

A Software Engineering Approach to Digital Twin Architecture: The HUman at home projecT and Twin Cooperation of roBot and human project case studies

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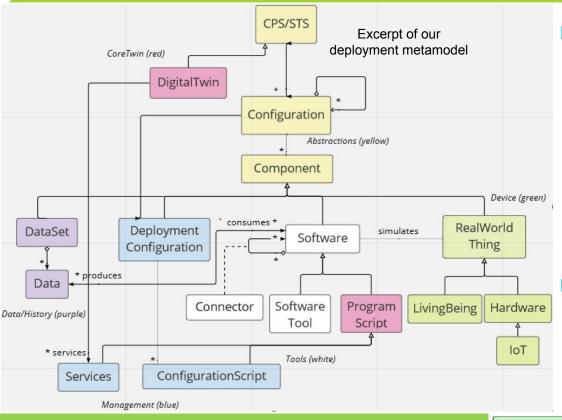
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A Software Engineering Approach to Digital Twin Architecture

The HUman at home projecT and Twin Cooperation of roBot and human project case studies



- ► Motivation Digital twin (DT), Internet of Things and Artificial Intelligence are key emerging technologies in Industry 4.0. However, concrete and operational models are still to be designed to manage the deployment of DTs [1]. Our proposed metamodel is a first step towards a model-driven approach for deployment. It is derived from our previous work on ADLs [2, 3].
- Objective Develop a metamodel that supports concrete operational descriptions of digital twins; Validate in two human-robot interaction case studies: a robotic arm and a home automation application.

Central Computer: Hardware

LinuxOS:SoftwareTool

Robotic arm application

In the robotic arm case study, DTs of the interacting human and robot are used for motion planning in pick-and-place tasks.

Our deployment metamodel can describe the combination of software hardware and used. including: ROS, Unity, Kinect, Xsens body suit, Kinova j2n4s300 robotic arm, etc.

The transformation of this model into executable deployment descriptors is being studied.

DigitalTwin HumanModel Unity Humandata:LivingBeings DigitalTwin HumanRobot Unity HumanSubject1 HumanSubject2 onfiguration_HR_Unity_Datastored DeploymentConfiguration DeploymentConfiguration Location] HumanTask HumanTask Haal Computer : Hardware SoftwareTool:XsensStudio Data UnityProject HumanModel UnityProject HumanDimensions:Dataset ProgrammScript Data HumandimensionsSubject1 ProgrammScript Data ConfigurationScript TCP/IP HumandimensionsSubject2 Ros Workspace/src ProgrammScript Connector HumanMovements:Datase DigitalTwin_Robot_Moveit ConfigurationScript RecodedMotionS1 Configuration_PickandPlace_j2n4s3 Moveit:SoftwareTool RecodedMotionS2 DeploymentConfiguration HumanTask Resources Ros Workspace/srd ProgrammScript Connector XsensSensors:IOT ConfigurationScript SoftwareTool:Moveit Robotic arm kinova : Hardware Unity:SoftwareTool

HomeAutomationSystem : CPS RaspberryPi : Hardware RaspberryPiOS : SotwareTool penHab : SotwareToo smartLightBulb : CPS D zWaveBinding zWave: zipatoLightBulbThing ZWaveDongle : Connector zipatoLightBulb: bedPressureDataCollector: SoftwareTool bedPressureSensorTh httpBindi ing: Script ng: Connector wifiCard: bedPressureSensorPr Hardware edictorThing: Script Connector wifiRouter: Hardware BedPressureSystem: CPS computerBedPressureSensor : Hardware linuxOS : SotwareTool pythonFlaskServerForBedPressureSensor: bedPressureSimulationService: SoftwareTool wifiCard: bedPressurePredictorM Hardware Con Octor odel: Script

Home automation application

In the home automation case study, DTs are used to handle and predict the interactions between a smart appartement and its inhabitants.

The validation of our metamodel is here twofold:

- modeling of CPS architectures including DTs of sensors/actuators and AI models,
- full implementation as executable deployment descriptors of the modeled elements using Ansible scripts.













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