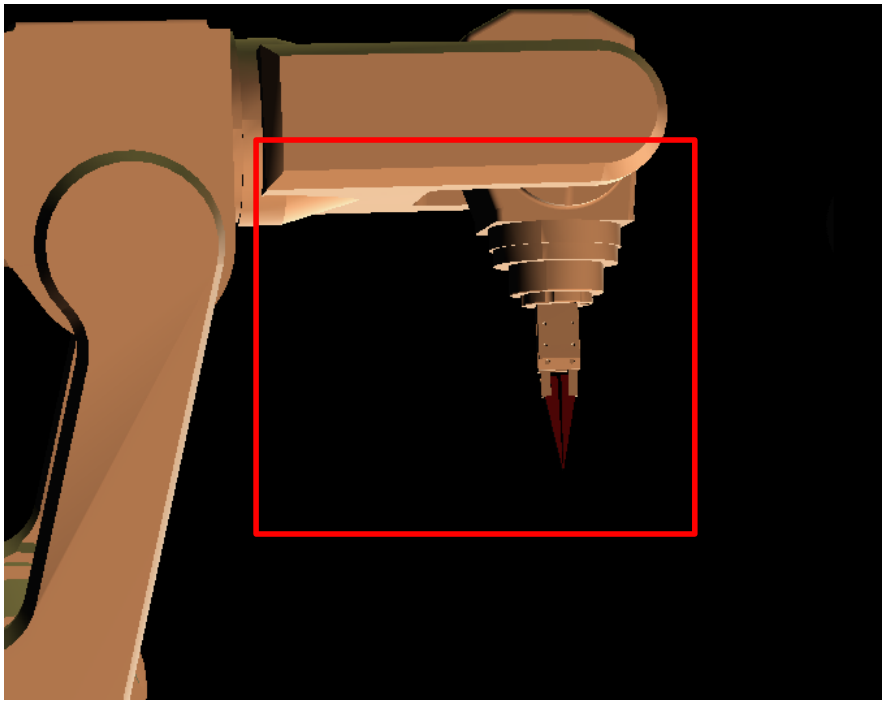
Human-Machine-Interface Triangle: Visual scale

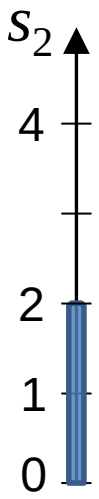




HMI Model

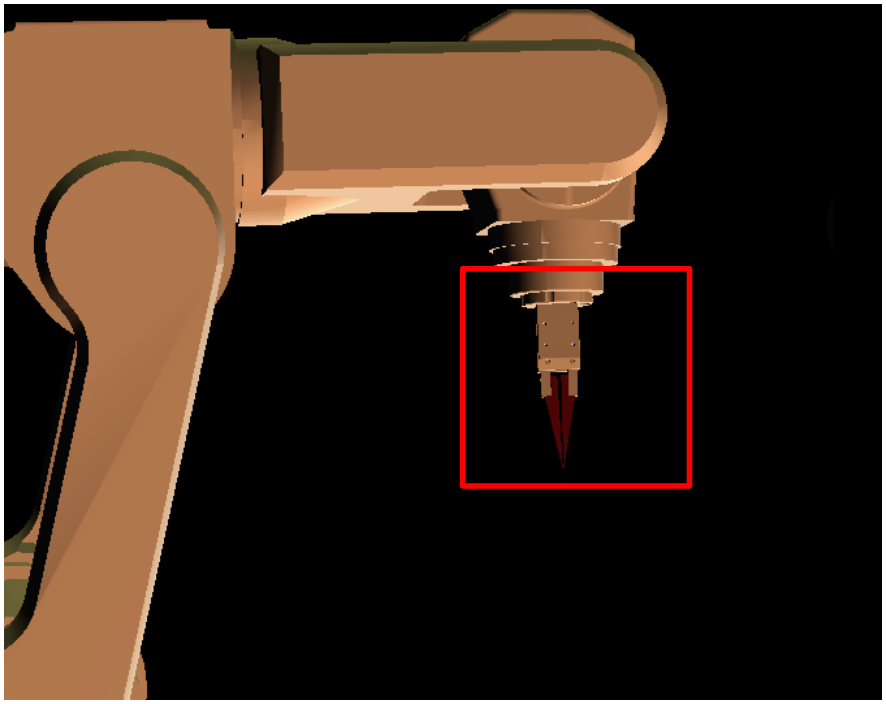
Human-Machine-Interface Triangle: Visual scale

