Measuring Reflective Properties of Surfaces Using OPTE-F3K

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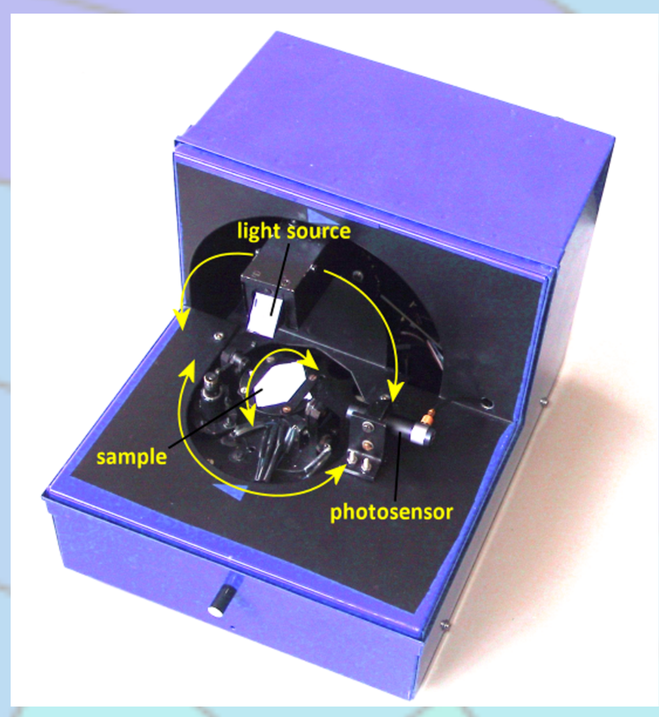
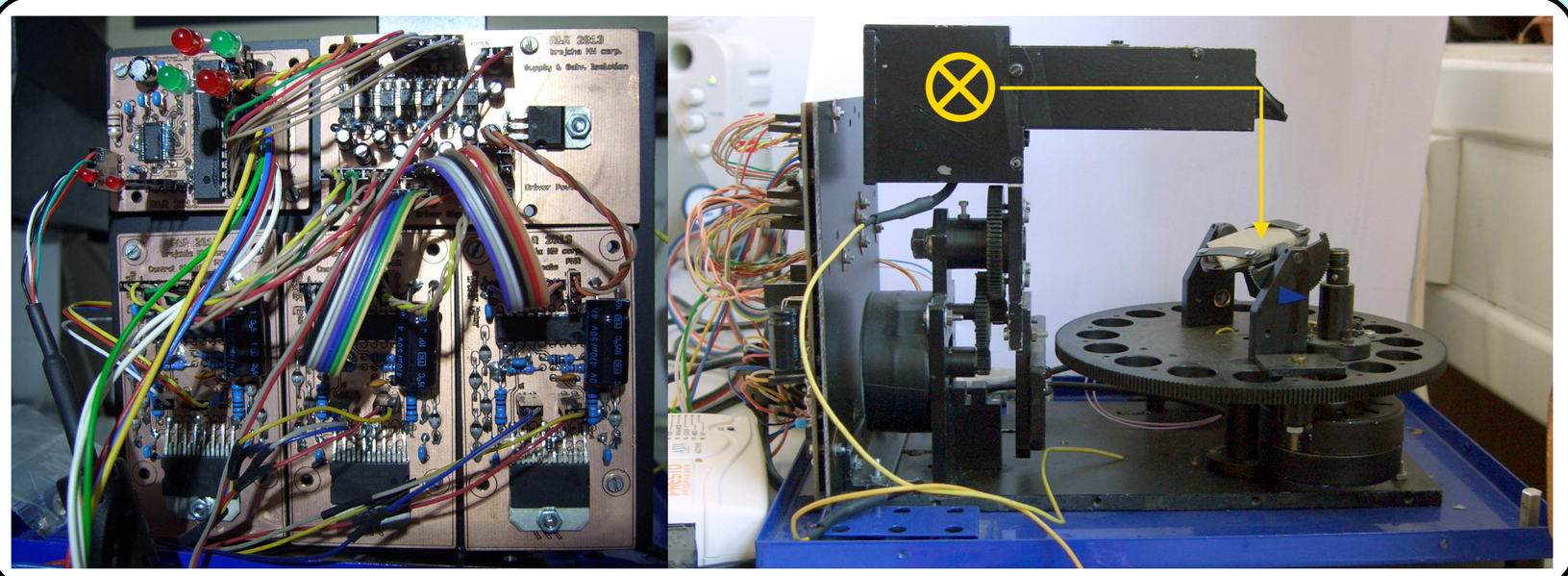
ABSTRACT

