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Automation systems and integration — Industrial data — Visualization elements of digital twins

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Foreword

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This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document analyses visualization elements to be shared or integrated between an avatar (digital replica) and a physical asset. Three component models of the digital twin, which are physical asset, avatar, and realtime interface, are adopted and elaborated in this document. The fidelity measure of the interface between the avatar and the physical asset is discussed.

Automation systems and integration — Industrial data — Visualization elements of digital twins

1 Scope

This document analyses visualization elements that are key components of the interface between the physical asset and the avatar (digital replica of the physical asset).

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
administration shell
bridge between a tangible asset and the IoT world

3.1.2
asset
economic resource, or something of value

3.1.3
avatar
digital replica of a physical asset

3.1.4
digital twin
compound model composed of a physical asset, an avatar and an interface

3.1.5
fidelity
level of accuracy whereby a copy reproduces its source

3.1.6
level of detail
decrease in complexity of a 3D model representation as it moves away from the viewer or according to other metrics such as object importance, viewpoint-relative speed or position

3.1.7
physical asset
asset which exist in the real world

3.1.8
accuracy
measurement deviation from true value and its scatter

Note 1 to entry: Accuracy consists of trueness (proximity of measurement results to the true value) and precision (repeatability or reproducibility of the measurement).

3.1.9
reality
sum or aggregate of all that is real or existent, as opposed to that which is only imaginary

3.1.10
realtime
guarantee response within specified time constraints

Note 1 to entry: Often referred to as "deadlines".

3.1.11
shape
form of an object or its external boundary, outline, or external surface, as opposed to other properties such as color, texture or material type

3.1.12
STEP model
product model which is described according to ISO 10303

3.1.13
synchronization
joining up of multiple processes at a certain point, in order to reach an agreement or commit to a certain sequence of action

3.1.14
visualization
technique for creating images, diagrams, or animations to communicate a message

3.2 Abbreviated terms

AI	artificial intelligence
AR	augmented reality
CAD	computer aided design
CAE	computer aided engineering
CG	computer graphics
CPS	cyber physical system
DPI	dots per inch
DTw	digital twin
LoD	level of detail
MAR	mixed and augmented reality
MR	mixed reality
O&M	operation and maintenance

P&ID piping and instrumentation diagram

RPM revolutions per minute

VR virtual reality

XR extended reality

4 Motivation

There is a need for standardization of visualization elements that should be shared or integrated between a physical asset and an avatar (or digital replica)[2]. As defined in this document, the digital twin is composed of a physical asset, an avatar, and an interface. Figure 1 shows this separation of the concept (three components model) and visualization elements of the digital twin.