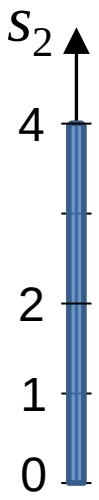


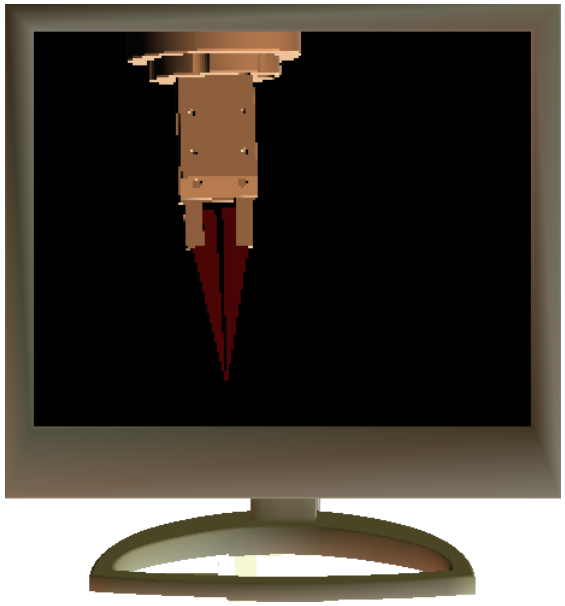


HMI Model

Human-Machine-Interface Triangle: Visual scale

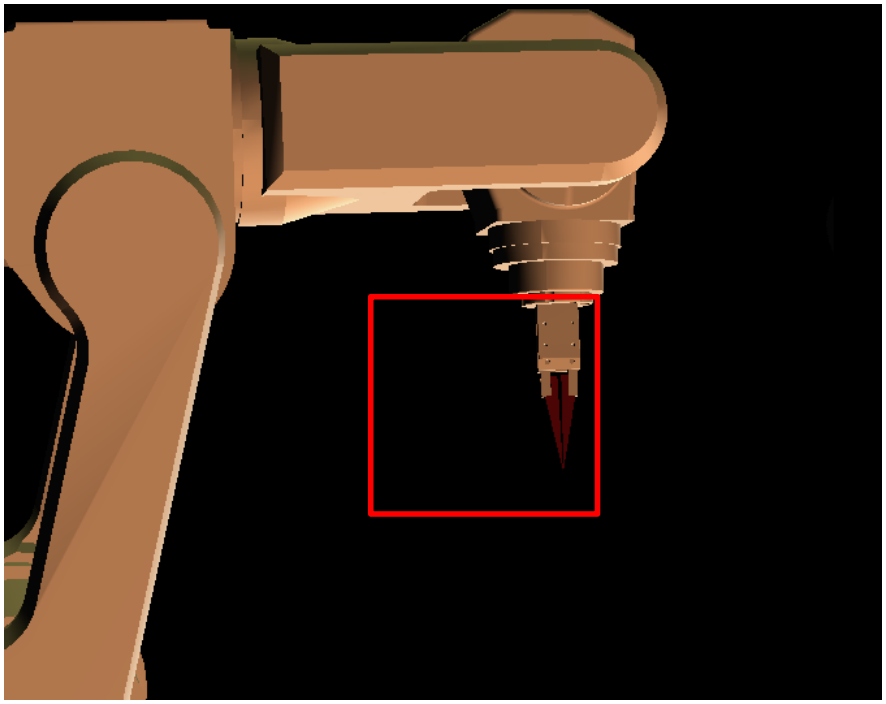


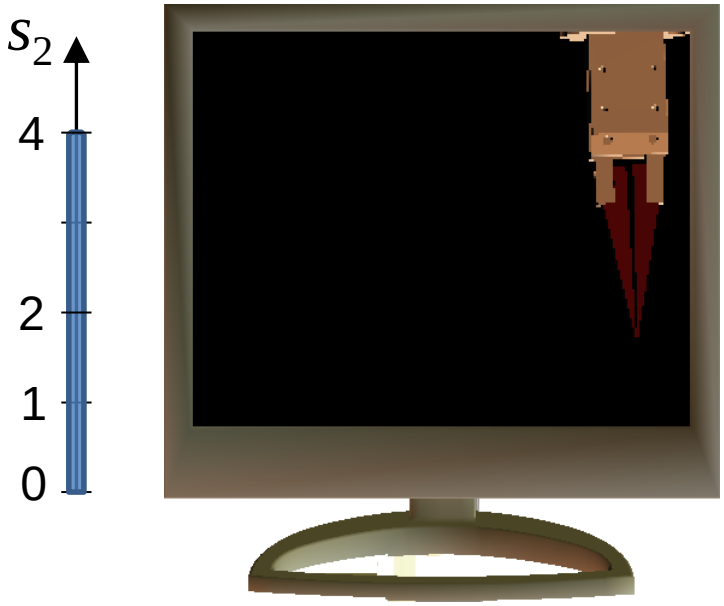




HMI Model

Human-Machine-Interface Triangle: Visual scale

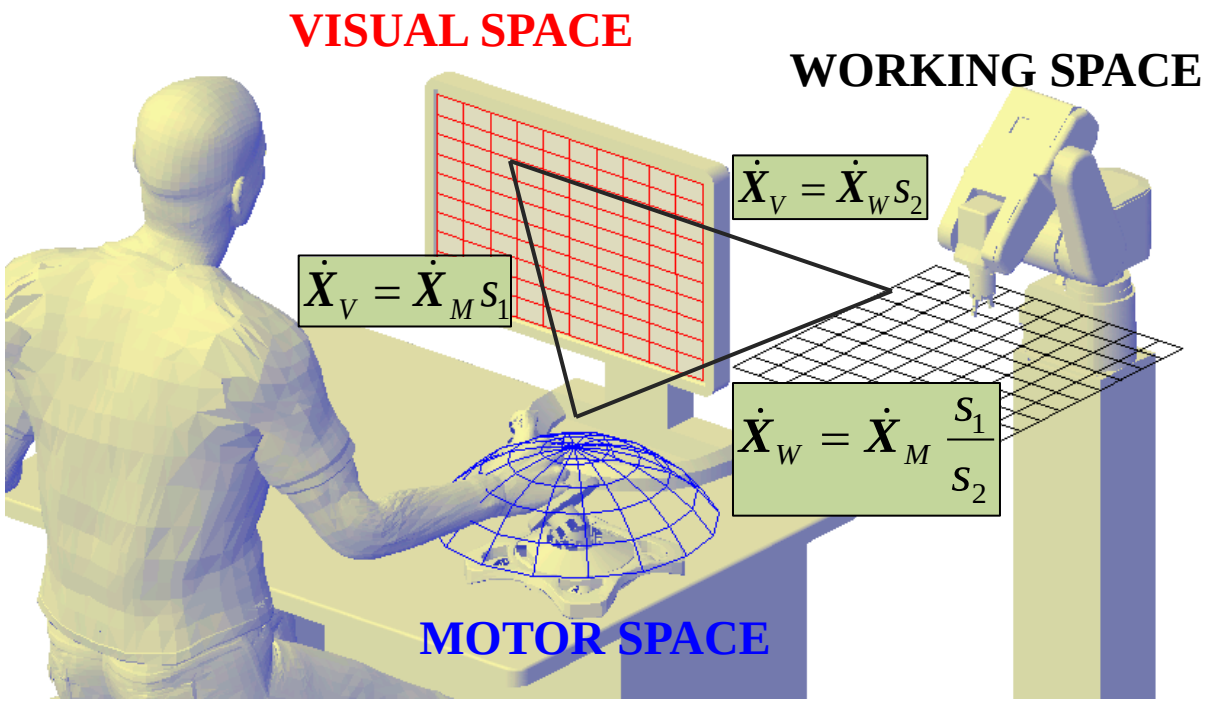




