Predicting and controlling the appearance of a material is of immense interest in different fields, from manufacturing to product visualization. Predictive rendering models are useful for designing and prototyping, and they can also be used for quality control in manufacturing. However, when an object is manufactured it often presents some deviations in appearance compared to the ideal model due to the manufacturing process. And it is not trivial to include these deviations in the predictive model. Being able to model the reflectance properties of a surface and then reproduce them on a physical object is also a hot topic in manufacturing. Unfortunately, this is often done by adding post-processing steps to the production pipeline and therefore adding extra costs and time to an already slow and expensive process. In this thesis, we address these challenges by proposing new techniques for appearance printing and predictive rendering. Specifically, our appearance printing techniques for 3D printing do not require any post-processing and can be directly implemented. And our predictive rendering models are derived for specific manufacturing techniques.

Our goal is to exploit the synergy between Computer Graphics and 3D Printing to build new predictive models and appearance printing techniques. More specifically, we contribute with two appearance printing techniques: the first one takes into account the limitations of color 3D printing and builds a predictive rendering model to overcome such barriers. The second technique, instead, makes use of grayscale images to obtain sub-voxel resolution in DLP 3D printing to print arbitrary micro-structure. On top of these, we propose an analytical model to predict the appearance and contrast of engineered surfaces and to perform quality inspection of such surfaces. We also describe a simple approach to quantitatively compare rendered images with photographs of 3D printed objects that can be used to build predictive rendering models. With these contributions, we demonstrate the advantages of combining techniques from different fields, such as Computer Graphics and 3D Printing, to obtain better predictive models and appearance printing methods.

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