A COMPUTER-AIDED VERIFICATION PROCESS FOR ENGINEERED SYSTEMS

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VICTOR ROMERO

ROMAIN PINQUIÉ

FRÉDÉRIC NOËL

G-SCOP
SCIENCES POUR LA CONCEPTION, L'OPTIMISATION ET LA PRODUCTION

Grenoble INP

UGA
Université Grenoble Alpes

MODEL-BASED VERIFICATION

INTRODUCTION

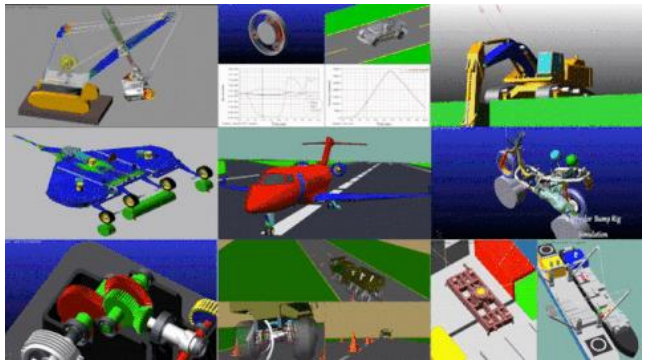
VERIFICATION OF COMPLEX SYSTEMS

"The purpose of the **Verification** process is to provide objective evidence that a system or a system element fulfils its specified requirements and characteristics." [INCOSE, 2015]

Test

Inspection

Demonstration

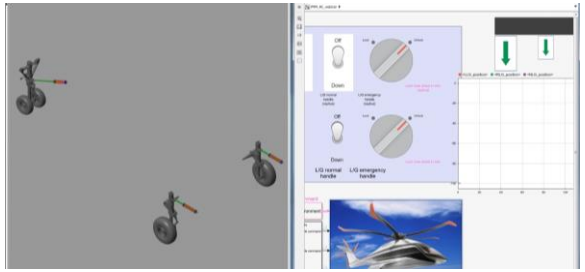


Analysis

Analysis is a verification technique based on analytical evidence obtained without any intervention on the submitted element using mathematical or probabilistic calculation, logical reasoning (including the theory of predicates), modelling, and/or simulation under defined conditions to show theoretical compliance. Mainly used where testing to **realistic conditions** cannot be achieved or is **not cost-effective**." [INCOSE, 2015]

PROBLEM

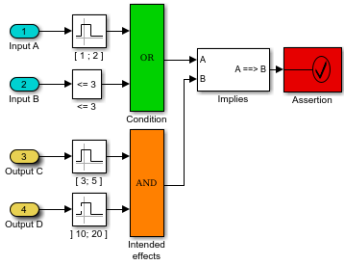
Tacit or textual specification



Unrealistic test conditions

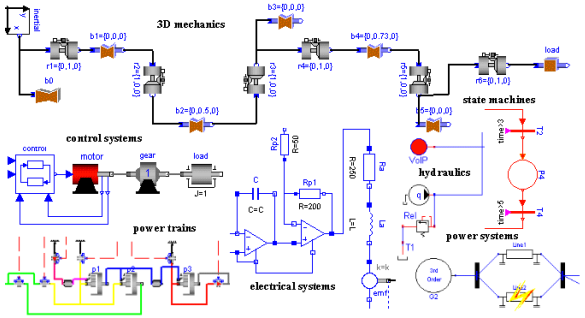
Unrealistic animations

Model-Based specification

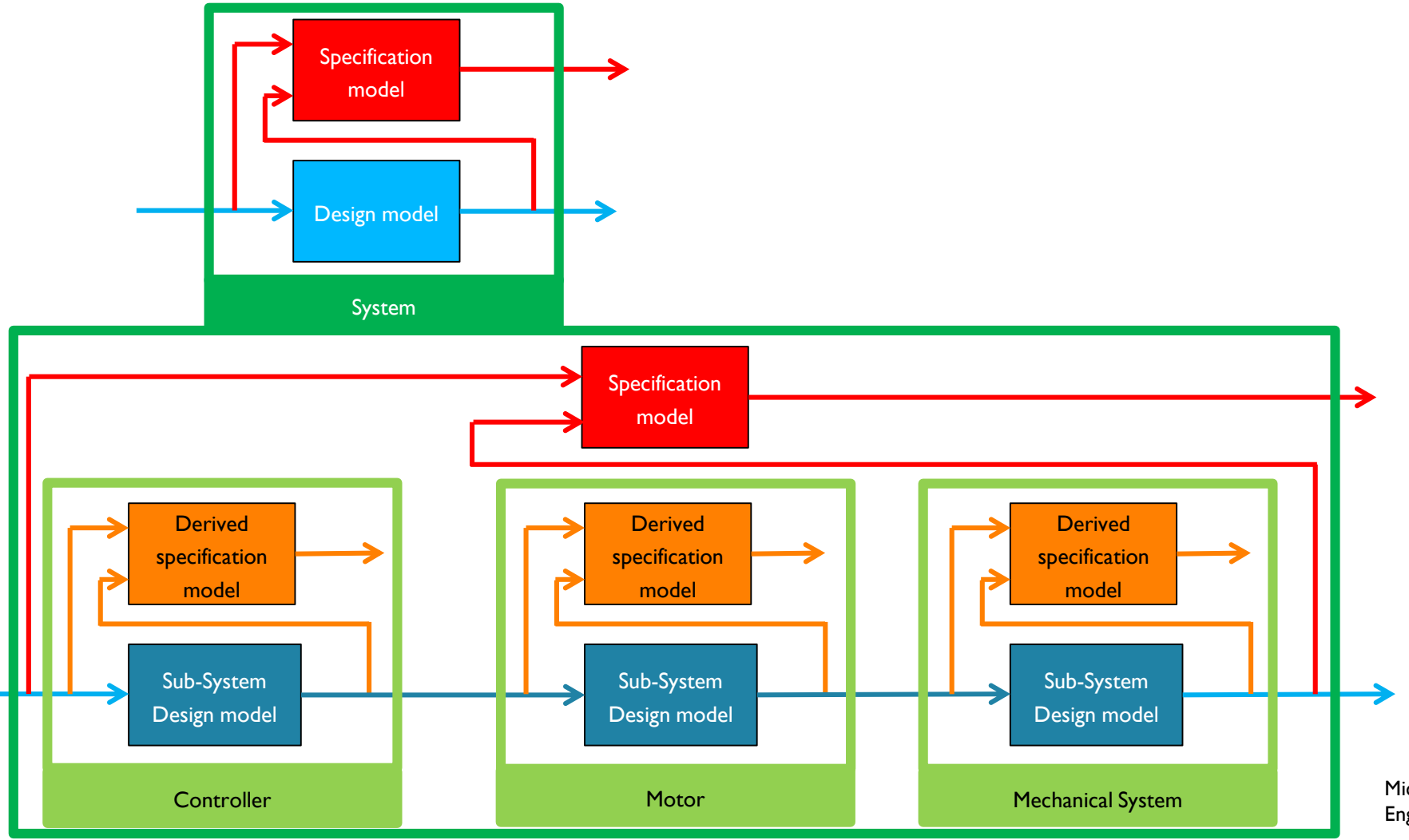


Immersive and interactive visualisation

Multi-Physic simulation and HIL



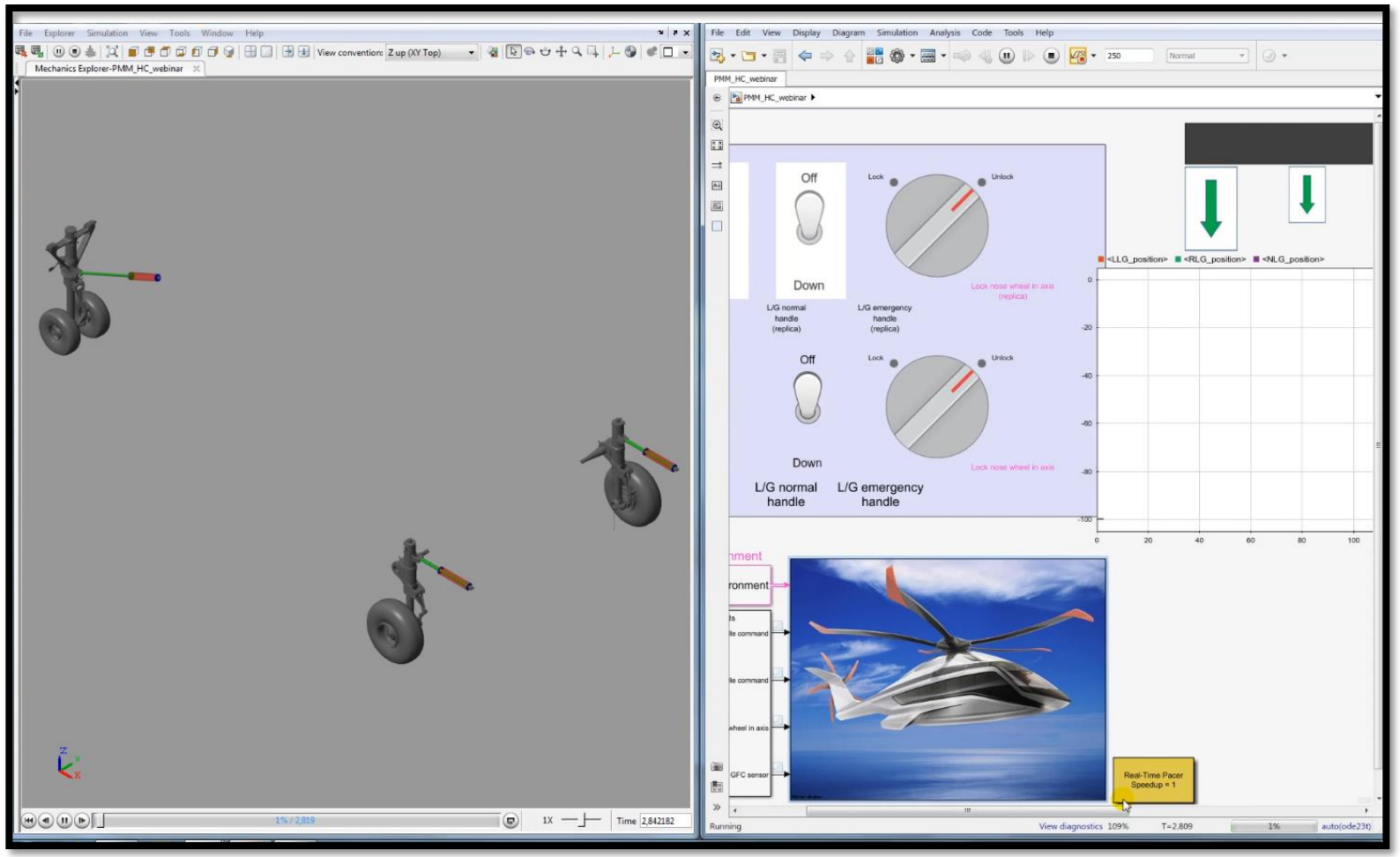
MODEL-BASED VERIFICATION



- Co-simulation of a specification model and a design model
- Sub-systems decomposition