panning

HMI Model

Human-Machine-Interface Triangle



Scale functions

Considerations

Constant scale $\Rightarrow$ Independent of the distance

Static scale $\Rightarrow$ Function of the distance

$\Downarrow$

Fitts' Law

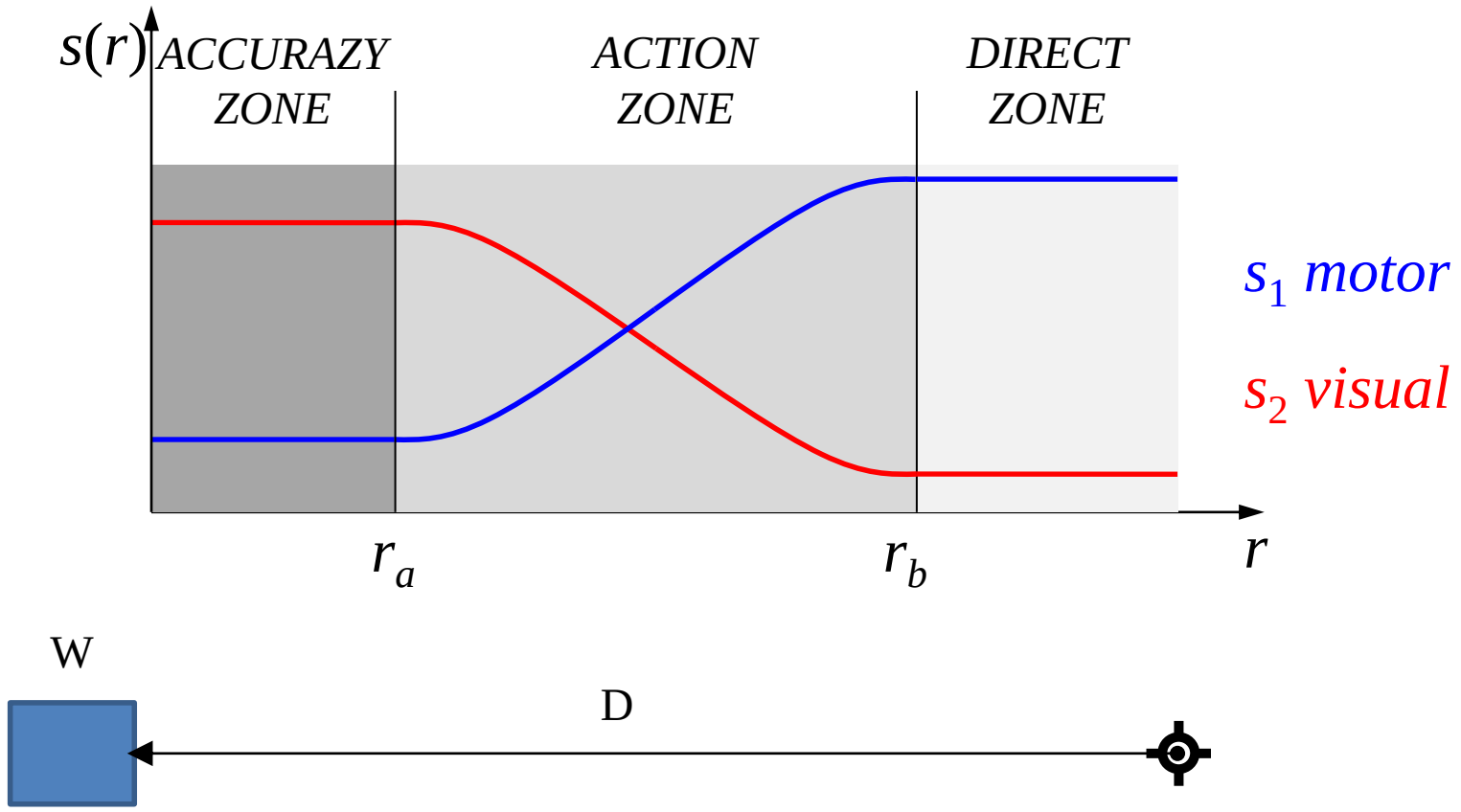
Dynamic scale $\Rightarrow$ Function of distance and velocity

