Politecnico di Torino – Department of Electronics and Telecommunications

Università di Trieste - Department of Engineering and Architecture

Joint Thesis Topics

The proposed thesis works are part of a cooperation between Università di Trieste (Prof. Gianni Ramponi) and Politecnico di Torino (Prof. Guido Masera and Maurizio Martina). Students have the option to spend part of the time in Trieste.

1. Hardware acceleration of Deep Neural Networks for face recognition

   Face recognition is currently being proposed in a growing range of applications, including payments (for identity verification in on-line commerce), access and security, healthcare, criminal identification and advertising. The introduction of Deep Neural Networks (DNN) has dramatically improved the quality of face recognition systems [1] , and opened the way towards new and complex fields of application, such as for example the use of face verification in unconstrained environments from mobile sources.

   The quality vs. complexity balance of different DNN's architectures in the task of face (detection and) recognition should be studied, also taking into account the application context. The requirements for a face recognition tool to be used in consumer electronics or in professional applications or for security are indeed very different. For example, Capsule Neural Networks (CapsNet) [2] (that process vectors bringing information on both probability and pose for a given feature), recently provided good results might be used.

   However, the actual adoption of DNNs (and even more CapsNet) requires dedicated hardware implementations, to achieve the needed levels of processing speed and to limit the amount of dissipated energy. The proposed thesis work will address this domain of investigation, by first developing a DNN-based face recognition model and then designing a dedicated hardware accelerator for a specific application of face recognition.

2. Deep learning based image processing

   An important element in several image and video processing applications is the visibility predictor, a tool able to evaluate the probability that an observer will notice the difference between the test and reference images [3] . In lossy image compression, the visibility predictor tunes the compression rate based on the comparison between the original and the compressed image, with the purpose of making the compression artifacts unnoticeable to the observer. Visual predictors are also used in computer graphics, to support adaptive rendering: in this case, the perceived image quality is optimized by focusing the processing on the most important regions of the image.

   Most of the known visibility predictors (e.g. the HDR-VDP, a visual model able to deal with images having large variations in the luminance) are implemented using traditional approaches, based on the analytical modeling of the psychophysical behavior of the human perception. The proposed thesis work aims at studying and developing an improved visibility predictor based on deep learning techniques.

References

[1] J. Bhattacharya, S. Marsi, S. Carrato, H. Frey and G. Ramponi, "Feeding a DNN for face verification in video data acquired by a visually impaired user," 2017 40th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), Opatija, 2017, pp. 1084-1089. doi: 10.23919/MIPRO.2017.7973585

[2] Tan, Kendrick (November 10, 2017). "Capsule Networks Explained", https://kndrck.co/posts/capsule_networks_explained/

[3] Mantiuk, R. K., and Ramponi, G. (2018) Age-dependent prediction of visible differences in displayed images. Jnl Soc Info Display, 26: 4–13. doi: 10.1002/jsid.623

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