Micouin (2013), "Property-Model Methodology: A Model-Based Systems Engineering Approach Using VHDL-AMS"

MODEL-BASED VERIFICATION



- Limits : Lack of realism in visualisation and interactions

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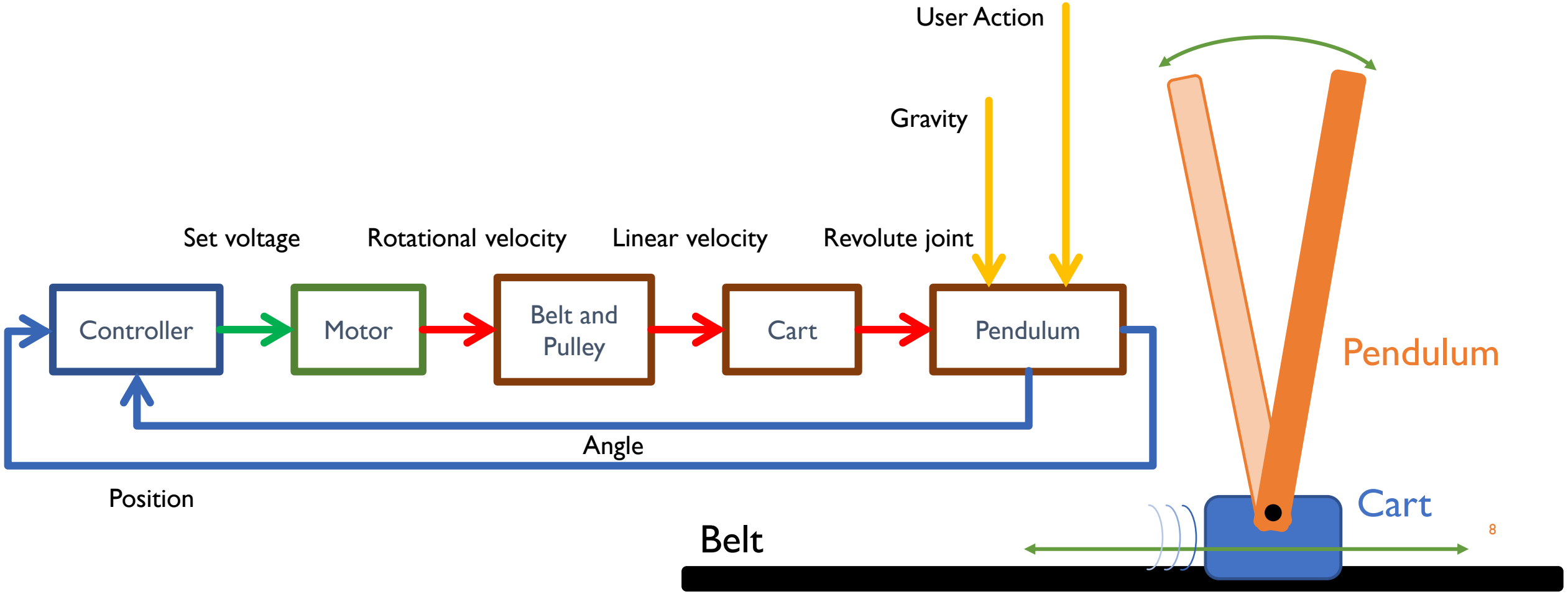
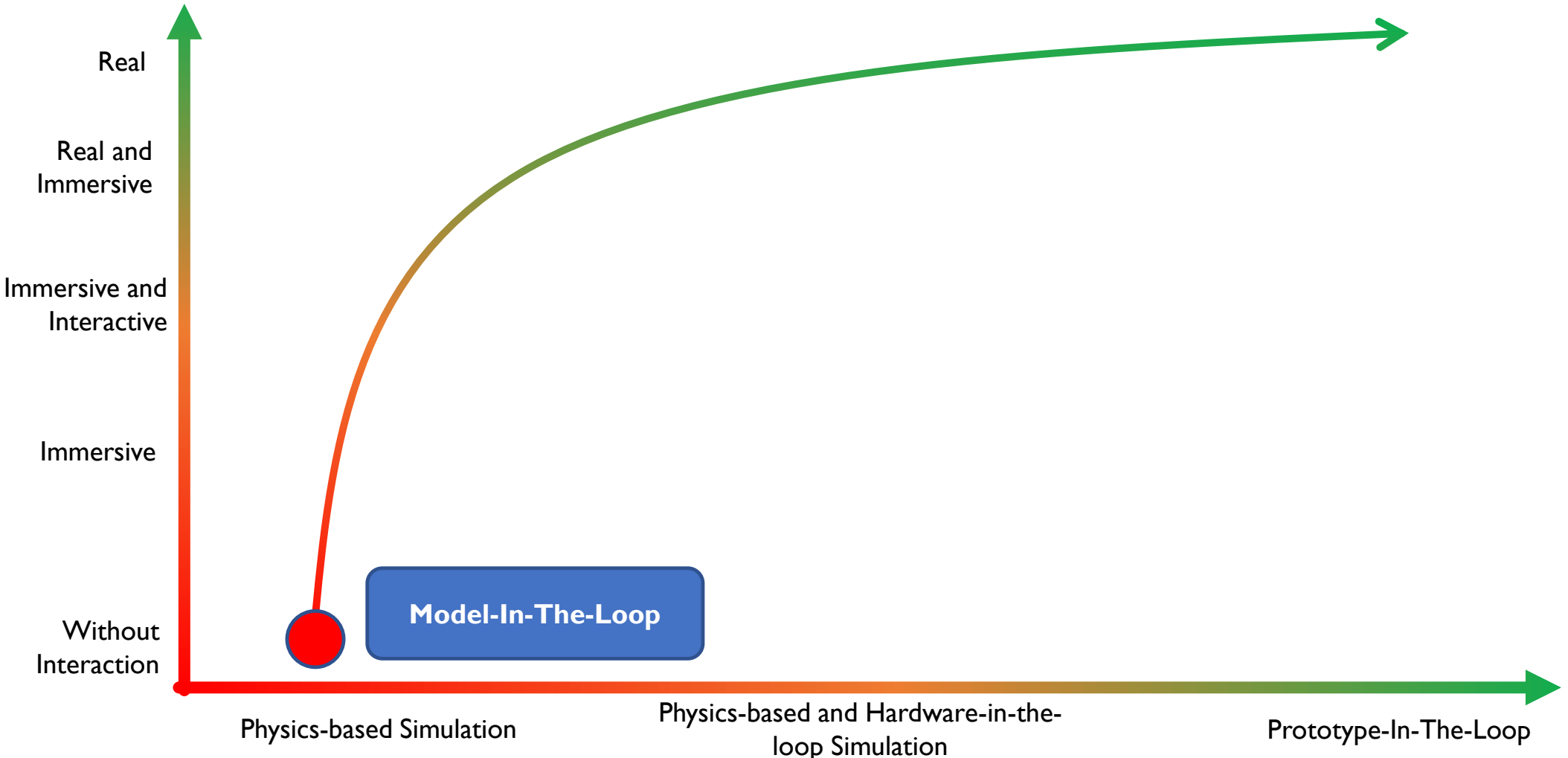
PROPOSITION