$\Downarrow$

Motor modelling

Static scaling

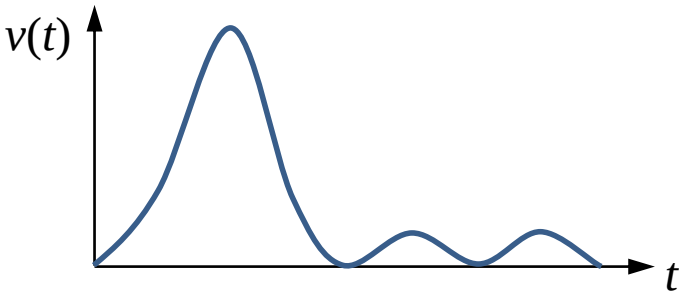
Characteristic zones



Motor Model

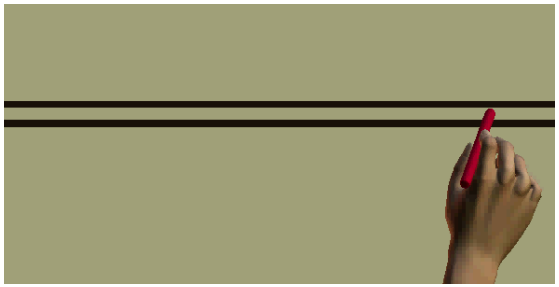
Kind of movements

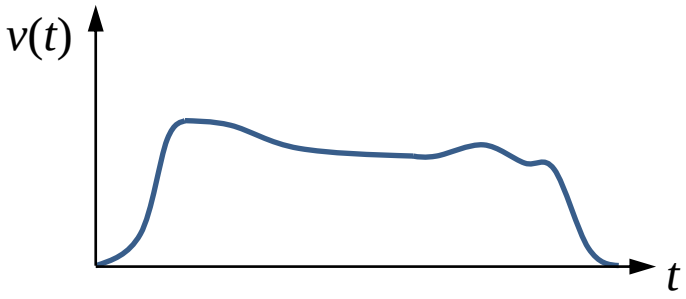
Ballistic



$\sigma_1 = K_1 V_1$

Navigation





$\sigma_N = K_N V_N$

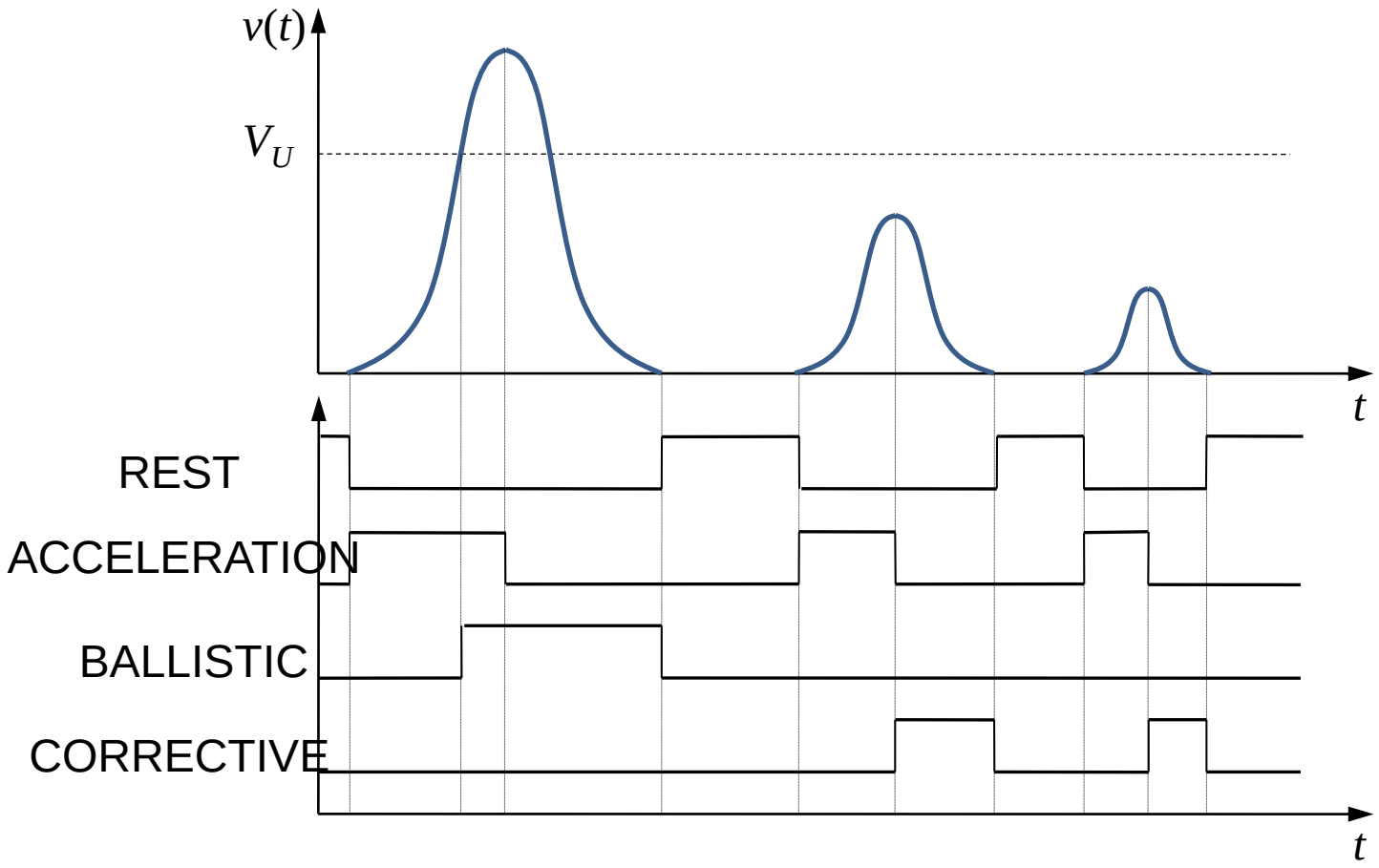
Motor Model

