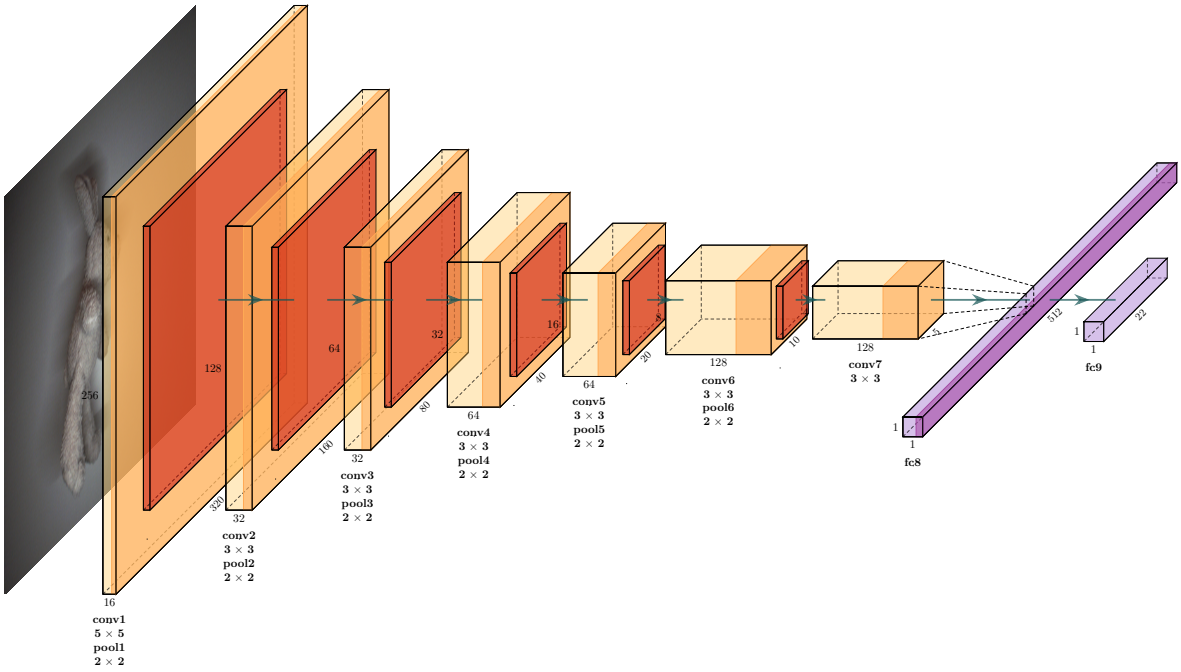
AI High-Performance Solution on FPGA

In a world of self-driving cars and automated quality control in manufacturing, real-time image classification is becoming increasingly important. Artificial intelligence (AI), and deep learning in particular, are achieving excellent classification accuracies. However, there are certain difficulties associated with this approach.



Architecture of the Convolutional Neural Network

Difficulties

There are two main difficulties that need to be overcome. For one thing, high-resolution image acquisition systems require a lot of processing power. For another, a large labeled dataset of images is required to train deep convolutional neural networks (CNNs). Additionally, the training dataset must represent real-world conditions.

Solutions

A solution for the former difficulty is to use field-programmable gate arrays (FPGAs) as hardware accelerators. Therefore, an embedded system featuring a multiprocessor system-on-chip with an integrated FPGA is deployed. The second difficulty is approached with data augmentation to artificially increase the size of the labeled dataset.

Results

The result is the deep convolutional neural network shown in the image above. It achieves a Top-1 classification accuracy of 97.2 % and a Top-5 classification accuracy of 99.5 %. In addition, the throughput of the image classification chain reaches 41.1 fps for color images of a size of 1280×1024 pixels.

Throwing Booth

The throwing booth is constructed from general-purpose aluminium profiles. Due to its robust impact strength, the rear panel is made of a white ABS plastic sheet and has a target hole. The white side panel serves as a consistent background for the images. It is made of a foamed PVC sheet with a fine-textured surface to reduce light reflections. The image acquisition system consists of a Baumer industrial camera combined with a suitable lens. Strong diffuse lighting is used to minimize the required exposure time and to illuminate the side panel as evenly as possible. Finally, a monitor is used to display the detected object.

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