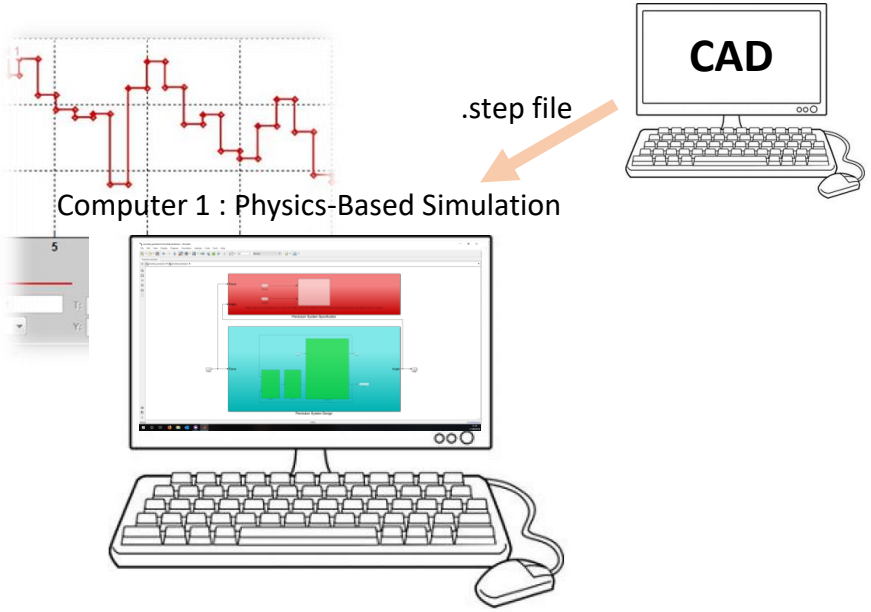
DEMONSTRATOR



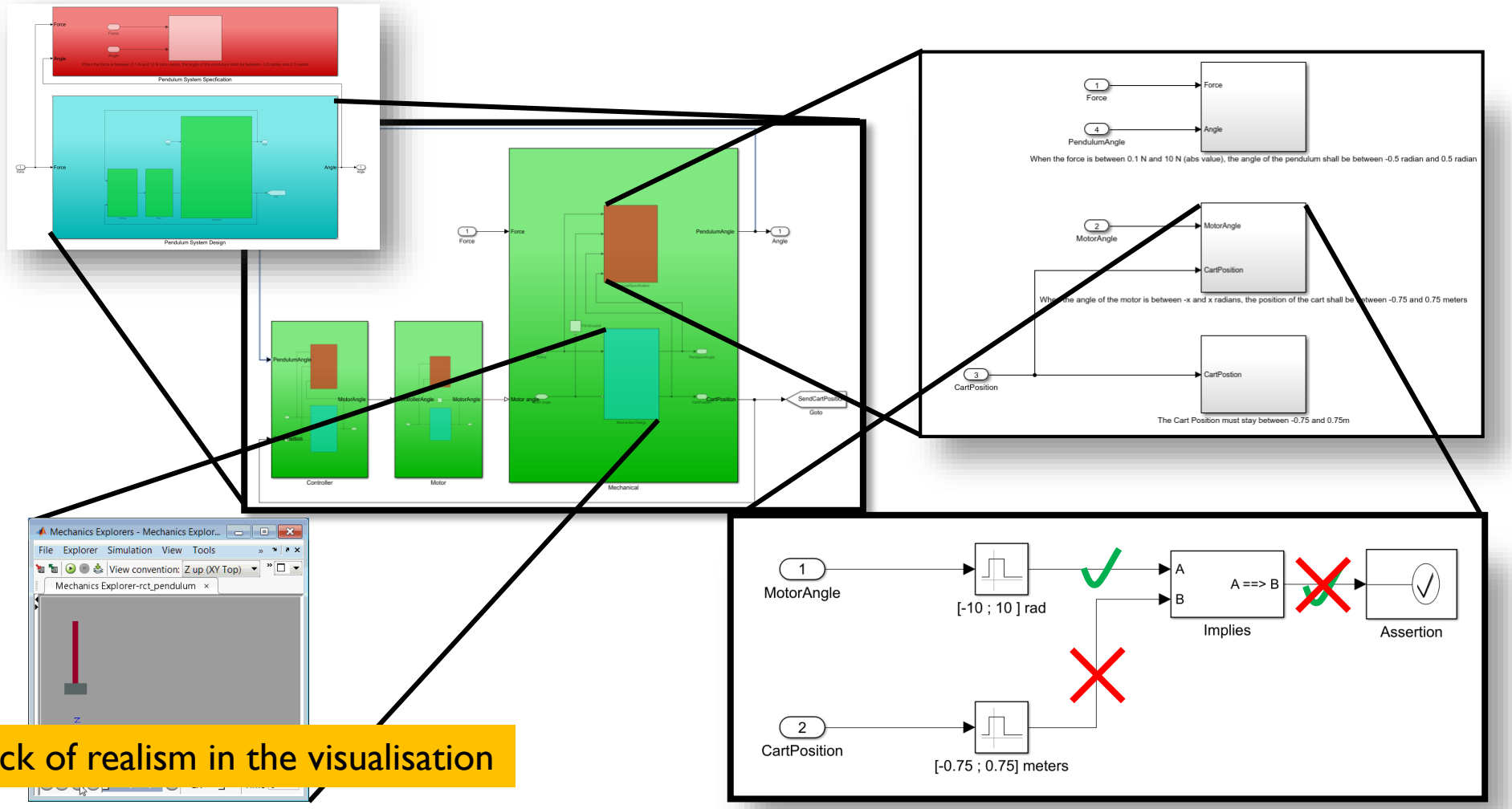
PROPOSITION



MODEL-IN-THE-LOOP – IMPLEMENTATION

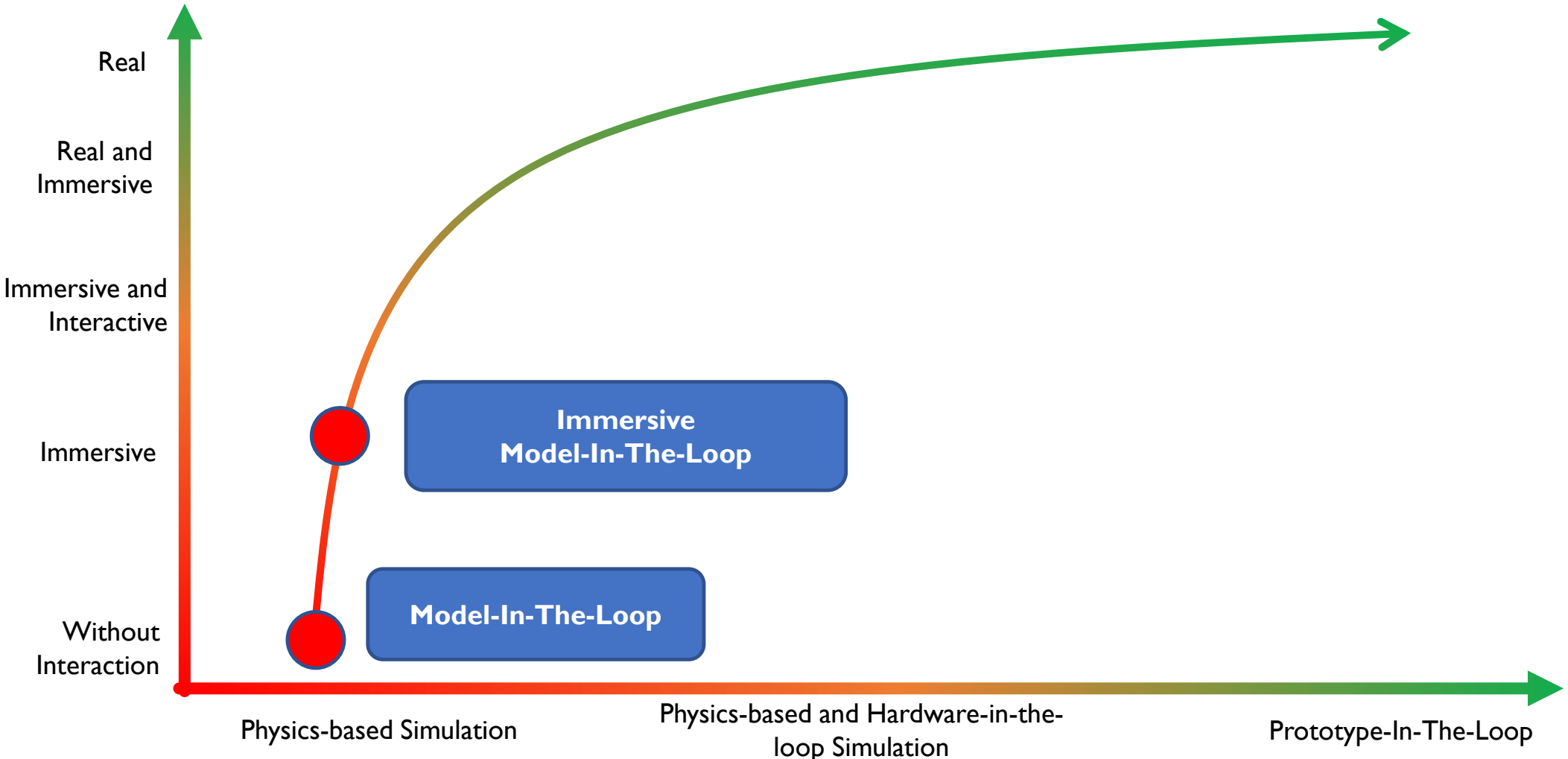


MODEL-IN-THE-LOOP – ILLUSTRATION

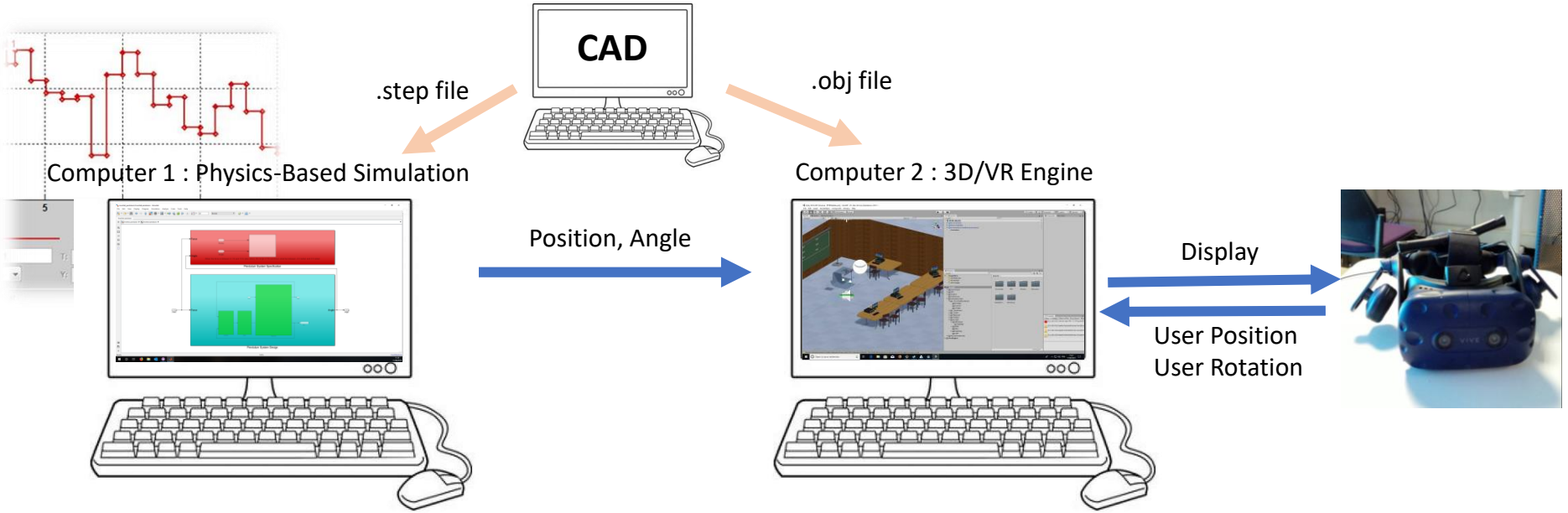