Movement states

- Rest
- Acceleration
- Navigation
- Ballistic
- Corrective

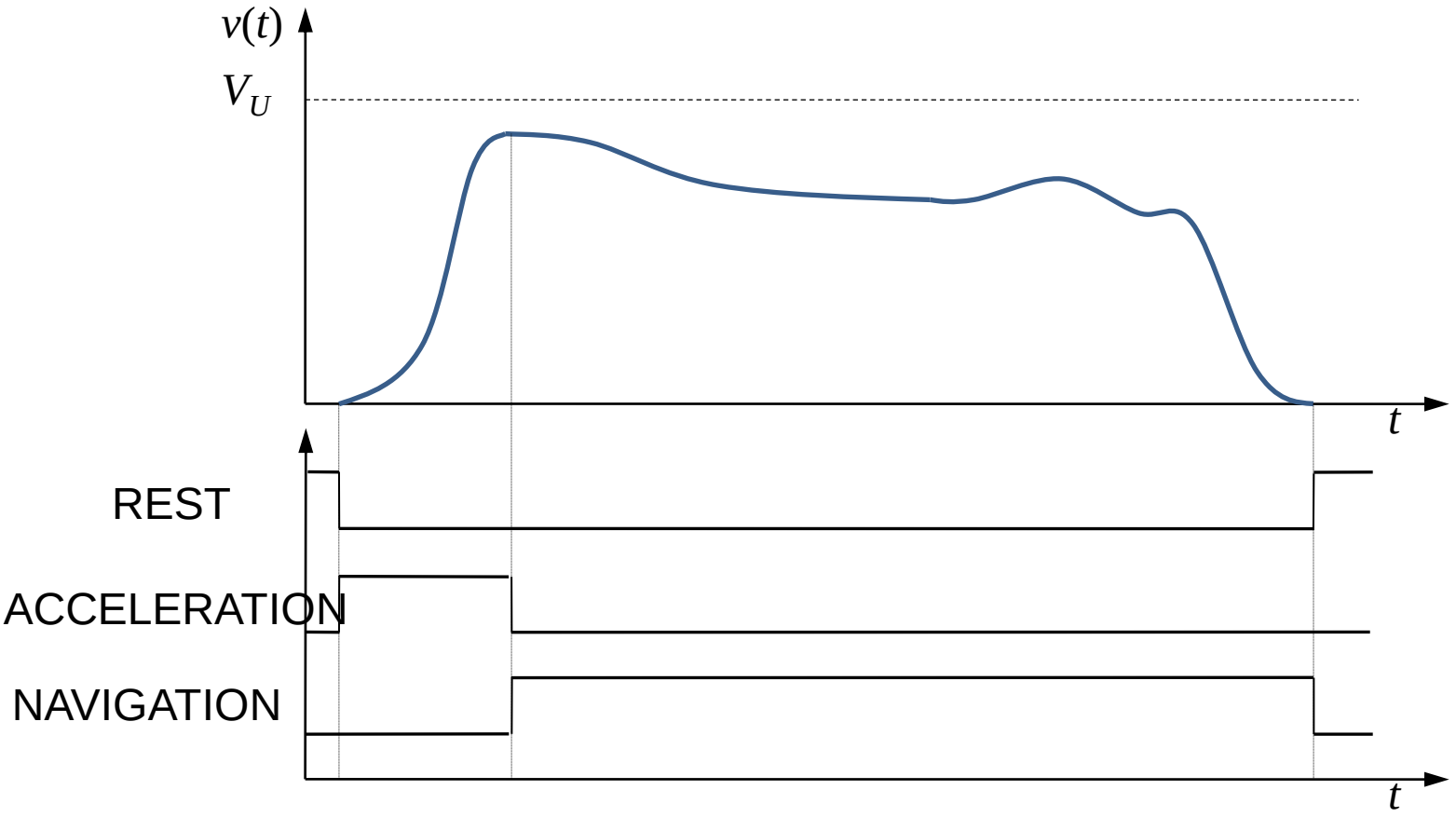
Motor Model

Velocity profile of the ballistic movement



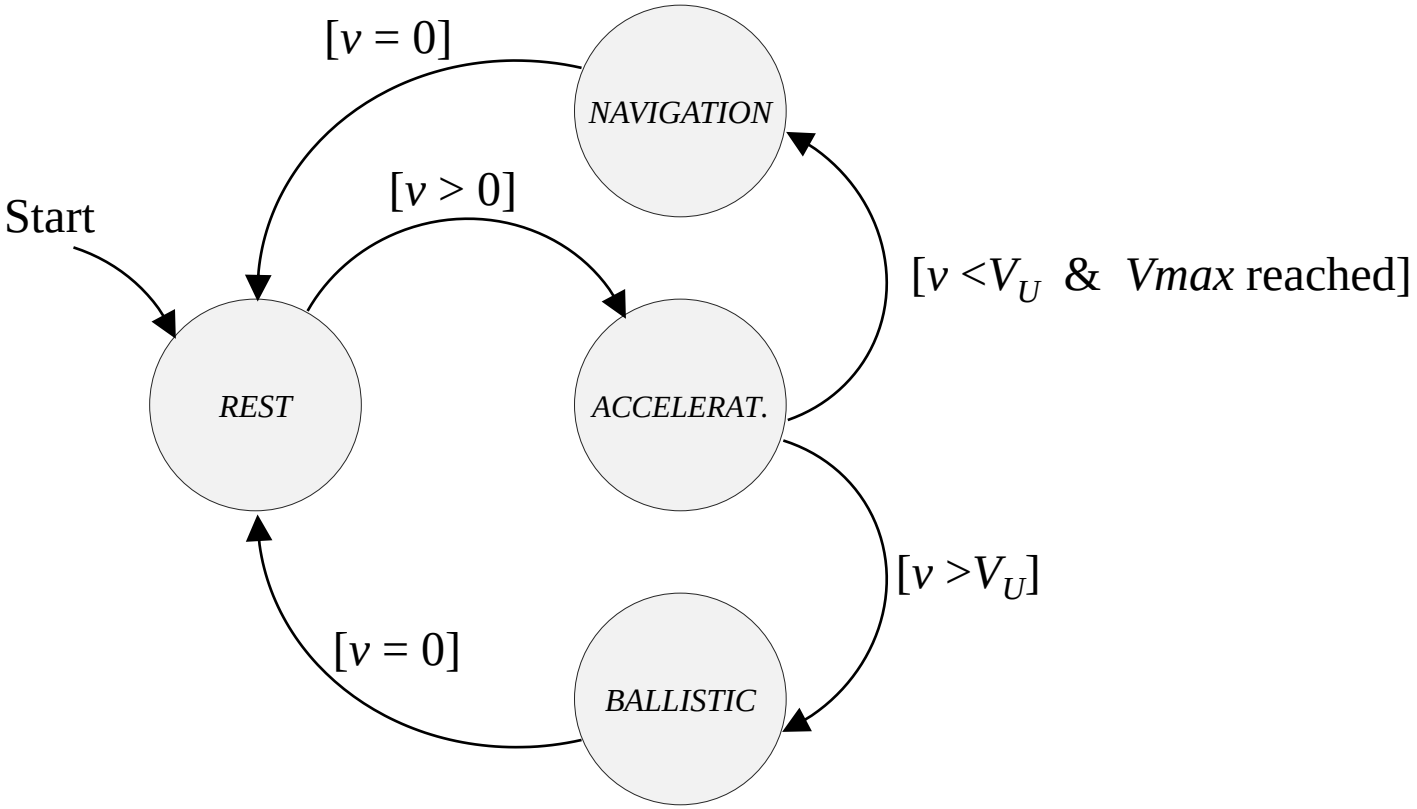
Motor Model

Velocity profile of the navigation movement



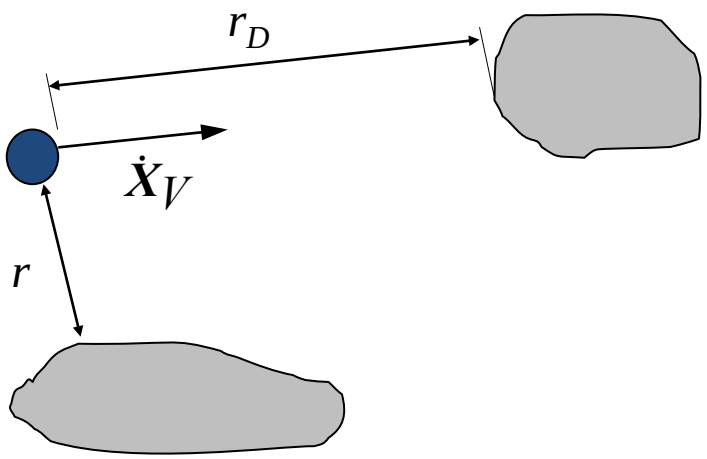
Motor Model

State machine



