Chapter 1
Acceleration of Image Processing and Computer Vision Algorithms

Aswathy Ravikumar
https://orcid.org/0000-0003-0897-6991
Vellore Institute of Technology, India

Harini Sriraman
Vellore Institute of Technology, India

ABSTRACT

Image processing combined with computer vision is creating a vast breakthrough in many research, industry-related, and social applications. The growth of big data has led to the large quantity of high-resolution images that can be used in complex applications and processing. There is a need for rapid image processing methods to find accurate and faster results for the time-crucial applications. In such cases, there is a need to accelerate the algorithms and models using the HPC systems. The acceleration of these algorithms can be obtained using hardware accelerators like GPU, TPU, FPGA, etc. The GPU and TPU are mainly used for the parallel implementation of the algorithms and processing them parallelly. The acceleration method and hardware selection are challenging since numerous accelerators are available, requiring deep knowledge and understanding of the algorithms. This chapter explains the deployment of HPC accelerators for CNN and how acceleration is achieved. The leading cloud platforms used in computer vision for acceleration are also listed.

INTRODUCTION

Image Processing combined with computer vision is creating a massive breakthrough in many research, industry-related and social applications. The image processing algorithms involve many complex processing steps like wavelet, Fourier, convolutions, vector multiplications, solving linear and quadratic equations, dimensionality reductions, graphical, sorting, and searching algorithms, etc. All these operations are

DOI: 10.4018/978-1-7998-8892-5.ch001

computationally demanding, and they can be effectively parallelized. Image processing is a fast-growing discipline that combines mathematical and computer programming principles. It is intrinsically linked to and impacted by image capture. The user community is diverse and includes not only regular consumers with digital photography but also astronomers who analyze the data from observatories and satellites, professionals in MRI scans, and biologists who utilize ocular microscopes. Users' expectations for picture quality are constantly increasing in high definition, sensor ratio, and dynamic range.

Consequently, pictures collecting equipment and image processing techniques continue evolving to meet user requirements. On the other hand, complicated image processing algorithms may be very time-intensive to calculate, even with modern computer technology. As a result, optimization is a vital aspect of the field, allowing complicated algorithms to be executed in an acceptable amount of time. The growth of big data has led to the enormous large quantity of high-resolution images that can be used in complex applications and processing. There is a need for rapid image processing methods to find accurate and faster results for the time crucial applications in the field of medicine, communication, autonomous driving cars, etc. In such cases, there is a need to accelerate the algorithms and models using high-performance computing systems. The traditional CPU systems are insufficient to attain the required speed, reduce processing time, and perform better. The acceleration of these algorithms can be obtained using hardware accelerators like GPU, TPU, and FPGA. The GPU and TPU are mainly used for the parallel implementation of the algorithms and processing them parallelly. These processors can be made energy efficient by adding high precision arithmetic units and more programmable units. Vision-based applications' processing speed is a major determining factor for the suitable selection of acceleration methods. The choice of the acceleration method and hardware is challenging since several accelerators are available, requiring deep knowledge and understanding of the algorithms. The GPU architectures are highly suitable for image processing algorithms. The use of GPU in computer vision is now increasing due to the ease of programming and its architecture. GPU faces many challenges like high power consumption, which is mainly effective for large datasets and the slow data transfer between GPU and CPU. For effective utilization of GPU and TPU, a clear idea of working the computer vision algorithms in them is needed. Similarly, the memory management of the HPC has become a significant concern. This chapter explains a detailed explanation of the computer vision algorithms on HPC systems and how acceleration can be achieved.

IMAGE PROCESSING AND COMPUTER VISION

Image processing research has resulted in developing several sophisticated operators that provide visually arresting results. In the recent decade, techniques have been developed that may drastically improve detail in a picture by adopting the style of a master photographer (Aubry et al., 2014), smooth the image for the goal of simplification (Xu et al., 2012; Zhang et al., 2014) and reduce the effects of scattering. Existing operators have a wide range of computing requirements and run times. Certain operators, such as filtering methods, have benefited from almost a decade of focused effort to accelerate their growth. One well-known technique for speeding up a wide variety of image analysis operators is to down sample the picture, run the operator at a low resolution, and then up a sample (J. Chen et al., 2016). This strategy has two significant downsides. The original operators must be assessed on a lower-resolution version of the picture. This may be a considerable disadvantage since certain operators are sluggish, and present implementations are incapable of running at interactive rates, even at different resolutions.