DELIVERABLE

WP6 – HDR Testing Tool Set

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1.1.1 HDR Testing Toolset (BUT)

1.1.1.1 Design and verification toolchain

This tool provides, based on a known trajectory (locations, speeds, and orientations in time), a simulated camera input for further processing by image/video processing software. This tool is intended for simulated HDR multiexposure assembly, potentially also for multi-RGB (with filters) multiexposure multispectral image assembly, etc. (this function is still in development). It is assumed that the tool will help to build the image/video processing software that will properly register the images and will avoid the need for unnecessary extensive image data acquisition, e.g., in the presence of wind, bad weather, etc. (see Figure 1).

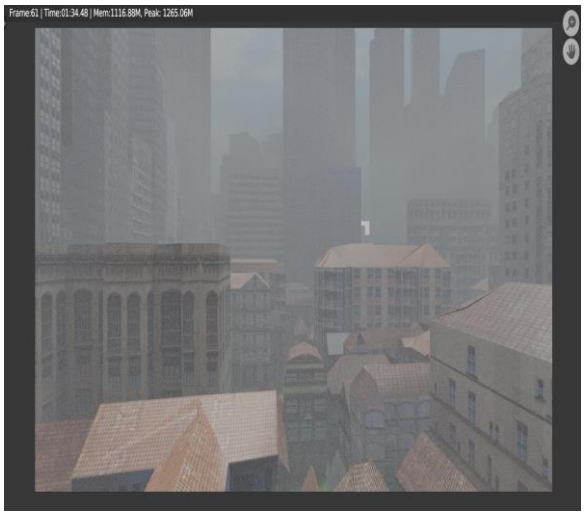

Figure 1: Sample city scene with fog.

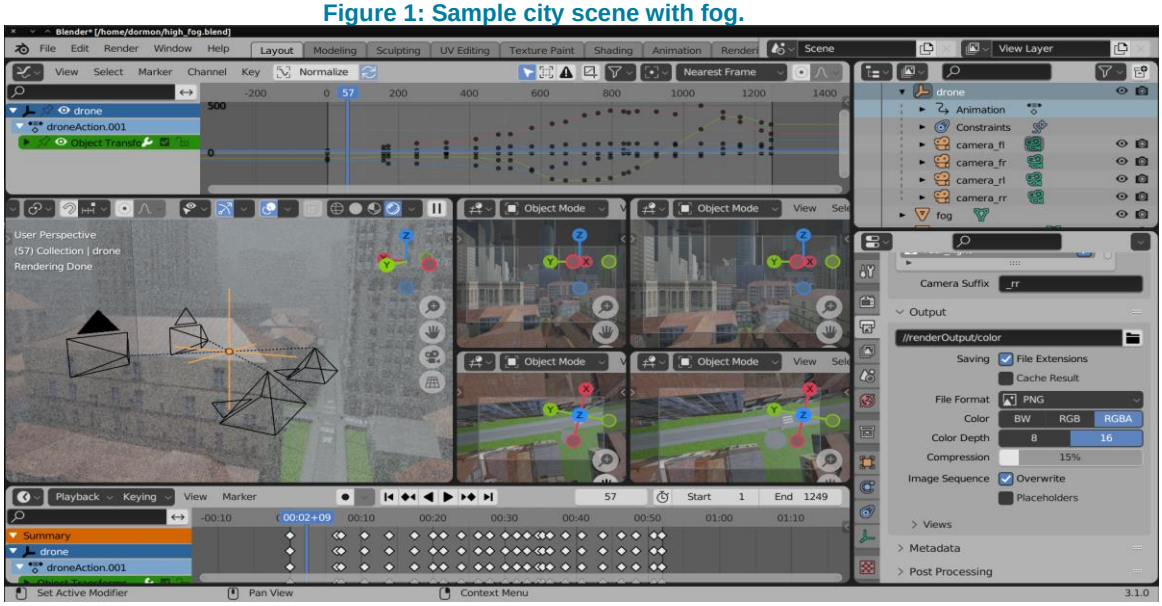

Figure 2: Blender with HDR Testing Toolset plugin.

HDR can be obtained using specialized HDR sensors or using standard sensors by the acquisition of image sequences with different exposition times. These images can be captured simultaneously e.g., through a beam splitter on several CCD/CMOS sensors, or more often sequentially. For economical and practical reasons (it is cheaper and easier to fly a simulated drone flight than a real UAV mission) BUT implemented a simulation tool which can provide simulated HDR data suitable for testing HDR and subsequent algorithms. This tool is implemented as a plugin into Blender.

The *HDR Testing Toolset* currently implements an algorithm for HDR fusion and HDR tone-mapping. These algorithms are provided as a component in WP4 in the form of a C/C++ library. HDR merging is based on the well-known method of Debevec and Malik, and tone-mapping is based on Durand's local operator extended with video processing support.
HDR Testing Toolset consists of two parts, which can be used separately: Simulated Data Acquisition Tool and HDR Processing Tool. The simulation tool simulates the flight of a drone with an installed camera (whose parameters are adjustable), and this camera captures a sequence of frames that are used as input into the HDR Processing Tool. As these two tools can be used separately *HDR Testing toolset* can be used in two modes:

- **Real-world data input** (Simulated Data Acquisition Tool is not used in this mode) - *HDR testing toolset* process HDR video (which consists of consecutive HDR frames in .exr format).
- Simulated data input – input data are captured using Simulated Data Acquisition Tool, which is based on BUT Modelling and Simulation Tool. This tool produces a sequence of low dynamic range images (with varying exposure).

