Energy Aware Collaborative Machine Learning on Energy-Harvesting Devices

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Abstract

Performing machine learning tasks on low end devices enables the development of various smart applications. Especially, these low end devices are often equipped with ultra-low-power microcontroller units (MCUs) that have weak compu- tation power and few memory resources. It is a more challenging work to put these machine learning tasks on those end devices powered by harvested ambient energy, which are often referred to as energy-harvesting (EH) devices, since the unstable ambient energy can lead to the execution failure of the machine learning tasks. This paper proposes an adaptive energy-aware design to coordinate multiple EH devices to accomplish multi-class classification computation. It also leverages the concept of the One-vs-All (OVA) strategy turning a multi-class classification into multiple binary classifications. The experimental results show our work performs better than the widely used round-robin policy and self-greedy policy in consideration of time and energy consumption.

Keywords—TinyML, Energy Harvesting, IoT, self-powered system

Research Focus

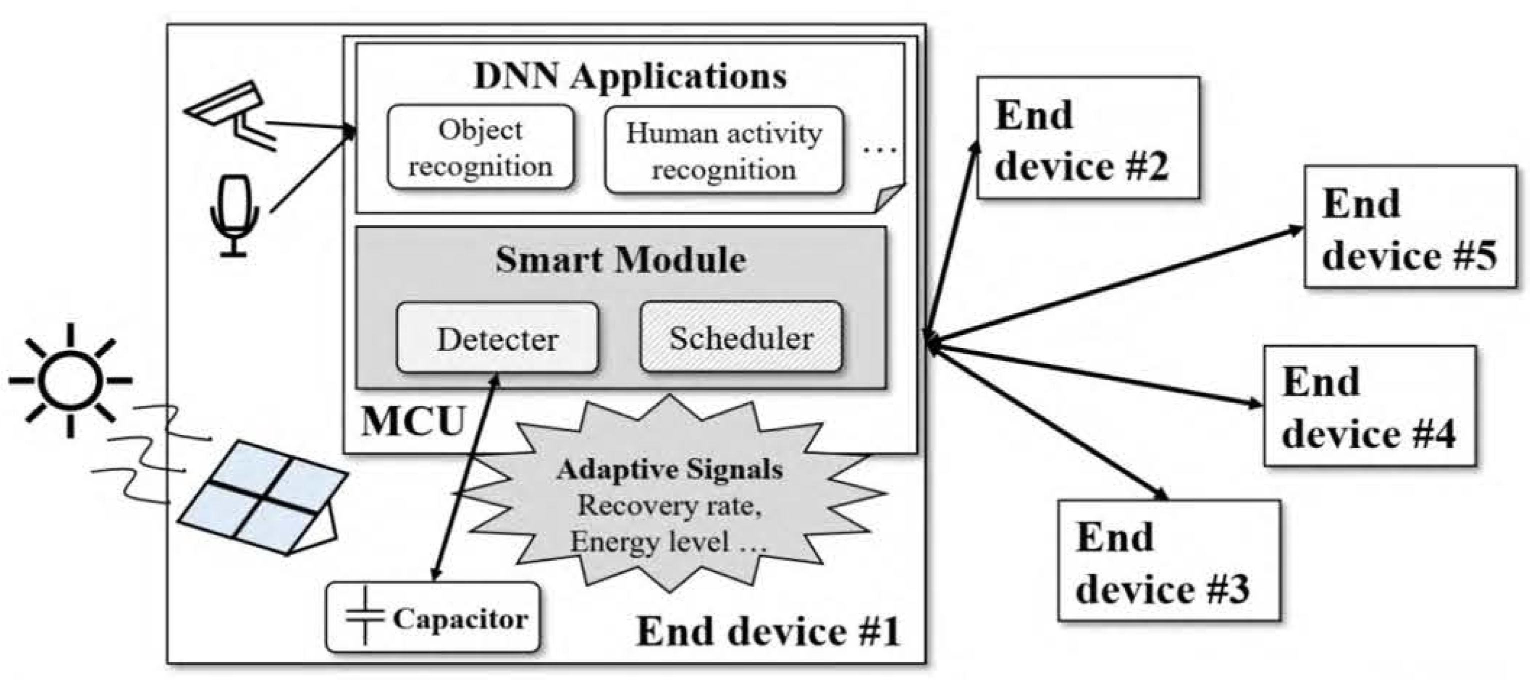

Figure 1. System architecture of the proposed framework and the star network of energy harvest devices.

