MASTER THESIS

Machine Learning on Embedded Systems

Monocular Depth Estimation using Self/Semi-Supervised Learning

The Christian Doppler Laboratory Embedded Machine Learning does research on Deep Neural Networks (DNN) in resource-constrained embedded devices. It studies how energy consumption and resource usage can be minimized while keeping high accuracy. The solution space is characterized by architecture parameters, DNN optimization and transformations, implementation platform configurations, and mapping options. This design space is huge, poorly understood, and it is rapidly evolving.

Monocular depth estimation is applied to many applications (such as robotics, autonomous driving, and 3D modeling) to estimate the depth of each pixel for an input image. While earlier attempts were based on probabilistic models, there has been a shift to Convolutional Neural Network (CNN)-based approaches due to the significant increase in performance. A CNN for monocular depth estimation generally consists of two parts: (1) A feature extractor, also called an encoder, which compresses the original image and provides a low dimensional representation of the original image. (2) A decoder, which converts the compressed representation back into pixel-level disparity values. However, a wide range of applications for monocular depth estimation is in the mobile domain, leading to the use of embedded systems platforms, which in turn have limited computational resources. Furthermore, such a monocular depth estimation possesses scale ambiguity, which could be corrected during training by providing some prior information, e.g., velocity and radar measurements.

This thesis project aims to extend an existing monocular depth estimation CNN and integrate prior information to predict scale-aware depth estimation. This developed CNN-based solution shall be deployable and executable in real-time on an embedded systems platform.

This thesis project consists of the following steps:

- Select one of the start-of-the-art datasets, e.g., RailSem19.
- Select one of the state-of-the-art depth estimation CNNs, e.g., PacketNet.
- Integrate velocity/radar for semi-supervised learning.
- Optimize/compress the CNN model to deploy it on an embedded systems platform, e.g., Nvidia Jetson.
- Train/test the monocular depth estimation.

This thesis offers you an excellent opportunity to get into the hot topic of deep learning. It allows you to become an expert in configuring neural networks. Moreover, you acquire critical skills in using neural networks in embedded systems and resource constraints.

Some of the M.Sc. projects may be combined with a part-time position.

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