

# A disruptive strategy for structural health monitoring with STKO

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## 1 Abstract

Artificial Intelligence (AI) has become the standard tool for data analysis in many scientific fields and has demonstrated its validity for structural health monitoring (SHM). In the standard data-driven approach to structural condition assessment, sensor network data are preprocessed and then classified in near real-time as regular or outliers through machine learning-based algorithms. The underlying model’s parameters are usually calibrated in a preliminary phase in which training data are recorded from the undamaged structure under normal operating conditions. However, such algorithms may fail for many uncontrollable reasons, producing false alarms or missing effective damage. The approach can be refined by constructing a digital twin (DT) of the structure, i.e., an accurate numerical model for simulating dynamic and environmental scenarios. The DT, if regularly updated to match the system examined, can be used to doublecheck possible alarms emitted by the data-driven counterpart and for “what-if” analyses. The idea of matching data-driven and model-based approaches to provide a hybrid solution, while not necessarily new, has yet to be perfected, as most of the dedicated projects realized suffer from major issues due to the lack of a common environment. Typically, each step in the SHM process is accomplished using different hardware components, software, and APIs provided by different suppliers: this creates format incompatibilities since each part produces outputs in different formats. Many problems arise in managing such large, heterogeneous datasets, including a slowdown of the algorithm and data loss. We propose a well-integrated, robust solution that overcomes such problems by using the framework provided by STKO (The Scientific ToolKit for OpenSees) for FEM analysis and exclusively using products supplied by ASDEA Software srl and ASDEA Hardware srl for all parts of the SHM process, from high-performance MonStr devices for data acquisition to dedicated APIs for data analysis. The HDF5 data format is used across all stages, meaning no conversion is necessary. STKO’s Python editor is used to incorporate the algorithms specifically designed for the process, and it also allows users to adapt and produce custom scripts according to their needs. The workflow below clarifies the proposed setup.

**Keywords** – structural health monitoring, digital twin, finite element methods, artificial intelligence.

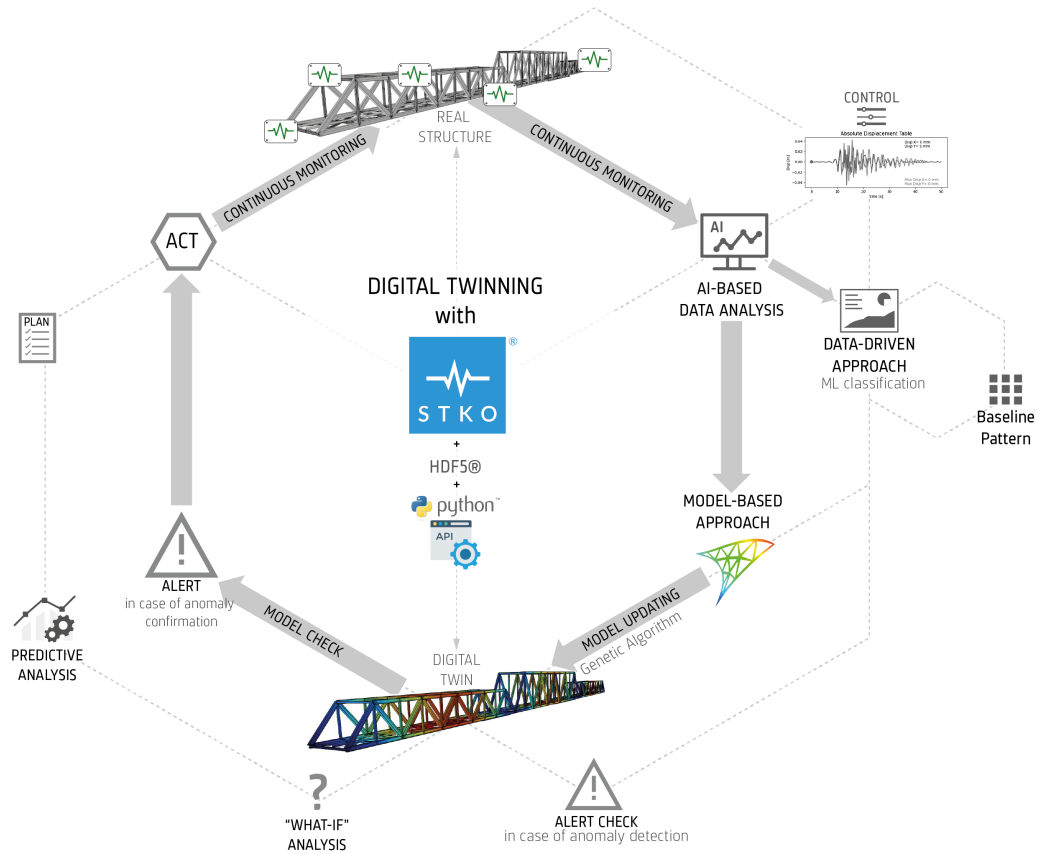


Figure 1: Schematic representation of the proposed workflow.