Peyman Mohajerin Esfahani
P.MohajerinEsfahani@tudelft.nl

Advanced Machine Learning Techniques for Image Feature Extraction and Classification in Lithography Systems

Mohammad Hajiahmadi
M.Hajiahmadi@tudelft.nl

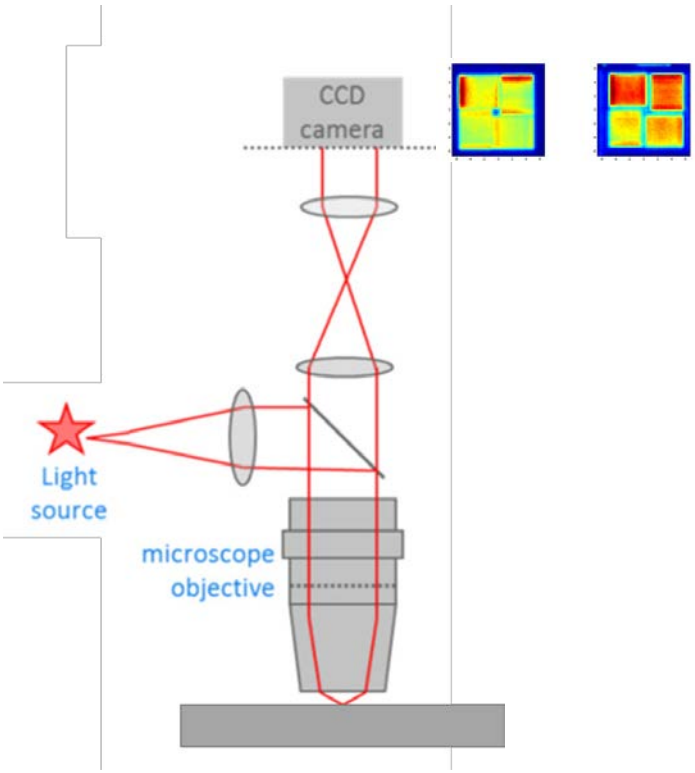

Figure 1 Yieldstar sensor scheme.

Background information

Image processing, Machine learning techniques including classification and clustering methods such as support vector machines (SVM), gaussian mixture models (GMM), K-means, deep learning schemes such as convolutional neural networks (CNN)

Your assignment

Train a deep convolutional neural network to automatically extract features from a metrology image dataset, and design an image classifier that categorizes images based on the extracted features

Your background

Optimization and Machine Learning, System Identification, Signal Processing, Applied mathematics/physics/electrical engineering

Introduction

The photolithography machines manufactured by ASML are used in the production of computer chips. In these machines, patterns are optically imaged on a silicon wafer that is covered with a film of light-sensitive material. This procedure is repeated dozens of times on a single wafer.

Chips continue to get faster and smaller -- and more difficult to be manufactured. ASML's Holistic Lithography products help chip makers to squeeze every bit of performance out of their lithography equipment. An important part of the Holistic Lithography package is YieldStar, a metrology tool that gathers data to maximize the performance of a lithography system -- which in turn allows manufacturers to produce more advanced chips. YieldStar works fast and with high accuracy because it uses an advanced technology called scatterometry.

YieldStar aims to evaluate the overlay, i.e., the drift between two consecutive steps of lithography, by taking images from special printed targets using the scattometry concept (See Figure). The signal extraction module in YieldStar aims to extract the overlay from the acquired images. Due to the optical properties of the underneath layers the acquired images are suffering from different optical defects and inherits various features.

Assignment

As mentioned above, due to the various optical properties of underlying layers of overlay targets, the acquired images have different properties. The goal of this study is to build up a neural network inference machine in order to extract discriminative features from images acquired by YieldStar. In this project, instead of manually extract image features, we would like to feed the images directly into a deep neural network that learns the features automatically. As a starting point, we can select a pre-trained CNN architecture like AlexNet, discard the classifier layer and retrain the feature extraction layers by supplying our images. The first layers of CNN capture basic image features, such as edges, etc., (activating features is done by convolving images with specific filters) we can then gradually include more layers to extract more features. If this step was not successful, we can build up a multi-layer CNN from scratch specific for our case.

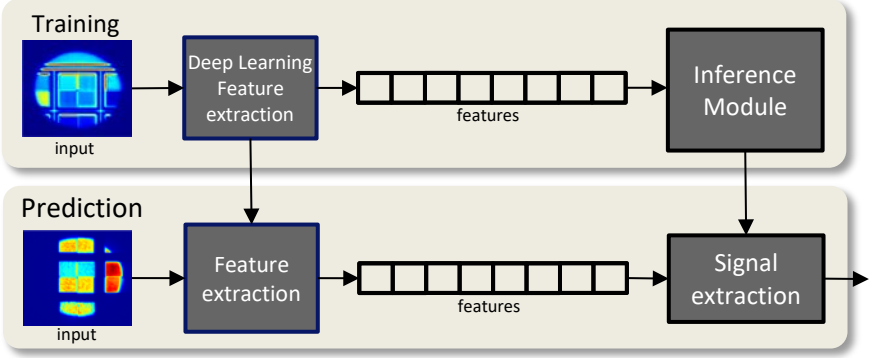

Figure 2 automatic feature extraction scheme.

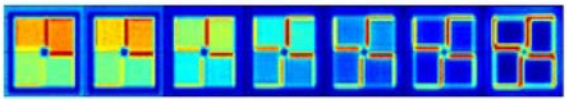

Figure 3 Training dataset