Limit : Lack of realism in the visualisation

PROPOSITION



IMMERSIVE MODEL-IN-THE-LOOP – IMPLEMENTATION



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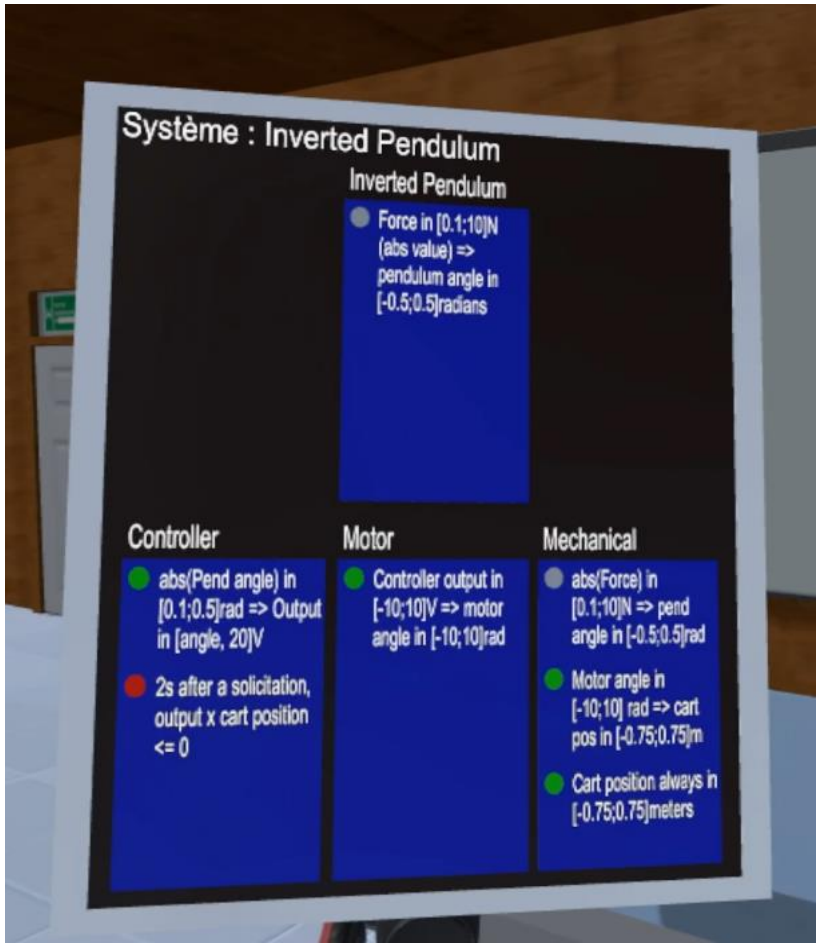
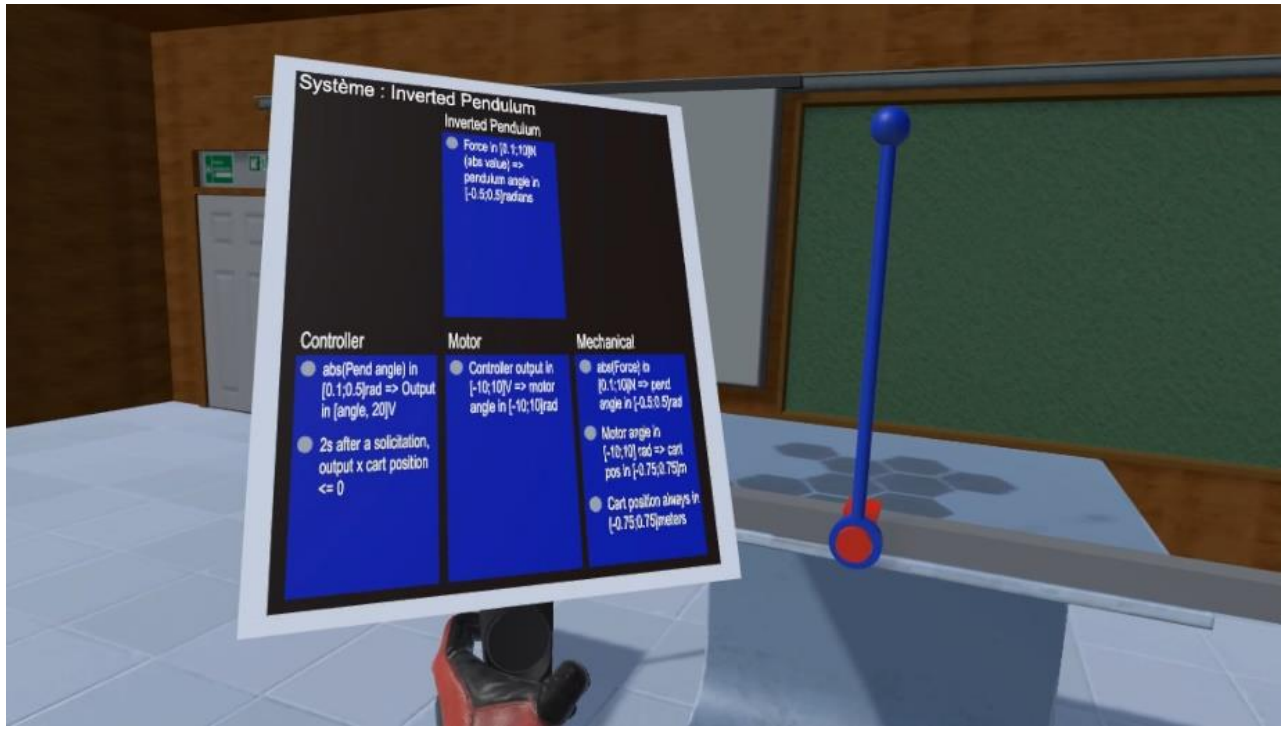
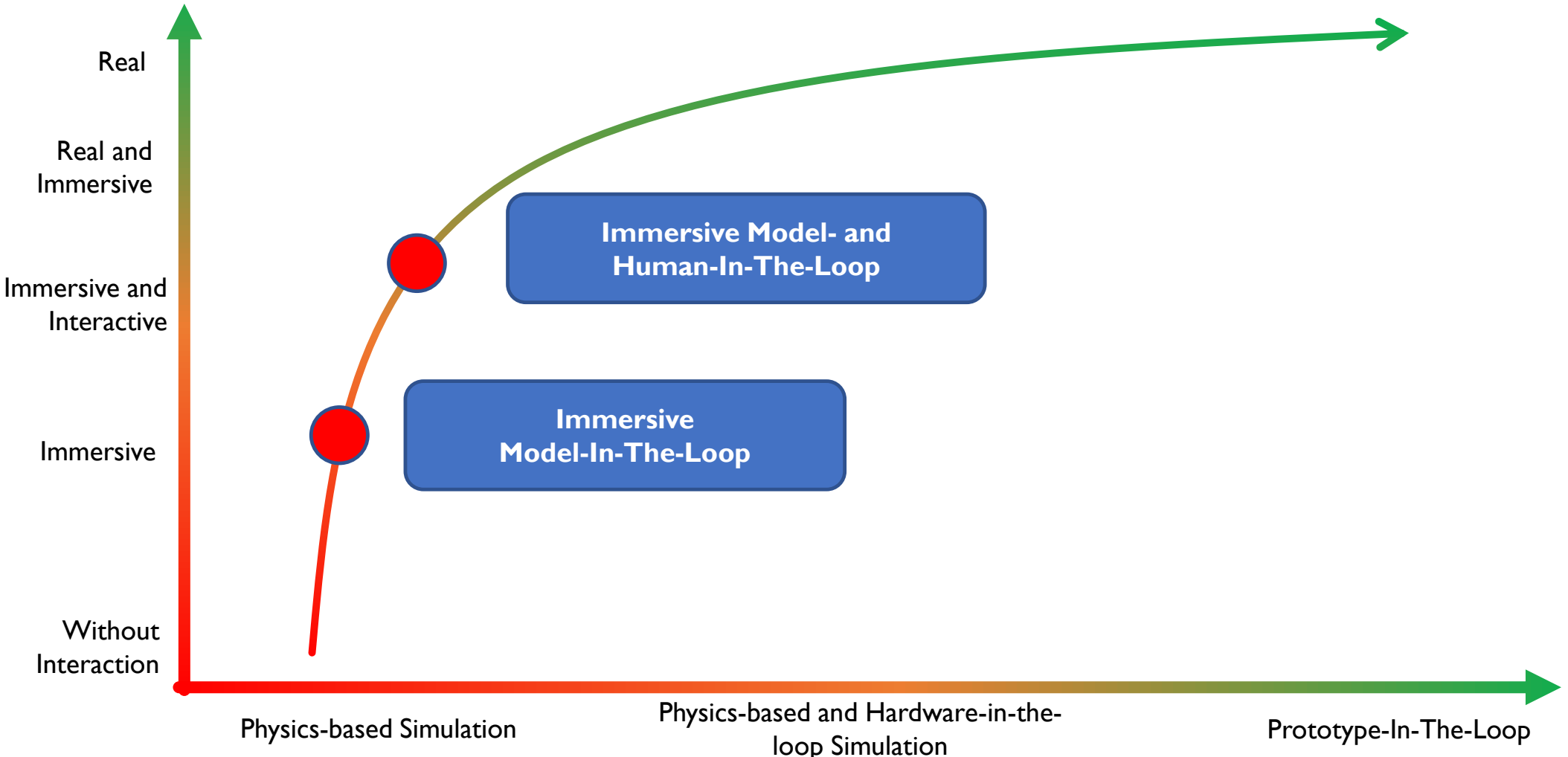