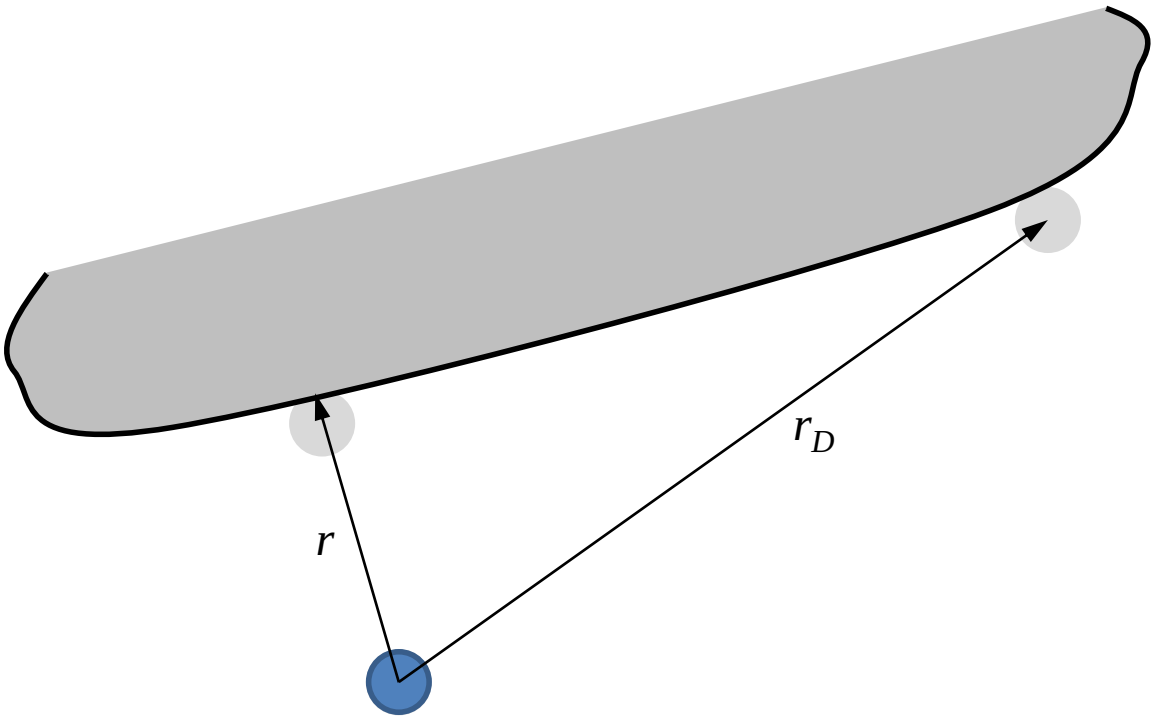
Dynamic scaling

Dependence on the distance and velocity



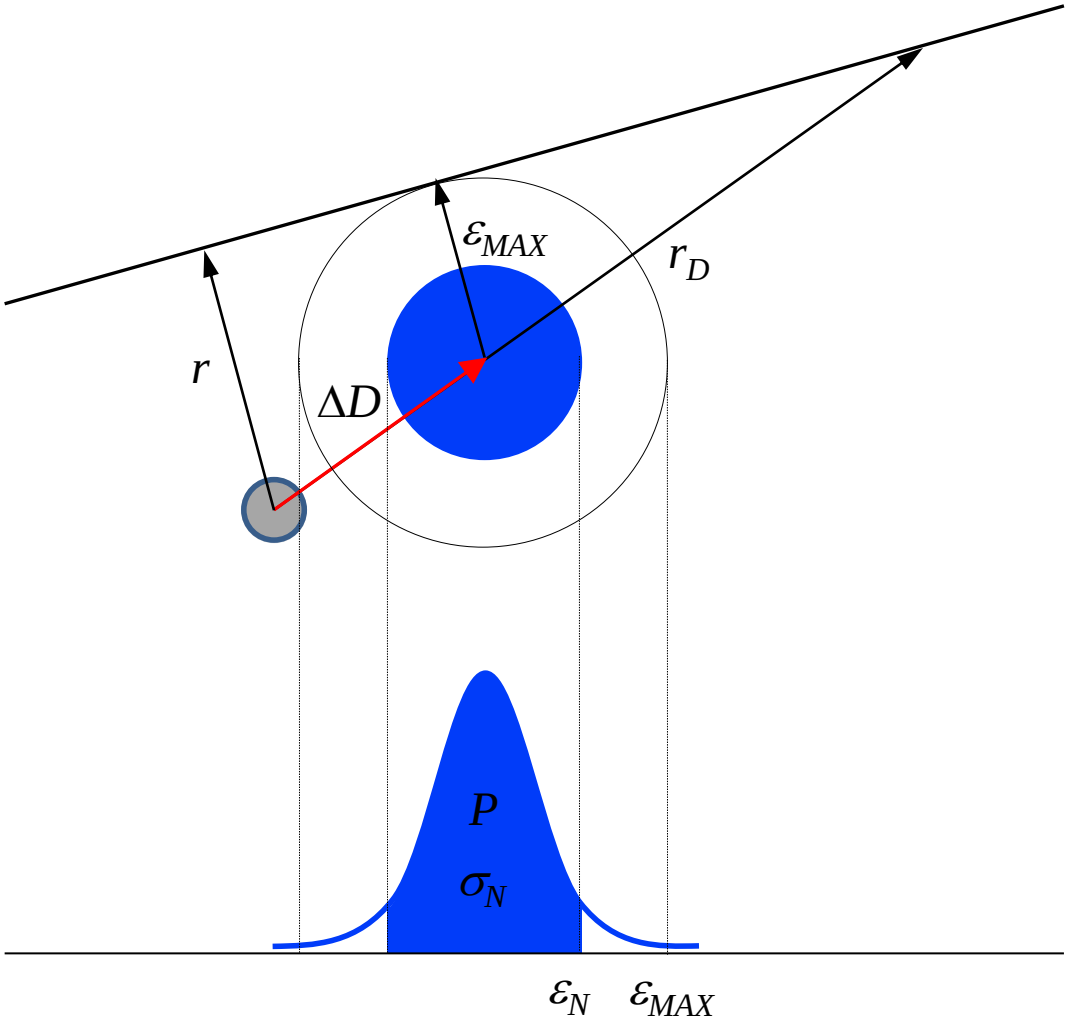
Dynamic scaling

Navigation Mode



Dynamic scaling

Navigation Mode



$$\Delta D = \Delta t\, v$$

$$\sigma_N = K_N v$$

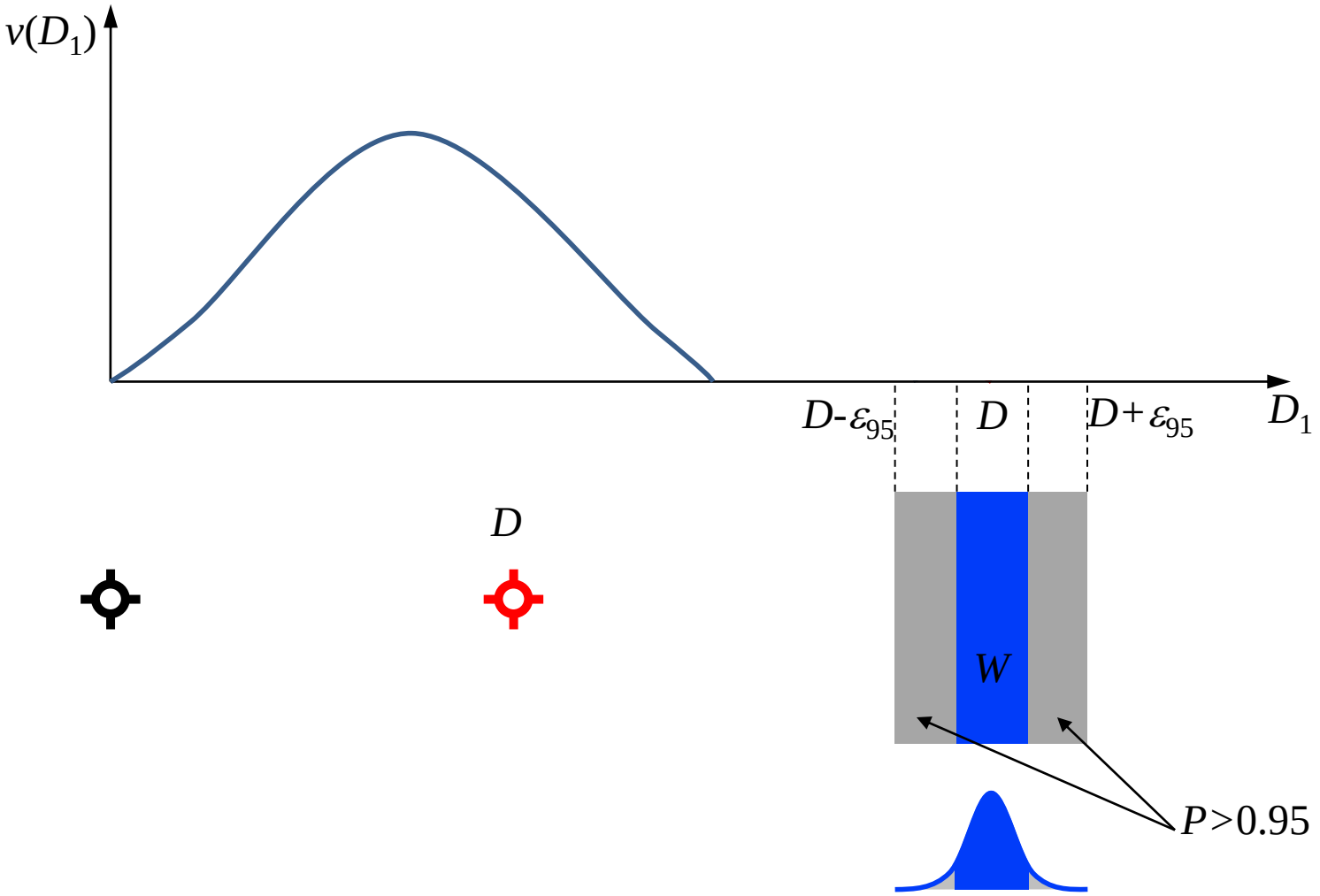
$$\Pr\left(\varepsilon_N < \varepsilon_{MAX}\right)$$