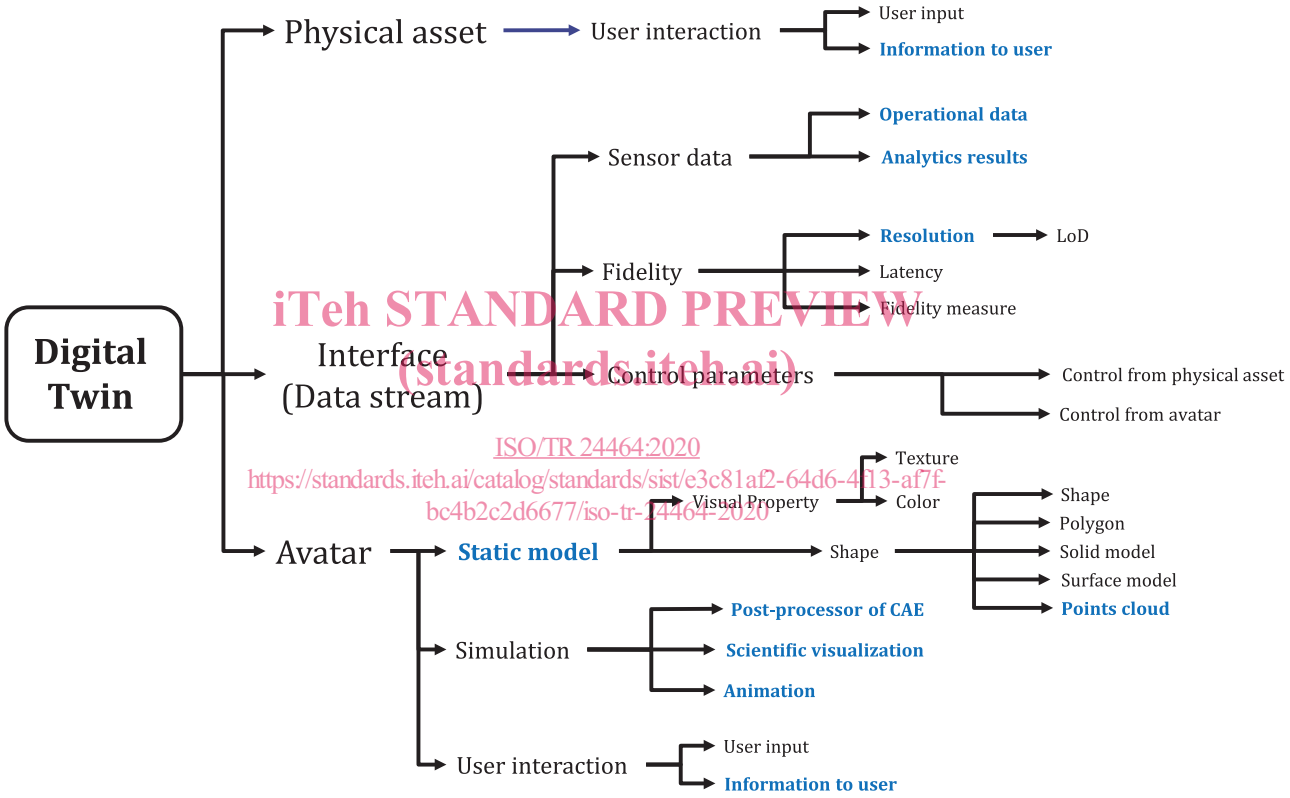

Figure 1 — Classification of terminologies of digital twin visualization

5 Digital twin visualization

5.1 Core technologies of digital twin

5.1.1 General

Core technologies of the digital twin that Deloitte consulting introduced[3] are sensors, actuators, integration, data, analytics. More technologies can be defined for the visualization of digital twins.

5.1.2 Sensor

Sensors that are attached to operating equipment can send the status (such as position, temperature, pressure, vibration, RPM) of the equipment to a user in near-realtime.

5.1.3 Data

Sensor data collected in near-realtime are generated continuously. The result can be a big data that is a collection of operating status information of the equipment.

5.1.4 Analytics

The technology which analyses big data is called analytics. As a bulk of digital sensor information is collected through the internet, the quantity of data exceeds the amount that human's analysing abilities. Consequently, data analysing technology using a computer with AI capability is being spotlighted.

5.1.5 Actuator

Once big data about the operating status is analysed by analytics, operating parameters of the product can be optimized and the operating status is adjusted based on the analysis result. The delivery device of modified parameters to drive the machine is an actuator.

5.1.6 Integration

The operating status information and the control information should be shared between the avatar and the physical asset for the integration of the digital twin. The interface component of a digital twin as is defined in this document enables the sharing and integration.

5.2 Visualization elements of digital twin

The relations between keywords which are being discussed among digital twin experts in Korea are shown in Figure 2. Data models or product models in the STEP standard (ISO 10303) which are being standardized can be regarded as elements of avatars. Not only design models, but also models for production or manufacturing are included in ISO 10303. There are also digital models for visualization that are specified in certain standards (see Annex A).

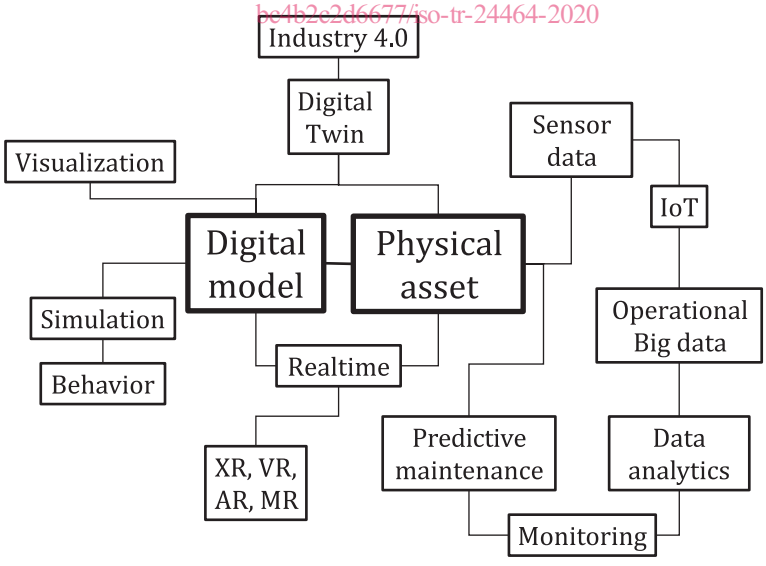

Figure 2 — Sample relations among keywords of digital twins

For the visualization of digital twins, most of the methods of virtual reality (VR) or augmented reality (AR) can be utilized. Visualizing properties such as shape, color, and texture of an avatar or a digital replica should be included, and animation also should be included.

Visualization of sensor data which shows the operating status of a physical asset should also be added for the visualization of digital twins. It is similar to the visualization elements of a post-processor in numerical simulations.

Additionally, visualization elements are dependent on the lifecycle of the product. The information that digital twins should share is changing along the lifecycle of a product which is usually made of plan, design, manufacturing, O&M, or discard, so that visualization elements change along the lifecycle of the product.

At the beginning of a product lifecycle, there is no physical asset. There is only the avatar or the digital replica. The conceptual product inside the mind of the designer is modeled as an avatar inside a computer at the beginning. The avatar is tested or simulated inside a virtual manufacturing system and the physical product then is realized into a physical asset through physical manufacturing. Only from this time both twins (avatar and physical asset) exist and can be integrated by sharing realtime status data from sensors and control parameters to actuators.

5.3 Detail elements of digital twin visualization

3D printing and 3D laser scanning, which have recently been under research and development also require a visualization model. In addition to the traditional CAD or mesh models, points cloud models are also being introduced. Depending on the fidelity of the avatar, different levels of detail (LoD) are being used as shown in Table 1.