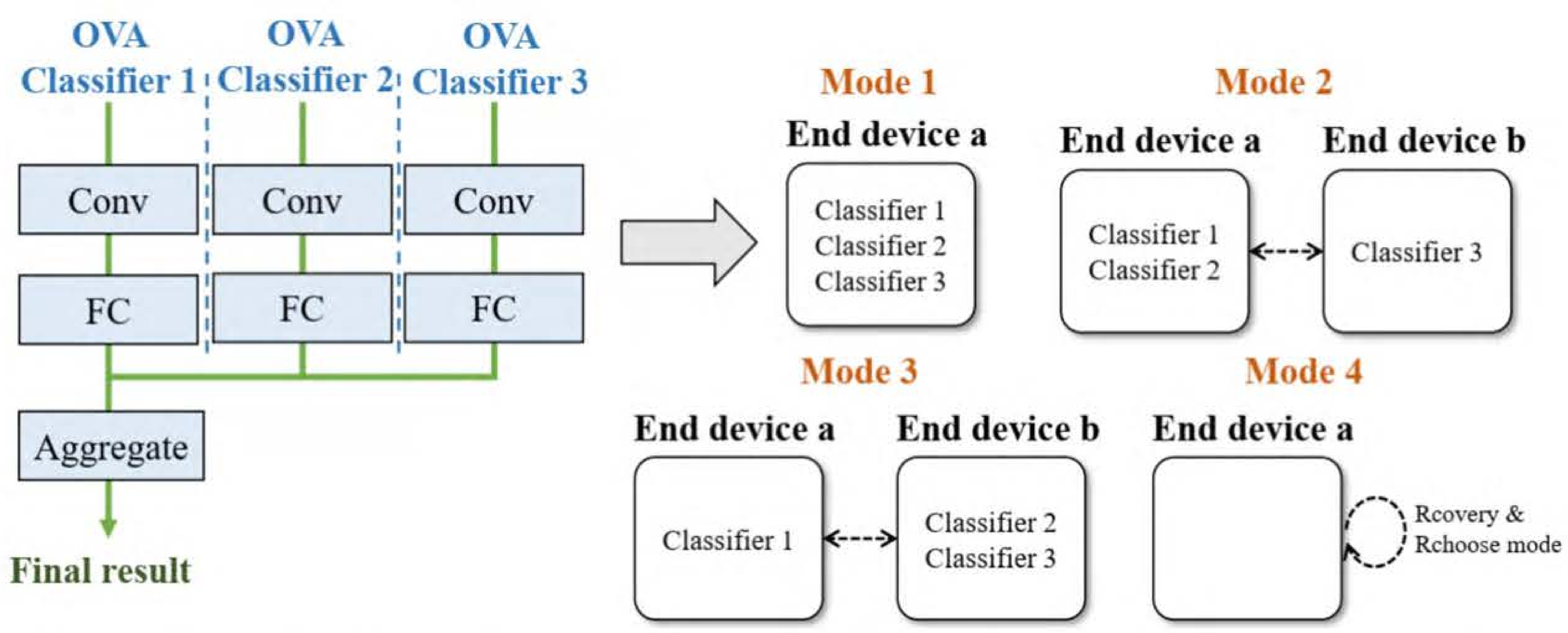

Figure 2. Workflow of the proposed framework and the schedule modes.

Summary

The major advantage of our proposed work is that it aware the states (i.e., energy level and energy recover rate) of current device and surrounding devices in the ambient environment. With the help of the smart module, computations are scale nearby actively idle devices. Preliminary results show that proposed schedule policy perform well, compared with widely used self-greedy policy (SG) and round-robin policy (RR).

Results and Discussion

We propose an adaptive energy-aware tinyML for the self- powered system to accomplish multi-classification by breaking down the original question and aggregating the results of multiple OVA classifiers. We compare the time and energy of our work with other commonly used schedule policies (SG and RR). In the future, we will extend the work with different environments and energy harvesters to apply to various applications.

Publications

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