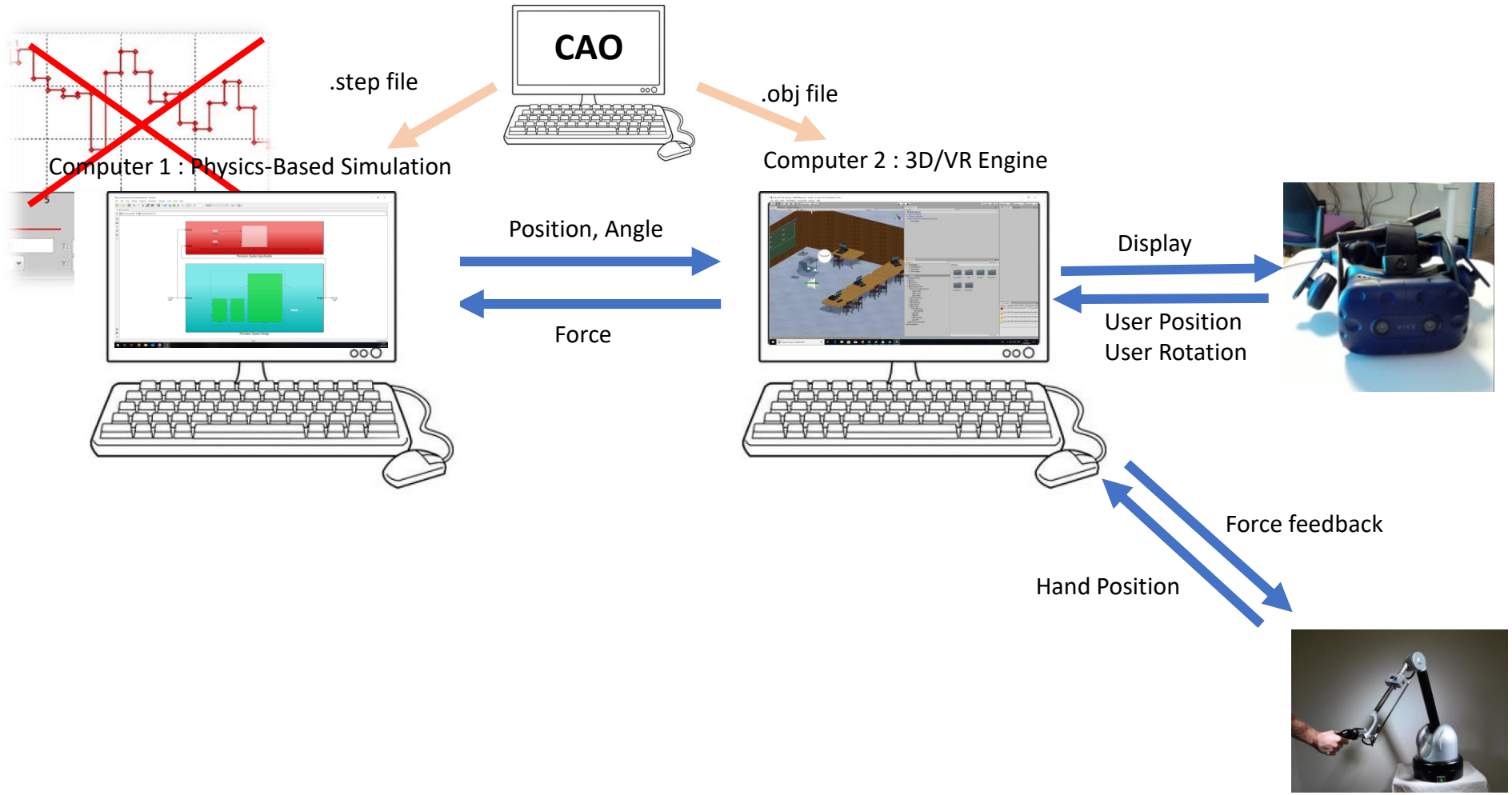


Limit : Lack of realism in the interactions

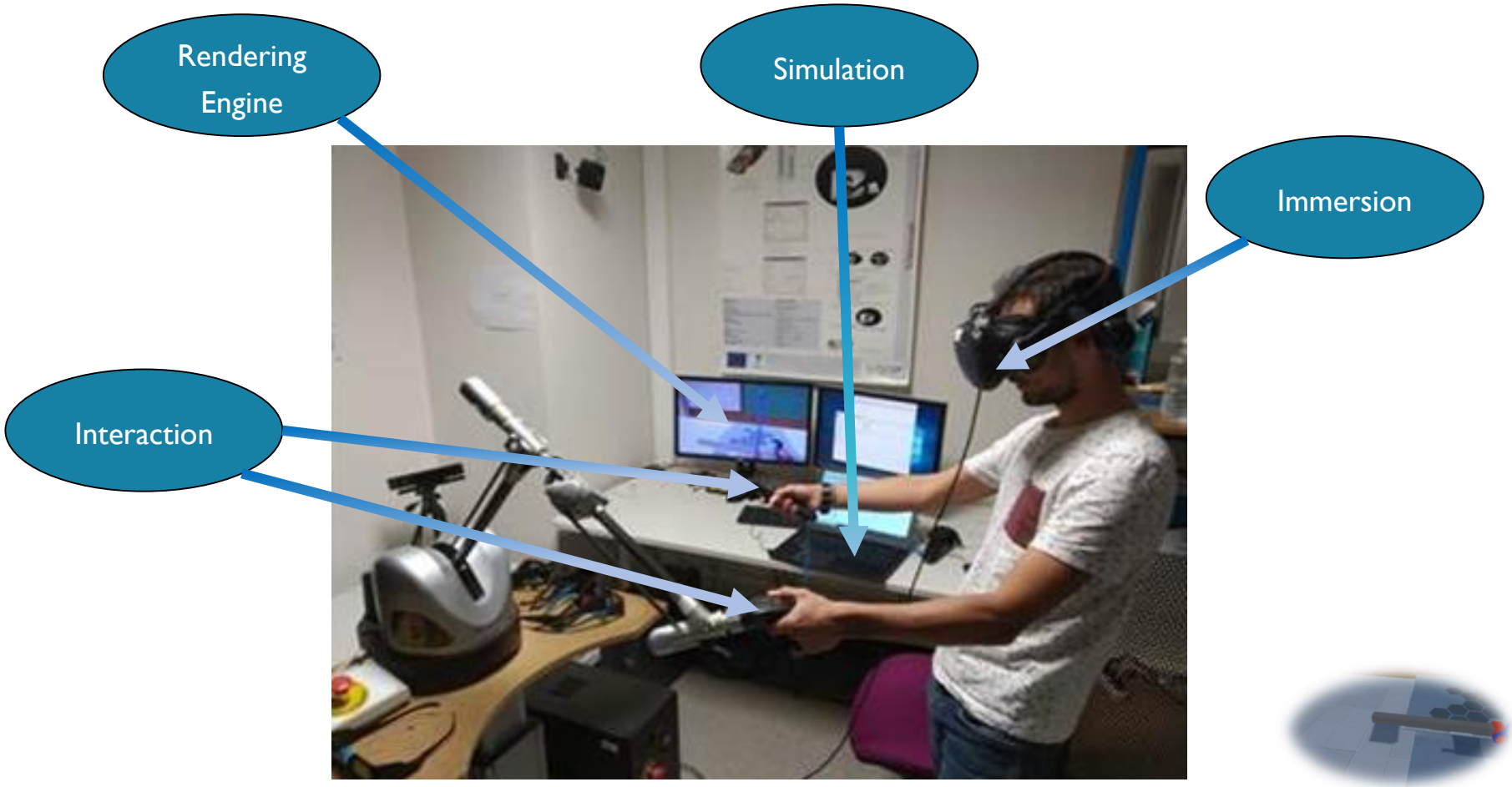
PROPOSITION



IMMERSIVE MODEL- AND HUMAN-IN-THE-LOOP – IMPLEMENTATION

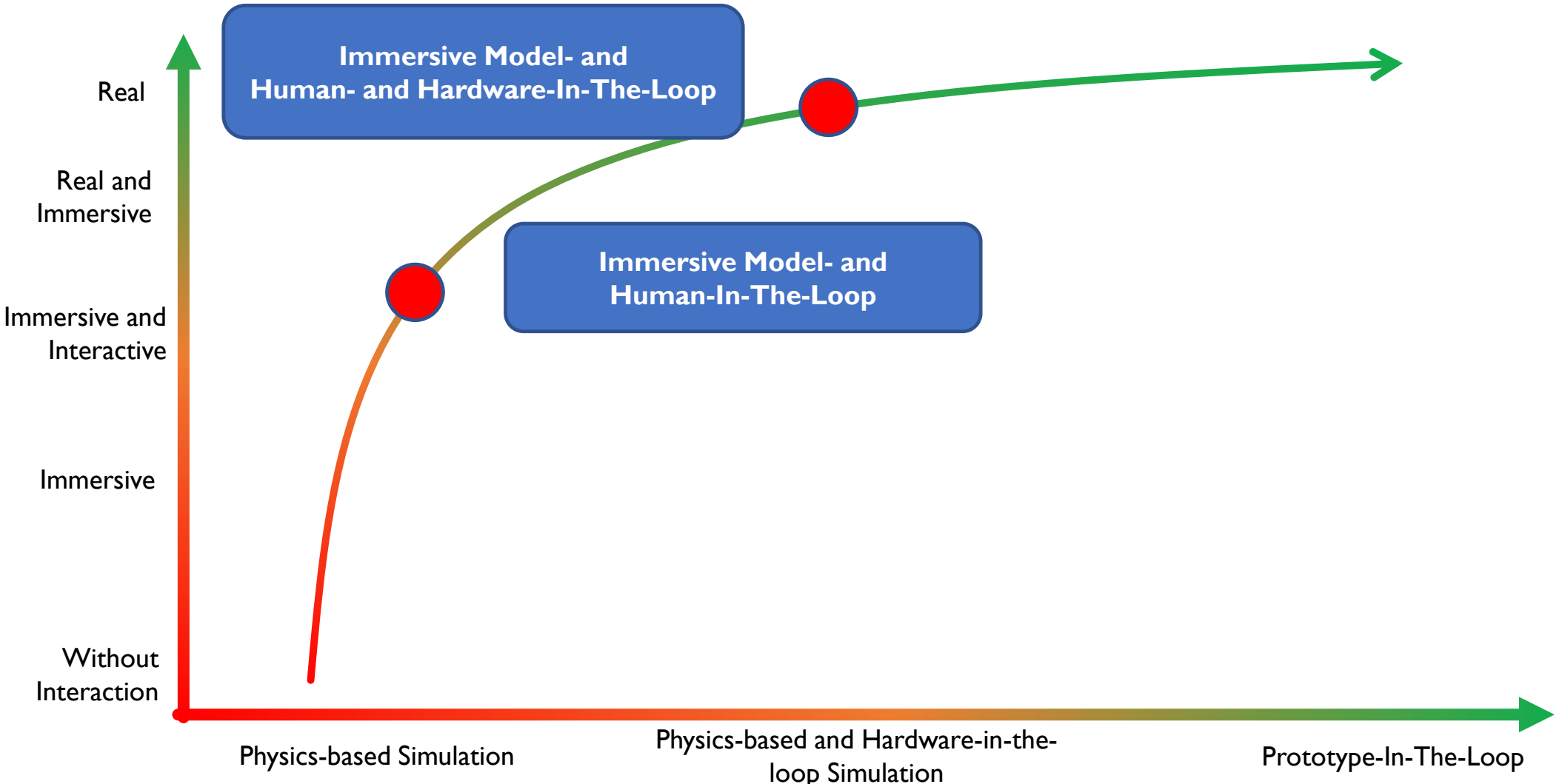


IMMERSIVE MODEL- AND HUMAN-IN-THE-LOOP – ILLUSTRATION

