UC4 Low-latency Object Detection as a generic building block for perception in the edge for Industry 4.0 applications

UC Leader: Siemens

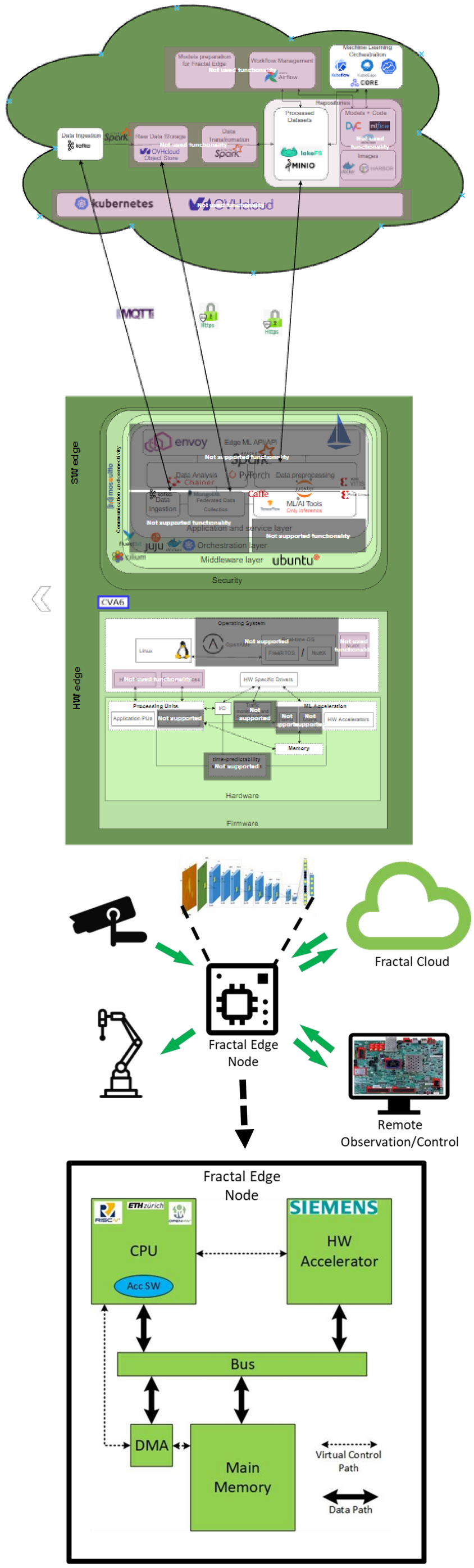
UC description

The objective of UC4 is to demonstrate the capability of the FRACTAL platform to perform real-time object detection on the edge by utilizing High-Level Synthesis techniques. The goal is to achieve a system that can perform computer vision on the edge with limited processing and power resources.

The proposed system will have the ability to:
- Detect the objects,
- Localize their positions in the image, and
- Label them based on pre-defined classification.

UC4 consist of:
- FRACTAL Edge node,
- Camera,
- Display,
- Connection to FRACTAL Cloud, and
- ML framework on FRACTAL Cloud.

UC4 is an important building block for many industrial applications where automation replaces manual work by enhancing the automation processes with intelligence to detect and recognize objects visually.



FRACTAL Components

The FRACTAL edge node offers a platform with a specialized hardware accelerator, tailored for execution of trained convolutional neural networks. The solution eliminates the need to send the raw data to some remote high-performance system or cloud services for data processing, keeps the responds time short and increases the privacy of the data by keeping them local.

The FRACTAL edge node used for the UC4 consists of:
- CVA6 RISC-V core processor,
- Hardware accelerator (SIEDLA+),
- System memory, and
- AXI bus.

The processor is developed by ETH and is a six stage in-order pipelined architecture with all the extensions required to run Linux system software. The hardware accelerator is developed by Siemens and contains a set of nine processing elements (PE) and a local memory. The PEs are organized in a way that each PE performs arithmetic operations in parallel with the other PEs and all of them read/writes the data at the same time directly from/to the local memory. The accelerator is developed using the Catapult High-Level Synthesis (HLS) toolset.

UC Components

You-Only-Look-Once (YOLO) is a real-time algorithm that performs object detection in extremely short time. It is based on Deep Learning which predicts simultaneously multiple objects and their position on a single step. Unlike classifier-based methods, YOLO evaluates the image only once. This is achieved by unifying all components required for object detection into a single neural network. The entire image is inspected at once and all the bounding boxes are predicted instantly.

For UC4 is used Tiny-Yolo version3 the light variation of the YOLO algorithm with less convolutional layers and fewer filters. This solution consists of 24 layers on which kernels of size 3x3 and 1x1 are used for convolutional layers and kernel of size 2x2 for pooling layers. The inference has a smaller size, is a few times faster than the main version and achieves a higher rate of frame processing.

KPIs

The frame rate at which the input images will be processed should be higher than 5fps.

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