Modern computer lighting design programs use for simplification reasons during calculations surfaces of purely diffuse reflection. For more accurate calculations it is necessary to use real reflective properties of surfaces that can be measured by a reflectophotometer. The reflectophotometer OPTE-F3K of the Department of Electrical Power Engineering, FEE CTU in Prague, allows to measure reflective properties of surface samples 2 by 2 cm. ReflectoSoft, an application designed especially for this reflectophotometer, enables measurements of BRDF in the Klems system of patches. The measured values can then be stored into an XML file containing the BRDF matrix of 145 × 145 elements. The results can be viewed using the software BSDFViewer. The goal of this paper is to present the current state of the renovation of OPTE-F3K, which enables the application of measured reflective properties of real materials to ray tracing algorithms.

INTRODUCTION

The human receives 80 to 90 % of information about the surroundings through his eyes. How objects affect luminous flux constitutes what we call the object's appearance. Most light-active surfaces around us are secondary light sources. Light emitted from primary light sources (sun, artificial light sources) is reflected from surfaces (secondary light sources), changing its properties and transmitting information about the nature of the surface. The photometric properties of material surfaces are especially important in the design and construction of light-active surfaces in terms of reflected light flux spatial distribution, e.g. to reduce brightness in certain directions while maintaining maximum efficiency of the arrangement.