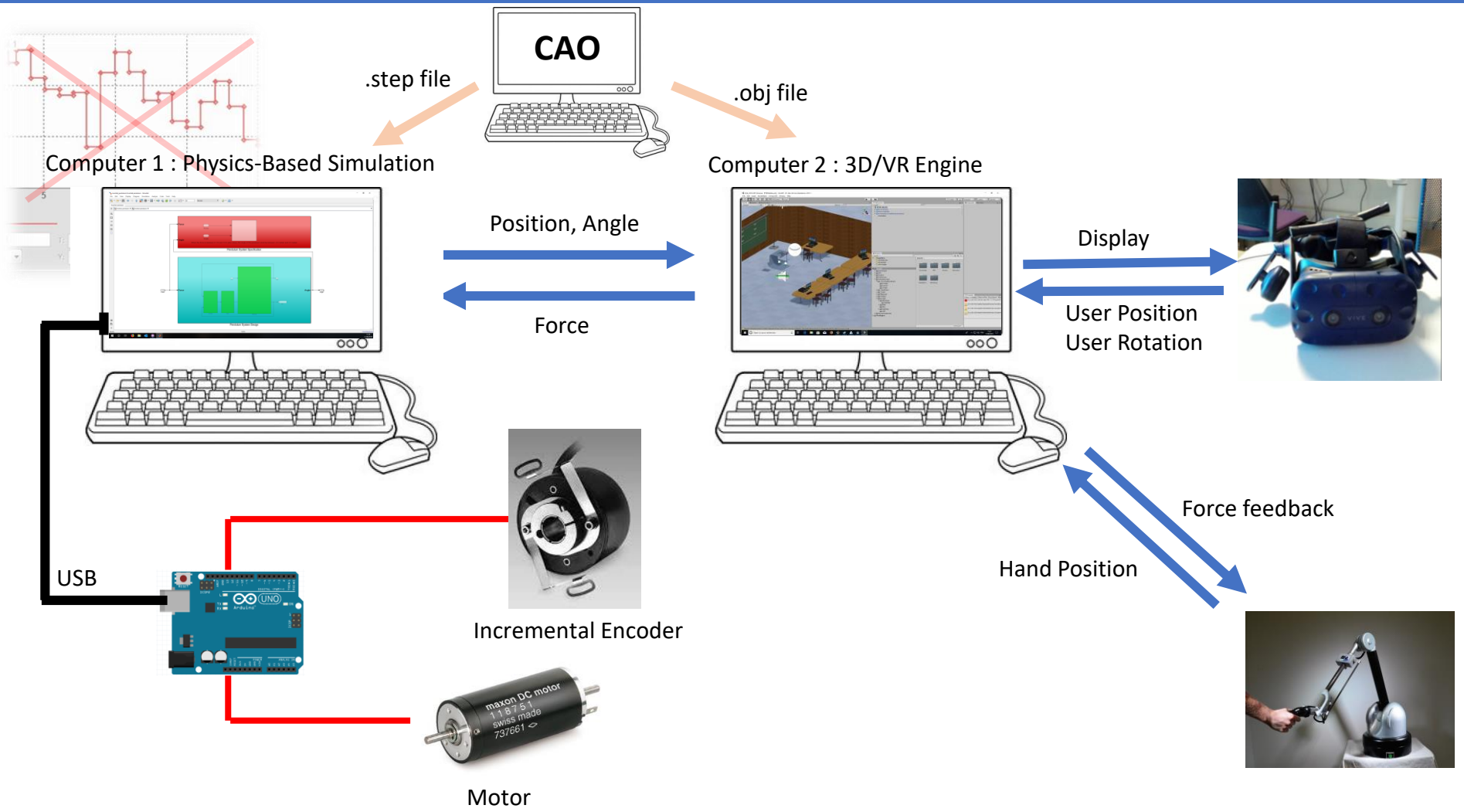


Limit : Modelling hypothesis for the simulation

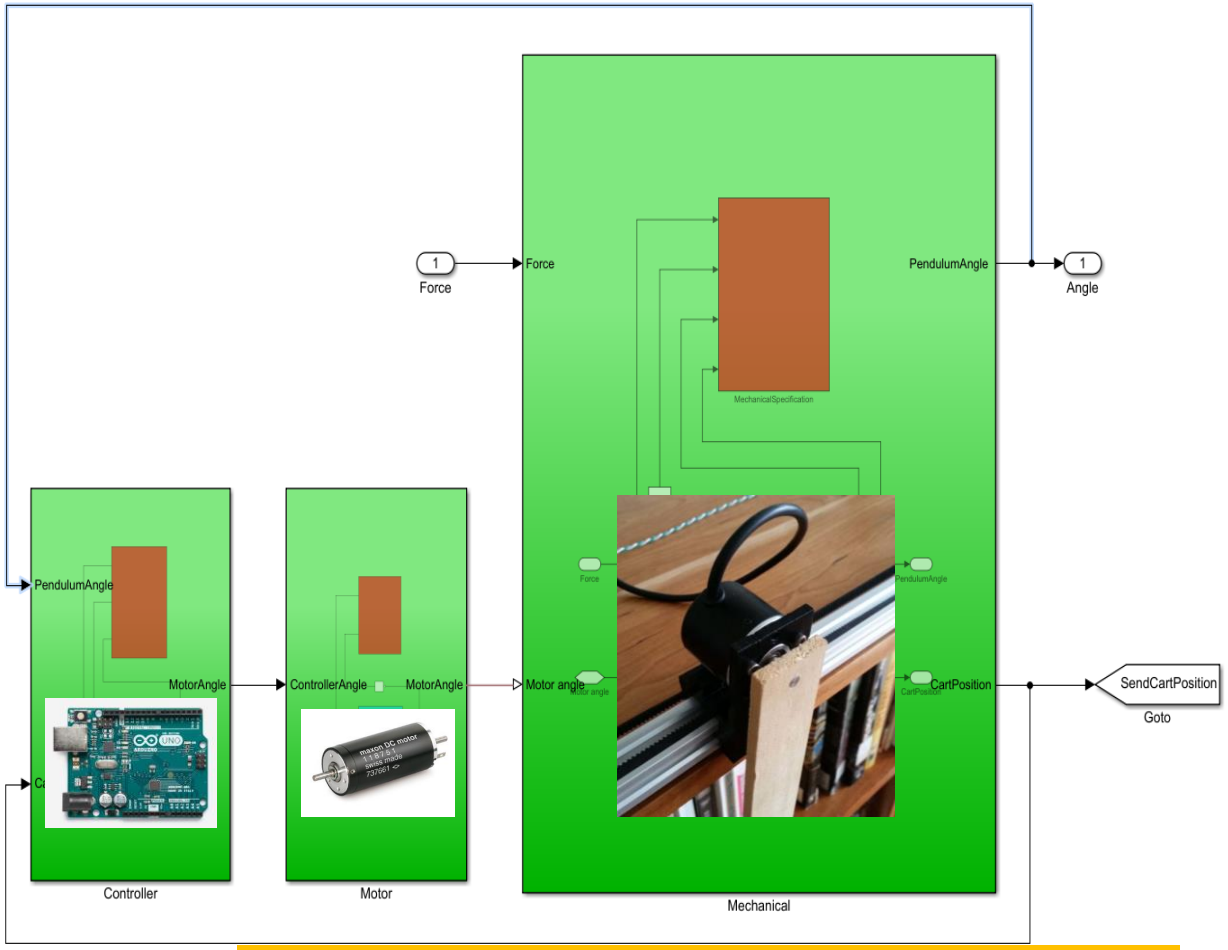
PROPOSITION

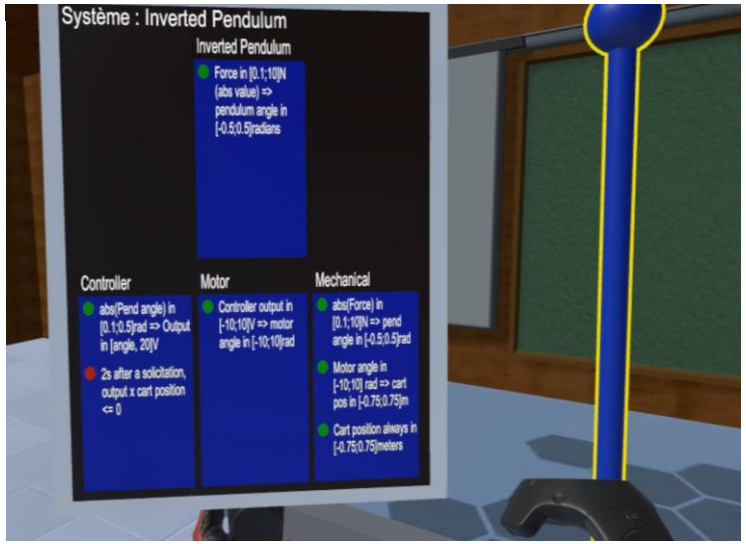


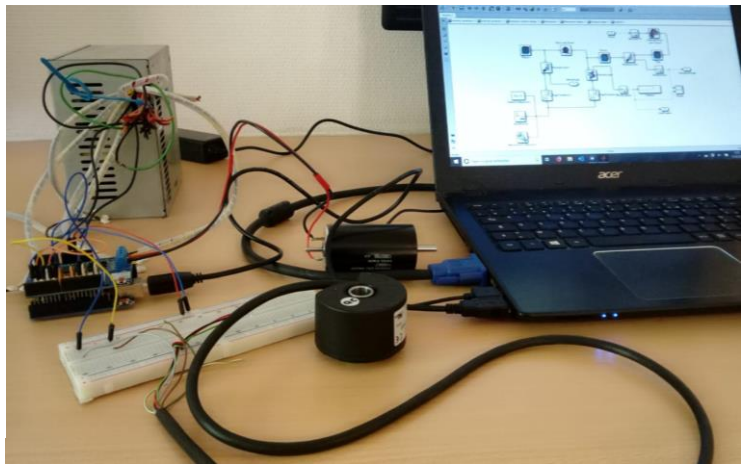
IMMERSIVE MODEL-, HUMAN- AND HARDWARE-IN-THE-LOOP - IMPLEMENTATION