$$v \Rightarrow V_U$$

Motor scaling s_1

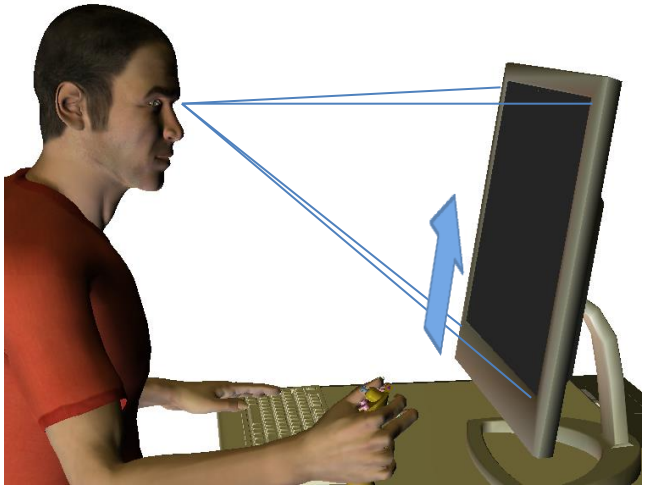
Dynamic scaling

Ballistic Mode



Dynamic scaling

Dynamics on visual scale



Visual flow

Panning

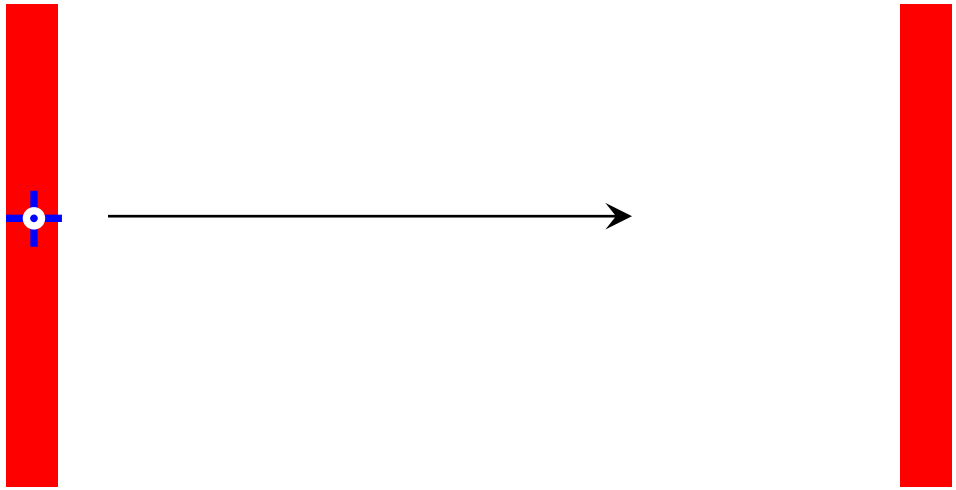
Scaling

Evaluation

ISO 9241-9
Ergonomic requirements for office work with visual display terminals (VDTs). Part 9: Requirements for non-keyboard input devices

Test:

Unidirectional connection



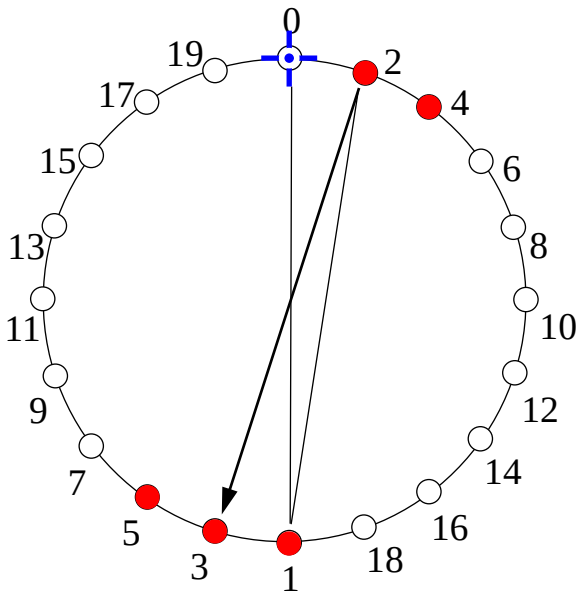
Evaluation

ISO 9241-9
Ergonomic requirements for office work with visual display terminals (VDTs). Part 9: Requirements for non-keyboard input devices

Test:

Unidirectional connection

Multidirectional connection



Evaluation

ISO 9241-9
Ergonomic requirements for office work with visual display terminals (VDTs). Part 9: Requirements for non-keyboard input devices

Test:

Unidirectional connection

Multidirectional connection

Unidirectional tracing

Evaluation

ISO 9241-9
Ergonomic requirements for office work with visual display terminals (VDTs). Part 9: Requirements for non-keyboard input devices

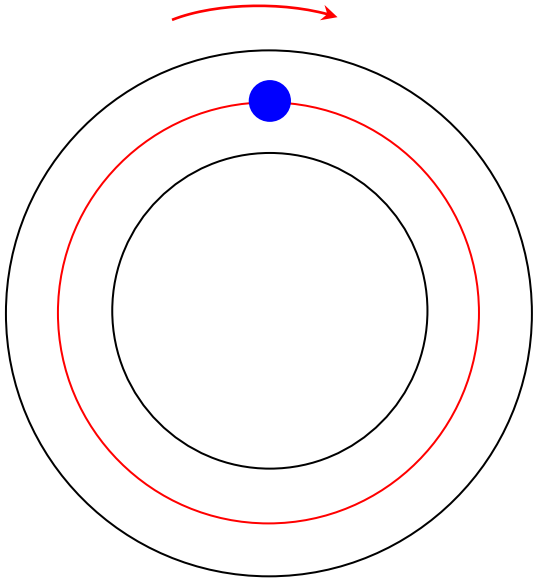
Test:

Unidirectional connection

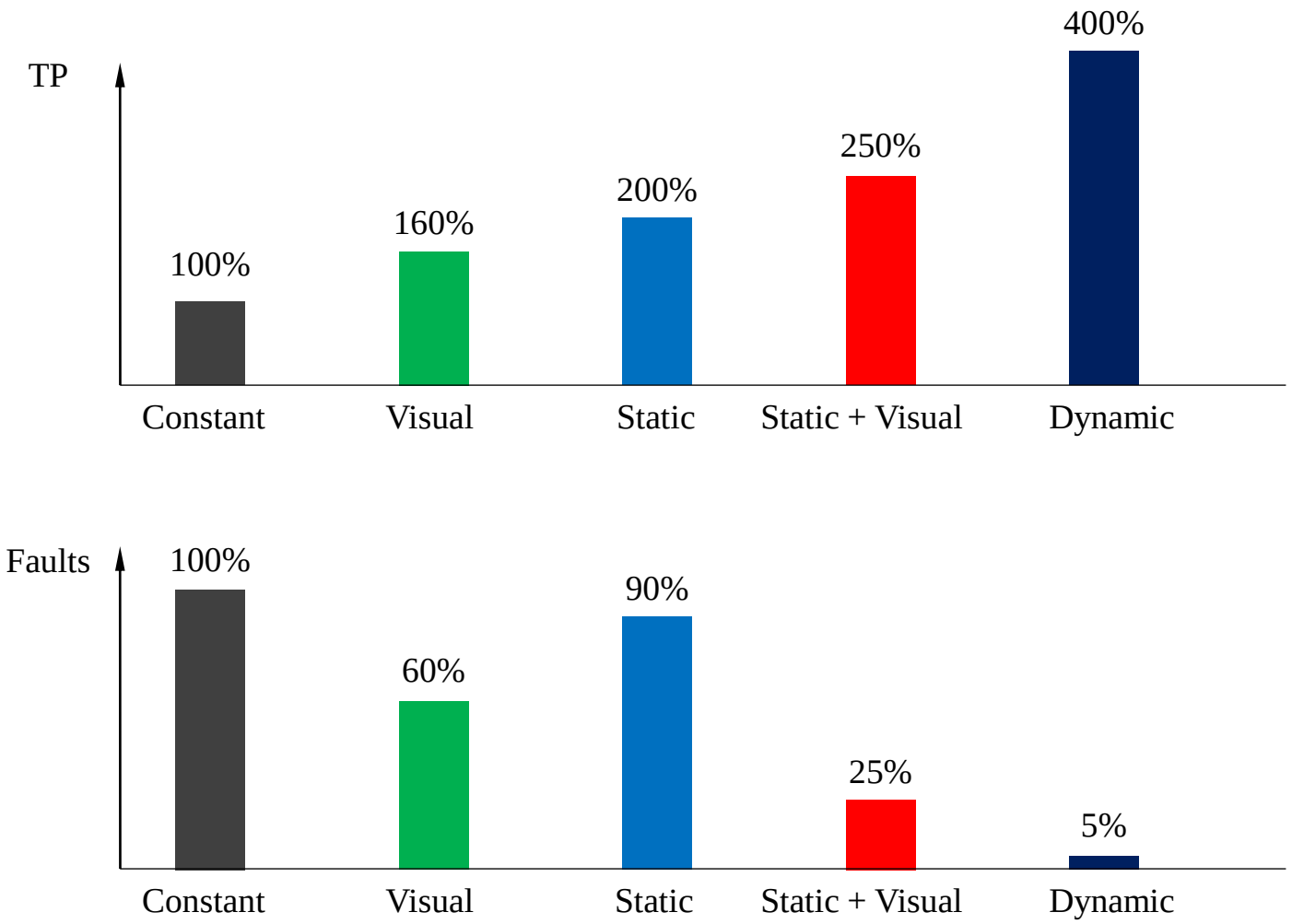
Multidirectional connection

Unidirectional tracing

Multidirectional tracing



Performance introducing scaling



Works in progress

Self adjust of the scaling functions

Automatic calibration

Integration with other techniques

3D Experimentation

Experimentation with BCI

Publications on the field

Journals papers

L.M. Muñoz, A. Casals. Improving the Human–Robot Interface Through Adaptive Multispace Transformation. *IEEE Transactions on Robotics.* Vol. 25, pp. 1208-1213. October 2009.

L.M. Muñoz, A. Casals, M. Frigola, J. Amat. Motor-Model-Based Dynamic Scaling in Human–Computer Interfaces. *IEEE Transactions on Systems, Man and Cybernetics: Part B.* Vol. 41, pp. 435-447. April 2011.

Editorial journals:

L.M. Muñoz. Human Direct Interface. *Journal of Ergonomics.* 1:1. December 2011.

L.M. Muñoz. Improving Ergonomics through Haptics. *Journal of Ergonomics.* 3:3. December 2013.

Book chapters

J. Amat, A. Casals, A. Monferrer, L.M. Muñoz, M. Frigola. Research in Underwater Robotics in the Automatic Control Department at the Technical University of Catalonia. *Automation for the Maritime Industries*. Ed. IAI-CSIC. P.p. 205-226. November 2004.

L.M. Muñoz, P. Ponsa, A. Casals. Human-Computer Systems Interaction. Backgrounds and Applications 2 .“Design and Development of a Guideline for Ergonomic Haptic Interaction”. Advances in Soft Computing. Ed. Springer Verlag. Pp. 15-29. November 2011.

Publications on the field

Congress

J.Amat, L.M. Muñoz, M. Las Heras, P. Ridao. Dextereus Teleoperation with Few Degrees of Freedom Arms. *International Advanced Robotics Program : Workshop on Underwater Robots.* Brasil 2001.

J.Amat, A. Casals, L.M. Muñoz, M. Las Heras. Dexterity Improvement in Teleoperation Through Computer Vision Based Automatic Correction. *15th IFAC World Congress*. Barcelona, July 2002.

A. Casals, L.M. Muñoz, J.Amat. Workspace Deformation Based Teleoperation fort the increase of Movement Precision. *IEEE Int. Conference on Robotics and Automation.* Taiwan, September 2003.

L.M. Muñoz, A. Casals, J.Amat. Scale Dynamic Adaptation of the Local Space for Assisted Teleoperation. *IEEE Int. Conference on Robotics and Automation*. USA, April 2004.

L.M. Muñoz, A. Casals, J. Amat. Improved micro-nano manipulation using object adapted space deformation*. IEEE Int. Conference on Robotics and Automation*. Barcelona, April 2005.

A. Casals, L.M. Muñoz, M. Frigola, J.Amat. Assisted Teleoperation and Dependability. *IARP Int. Workshop on Technical Challenges on Dependable Robots in Human Environments*. Italia, April 2007.

L.M. Muñoz, A. Casals. Dynamic Scaling Interface for Assited Teleoperation. *IEEE Int. Conference on Robotics and Automation.* USA, May 2012.

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