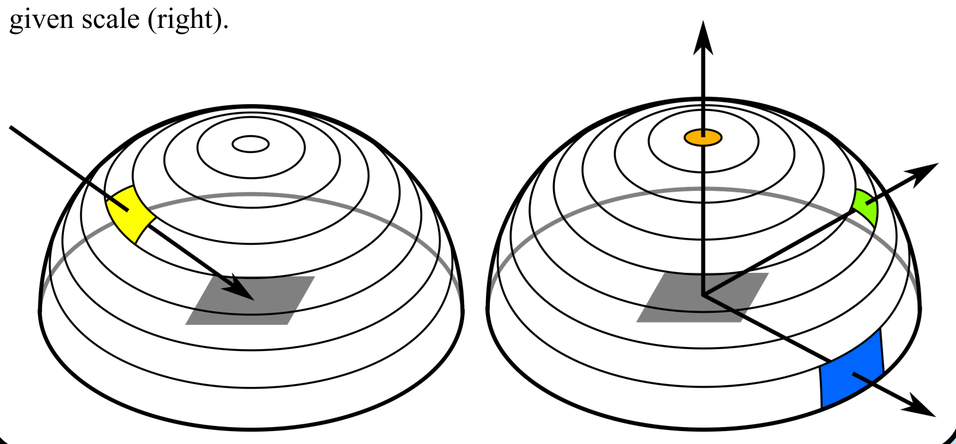


Reflectophotometer OPTE-F3K

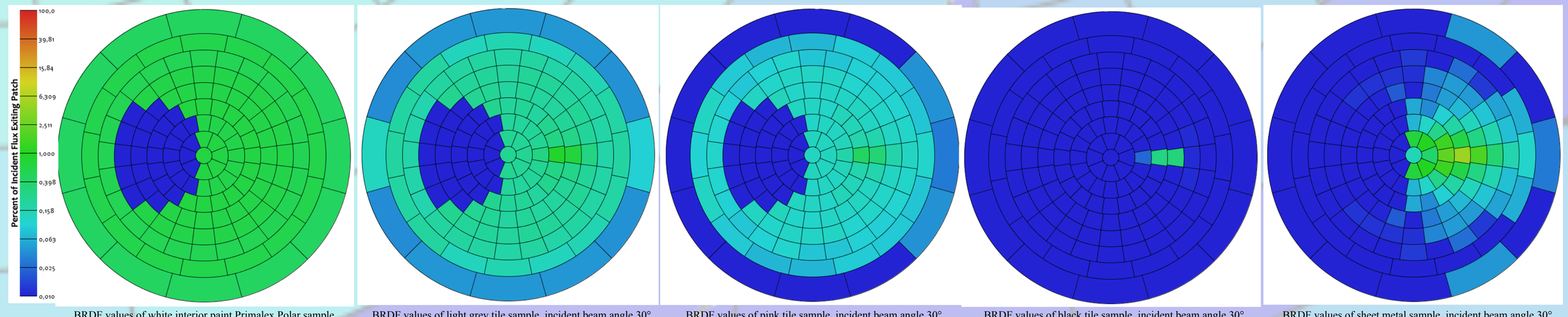
Measuring reflective properties of material surfaces can be carried out using the reflectophotometer OPTE-F3K of the Department of Electrical Power Engineering. This device requires a Bruel & Kjaer Type 1100 luminance contrast meter with an external optical sensor (measuring cell UA 601, acceptance angle ± 1,1°) to measure reflective properties of material surfaces. The sensor is fixed in the reflectophotometer, its output connected to the contrast meter Fig. 1. Reflectophotometer OPTE-F3K and the analog luminance voltage output fed back to the reflectophotometer digitizing this value.

Light source angle and sample tilt and rotation angles are chosen to conform to Klems patches in the course of automated measurements. By using Klems patches it is possible to export the measured data into BSDFViewer XML format used by the BSDFViewer utility.
Outputs of various measured materials can be found bellow as displayed by BSDFViewer. The white interior paint Primalex Polar sample is a near diffuse reflecting surface, i.e. luminances, for a given angle of light incidence, are constant for all reflected directions. The outputs of measured tile samples are showing specular reflections. The light grey tile reflects the most light flux of the tile samples. The black tile sample reflects only the specular light flux. The sheet metal sample output shows a specular reflection with a wider spread.

BSDFViewer output: after a light incidence angle is chosen (left), percent of reflected light flux into Klems segments is displayed as colors according to a given scale (right).



BSDFViewer application outputs of measured sample data dispalying reflections into the top hemisphere for light incidence angle 30° (angle between the light ray and sample surface normal):



BRDF values of white interior paint Primalex Polar sample, incident beam angle 30°

BRDF values of light grey tile sample, incident beam angle 30°

BRDF values of pink tile sample, incident beam angle 30°

BRDF values of black tile sample, incident beam angle 30°

BRDF values of sheet metal sample, incident beam angle 30°

CONCLUSIONS

By using the upgraded reflectophotometer OPTE-F3K, application ReflectoSoft and the utility BSDFViewer, it is possible to measure and view reflective properties of samples of sizes 2 by 2 cm. Optically isotropic materials can only be measured due to the limitations of possible angle combinations of the light source and sample tilt and rotation. OPTE-F3K is only experimental, uncertainties have not been evaluated. Themeasuring process takes about 3 hours without the need ofhuman interaction during that period. This time is affectedinsignificantly by the performance of the computerReflectoSoft is running on.For further utilization of the measured data it is necessaryto minimize the size of the blind spot and/or to implementinterpolation to calculate values of the skipped patches. Theacquired BRDF data can than be used by ray tracing algorithmsto calculate photometric values in a system of nondiffusesurfaces taking multiple reflections into account.