IMMERSIVE MODEL-, HUMAN- AND HARDWARE-IN-THE-LOOP - ILLUSTRATION

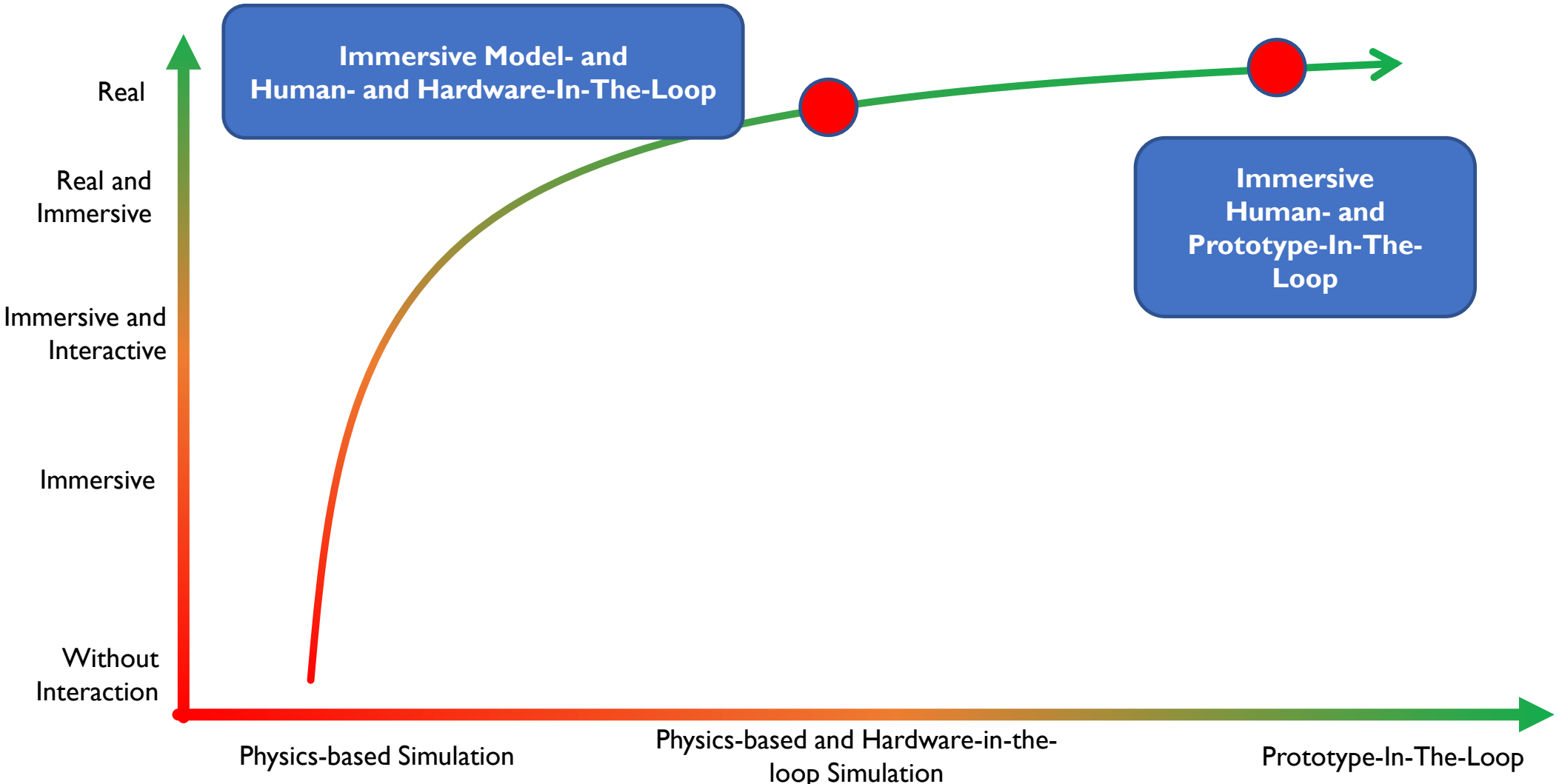




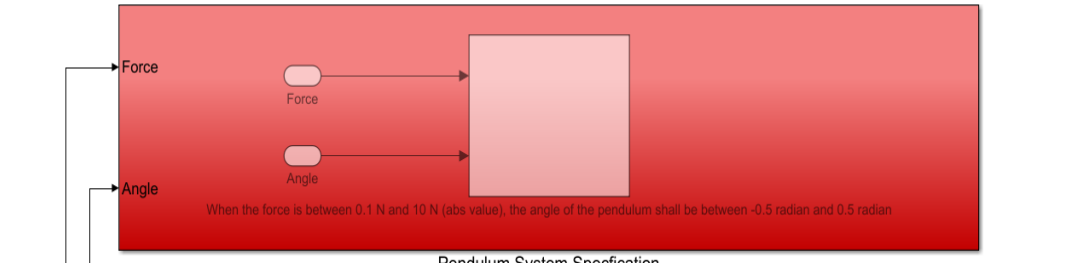


Limit : Modelling hypothesis for the simulation

PROPOSITION



IMMERSIVE HUMAN- AND PROTOTYPE-IN-THE-LOOP



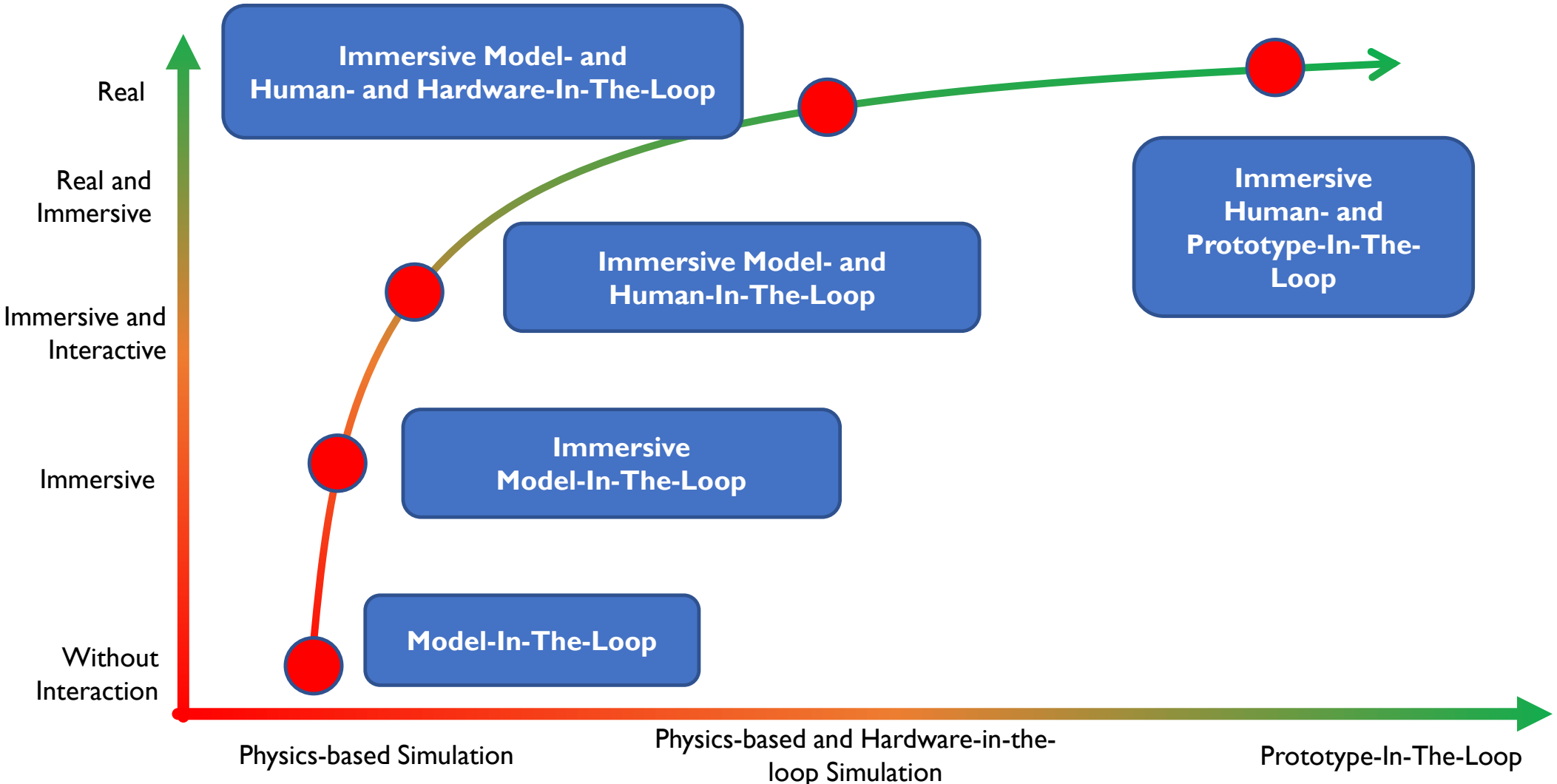
Pendulum System Specfication


Pendulum System Design

HOW FAR TO GO ?

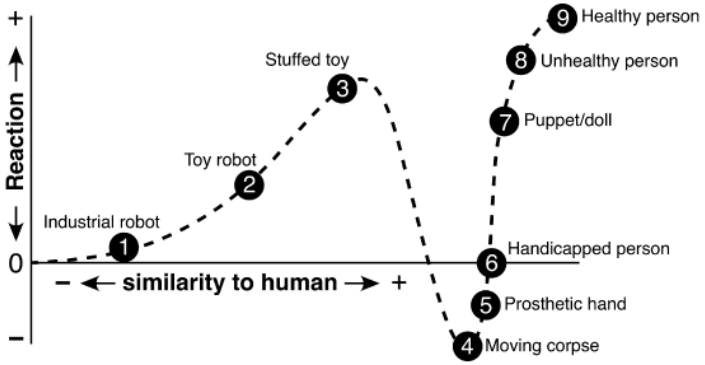
CONCLUSION

CONCLUSION - PROPOSITION



