IMAGE PROCESSING UNDER GRAY VALUE UNCERTAINTY

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In computer vision applications, e.g. medical or scientific image data analysis, as well as in industrial scenarios, images are used as input measurement data. Of course it is good scientific practice that proper measurements must be equipped with error estimates. Thus, for many applications not only the measured values, but also their errors should be taken into account for further processing. This error propagation must be done for every processing step, such that the final result comes with a reliable precision estimate. In the talk we discuss an approach that yields reliable precision estimates for PDE based image processing under measurement errors, and it allows to quantify the robustness of the image processing result in noisy images and under gray value uncertainty. We identify the image data with random fields in order to model images and image sequences which carry uncertainty in their gray values. Thus, the noisy behaviors of gray values is modeled as stochastic processes which are approximated with the method of generalized polynomial chaos (Wiener-Askey-Chaos). The Wiener-Askey polynomial chaos is combined with a standard spatial approximation based upon piecewise multi-linear finite elements. We discuss the basic building blocks needed for computer vision and image processing in this stochastic setting. Finally, we show applications of our framework to derive stochastic analogs of well known PDEs for denoising, segmentation and optical flow extraction.