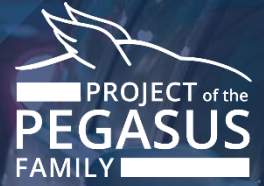




**VERIFICATION
VALIDATION
METHODS**



COMPONENT TESTING WITH MECHANICAL HARDWARE-IN-THE-LOOP

Bridging the gap between simulation and in-vehicle testing.

Jonathan Millitzer, Fraunhofer LBF, Darmstadt

Image-based object classification depicts an integral part of highly automated driving capabilities. In this context, the **verification and validation of camera-based systems** might lead to new concerns. Rolling shutter, motion blur and deviations in object classification are

some of the known effects caused by **mechanical high-frequency excitation** of camera equipment.

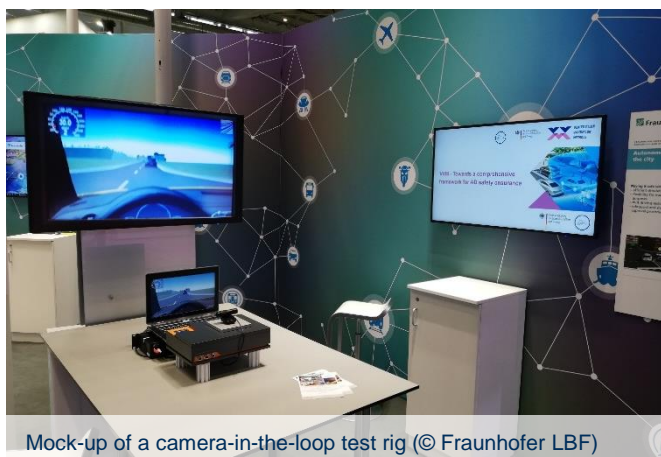
While the emergence of vibrations at the mounting position of the camera is well understood and simulation models are available, the same isn't true for image acquisition and processing under vibrational loads. Nowadays, testing of sensitive camera equipment is performed in expensive and hard to reproduce in-vehicle tests.

VVM bridges the gap and combines highly repeatable vibration simulation with testing of camera equipment in a camera-in-the-loop test environment. The test environment makes use of a real-time vehicle simulation and a mechanical HIL interface which exactly reproduces the vibrations at the mounting point of the camera during component testing. Including a synchronized real-time rendering of a scene, pixel information and classified objects can be investigated under vibrational loads.

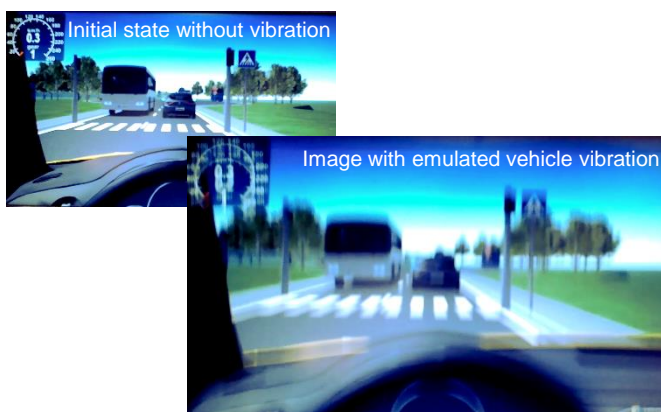
Camera-in-the-loop testing will serve the **refinement and separation of concerns** regarding camera-based object classification under vibrational loads. It further supports the quantification of quality criteria for both pixel information and object classification.



Mechanical hardware-in-the-loop interface (© Fraunhofer LBF)



Mock-up of a camera-in-the-loop test rig (© Fraunhofer LBF)



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