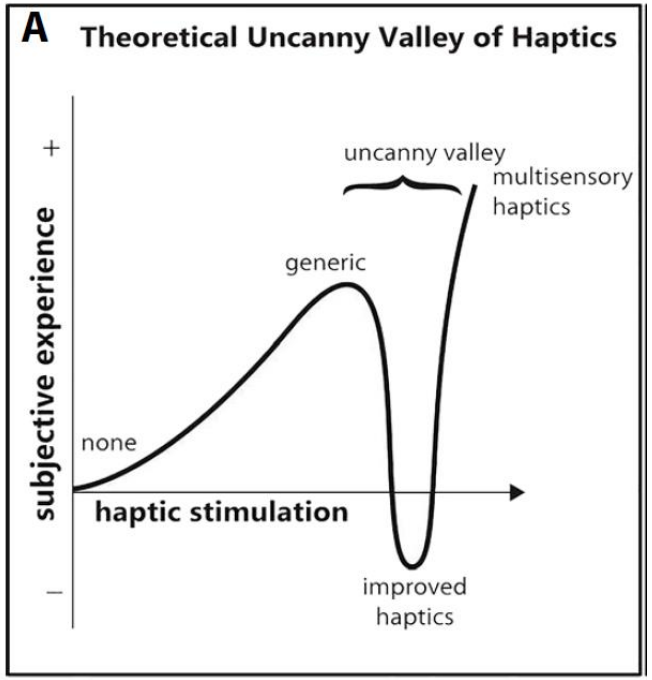
THE UNCANNY VALLEY

A robotics phenomenon …



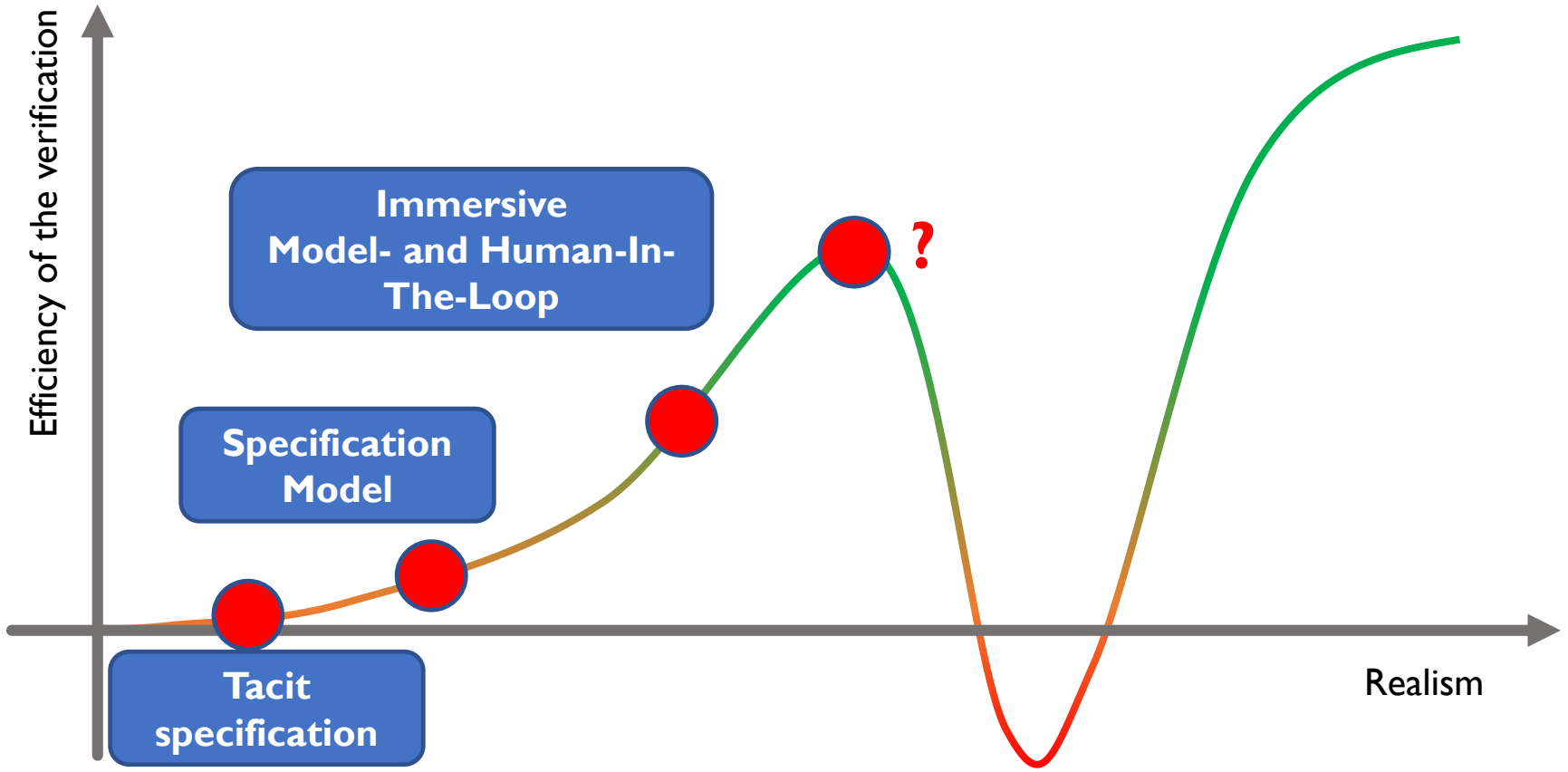
Mathur & Reichling (2016), "Navigating a social world with robot partners: A quantitative cartography of the Uncanny Valley"

… also observed for haptics



Berger et al. (2018)

CONCLUSION


Efficiency of the verification
Immersive
Model- and Human-In-
The-Loop
?
Specification
Model
Tacit
specification
Realism

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