HDR Testing toolset produces output in the form of video processed using HDR merging and tone-mapping algorithms. The use of the tool makes it easier to process a large number of images in difficult lighting conditions (hence the need to add support for various weather effects). Weather effects have been added to the simulation tool to allow fast generation of input data. This allows quick testing of the HDR algorithm but also of subsequent computer-vision and image processing algorithms.

1.1.1.2 V cycle coverage

The tool can be used in several steps of the V-cycle:

- System requirements analysis, System Design, IT Analysis & Design:

  Since the input data to the tool can be simulation data as well as real recorded data, the tool can be used for either specification and design of suitable hardware parts (suitable camera selection) and software components/libraries/algorithms.

- SW development:
  In this step of V-Cycle, developers can use this tool for testing computer-vision algorithms
- IT integration and Verification, System Acceptance verification:
  The tool can be used to verify whether the system meets the requirements (typically for camera requirements verification) using real-world data as input.

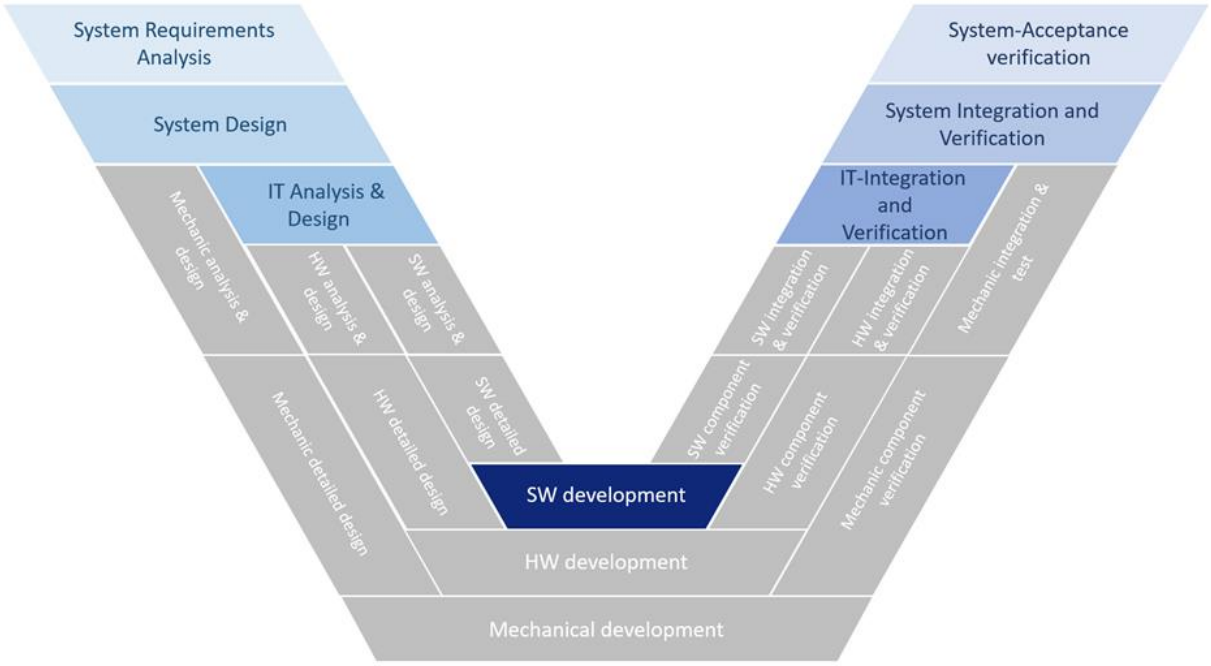

Figure 3: Scope of HDR Testing Toolset in the V-cycle

The interoperability with other tools is built-in by design because input into this tool is a sequence of raw alternating exposure images. There is potential interoperability with BUT Modelling and Simulation tool which can provide simulated input data.

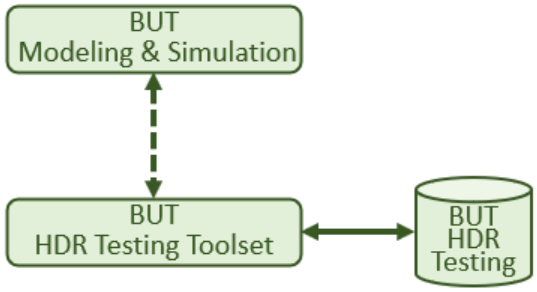

Figure 4: HDR Testing Toolset interoperability

1.1.1.3 Evaluation metrics

Table 1: Requirements and evaluation metrics for HDR Testing Toolset

ID	Requirement description
UC4-DTC-33	The simulator shall simulate weather and wind effects.
UC4-DTC-34	The simulator shall allow capturing simulated HDR for HDR multi-exposure assembly.

1.1.1.4 Assessment of metrics vs requirements

The rationale for UC4-DTC-33 is to provide weather effects to BUT Modelling and Simulation Tool which provides simulated data input into *HDR Testing Toolset*. These weather and wind effects affect simulated drone flight. The requirement UC4-DTC-34 is meant to enable the acquisition of simulated HDR images. This leads in saving in the modelling of missions for drones because HDR data can be captured in one simulated flight. According to our experiments, more than 20% of modelling effort is saved as the tool provides high-quality HDR input data (with different adverse effects).