Abstract to be submitted to the IEA SolarPACES Symposium

Solar Thermal 2000, Australia

Improving the Calibration Accuracy of CCD Camera Systems Using Band Filters

J. Kaluza, A. Neumann
jens.kaluza@dlr.de
Tel: +49 2203 601 2482
Fax: +49 2203 66900
Deutsches Zentrum für Luft- und Raumfahrt
D-51170 Köln

ABSTRACT

Flux mapping systems using CCD cameras are frequently used for testing, analysis and control of solar concentrating systems. Determining absolute values of irradiance data like flux density or total power requires a calibration of the CCD camera system because cameras primarily deliver relative intensities. Usually the spectral sensitivity of a CCD-detector differs from the spectral range of the solar radiation that has to be measured.
The calibration of a flux mapping system is expected to suffer from this effect. We show theoretical evaluations and experimental work dealing with this problem.

Model Simulations
In a former work /1/ we started with a computer model to estimate the CCD signal that is caused by a specific spectral distribution falling onto the detector. We found an erratic calibration leading to an underestimation of 23% of the power measured with a CCD camera for low sun positions if the system has been calibrated at high sun positions.
Beside the solar irradiance the camera signal is determined by the transmission properties of the optics and the sensitivity of the CCD sensor. The only thing that can be influenced easily is the transmission of the imaging optics. The computer simulations showed that the quality of the calibration may be improved replacing the grey filters with bandpass filters.

Experimental Work
In an experimental set-up we tried to measure this effect. Two cameras and a pyrheliometer were mounted on a solar tracker facing the sun all over the day. To attenuate the radiation the conventional camera has been equipped with photo quality grey filters while we use several bandpass filters with the test camera.

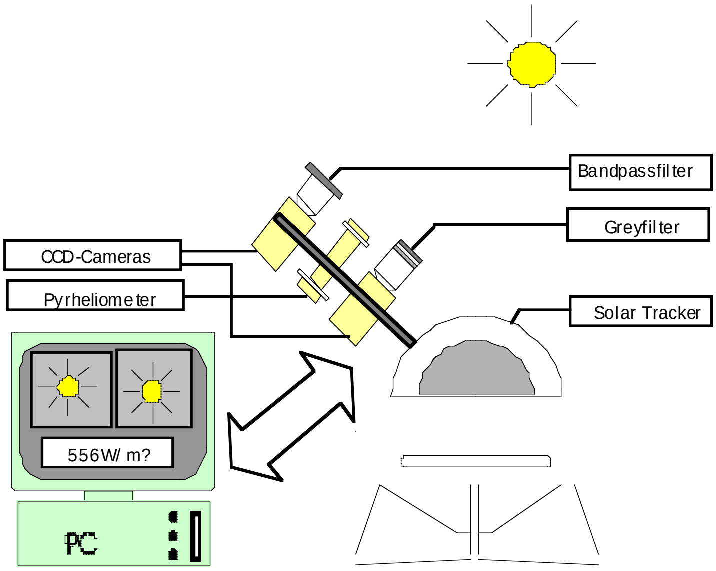

Fig. 1: Experimental set-up: Two cameras with different filters and a pyrheliometer follow the sun all over the day. The camera images are processed and compared to the pyrheliometer signal taken at the same time. The correlation of the camera signal to the pyrheliometer signal is observed under different air mass.

The images taken by the cameras were processed determining the mean signal value in the area of the sun ('camera signal'). Both camera signals and the pyrheliometer signal were recorded all over the day with changing air mass and irradiance spectra. A linear correlation between the pyrheliometer and the camera signal characterizes a suitable measurement system.

/ 1 / Kaluza, J., and A. Neumann: Measurement of Solar Radiation With CCD-Cameras: Influence of the Spectral Characteristic. Proceedings of the International Solar Energy Conference Solar Engineering 1998, ASME Albuquerque, ISBN No. 0-7918-1856-X, p. 425-428, 1998.