Summary

The introduction and recent advancements of computational photography have revolutionized the imaging industry. Computational photography is a combination of imaging techniques at the intersection of various fields such as optics, computer vision, and computer graphics. These methods enhance the capabilities of traditional digital photography by applying computational techniques both during and after the capturing process. This thesis targets two major subjects in this field: **High Dynamic Range** (HDR) image reconstruction and **Light Field** (LF) compressive capturing, compression, and real-time rendering.

The first part of the thesis focuses on the HDR images that concurrently contain detailed information from the very dark shadows to the brightest areas in the scenes. One of the main contributions presented in this thesis is the development of a unified reconstruction algorithm for spatially variant exposures in a single image. This method is based on a camera noise model, and it simultaneously resamples, reconstructs, denoises, and demosaics the image while extending its dynamic range. Furthermore, the HDR reconstruction algorithm is extended to adapt to the local features of the image, as well as the noise statistics, to preserve the high-frequency edges during reconstruction.

In the second part of this thesis, the research focus shifts to the acquisition, encoding, reconstruction, and rendering of light field images and videos in a real-time setting. Unlike traditional integral photography, a light field captures the information of the dynamic environment from all angles, all points in space, and all spectral wavelength and time. This thesis employs sparse representation to provide an end-to-end solution to the problem of encoding, real-time reconstruction, and rendering of high dimensional light field video data sets. These solutions are applied on various types of data sets, such as light fields captured with multi-camera systems or hand-held cameras equipped with micro-lens arrays, and spherical light fields. Finally, sparse representation of light fields was utilized for developing a single sensor light field video camera equipped with a color-coded mask. A new compressive sensing model is presented that is suitable for dynamic scenes with temporal coherency and is capable of reconstructing high-resolution light field videos.