Calibrated LCD stimulus presentation in fMRI

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Standard stimulus presentation on an LCD or CRT screen shows drastic distortions in luminance and contrast across the screen and across grey levels. Common gamma-correction does not address screen inhomogeneity. Moreover, common calibration techniques are prohibitive in the MRI scanner.

MR-scanner

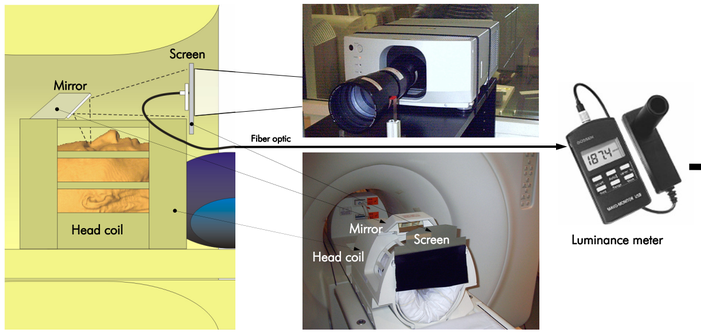


Fig. 2. Visual stimulation setup for fMRI in Magdeburg.

By the technique described, images displayed to a subject in functional MRI can be specified with high precision by an *image matrix of target luminances* rather than by local grey value.

With the aid of a fibre optic, we measured for our monitor screen luminances for the full space of *screen position* and image *grey values*.

Messy reality

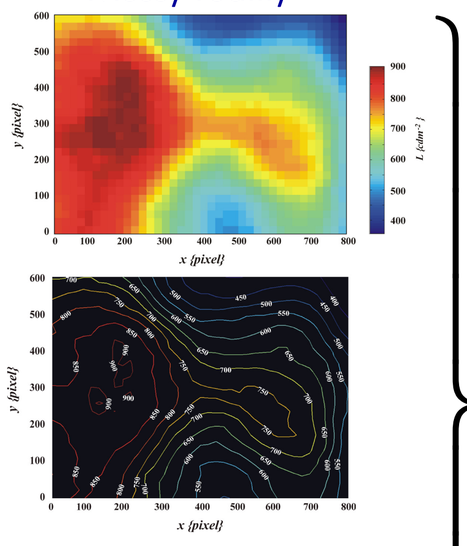
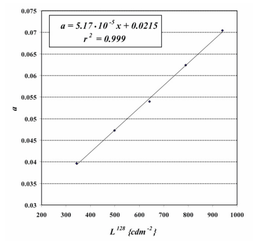


Fig. 2. Uncalibrated luminance distribution on the matte screen visible to the subject, for constant grey value of 128. a) Colour coded; b) isoluminance contours.

Fig. 4. Interpolation of the second-order term (a) to arrive at a unified model for the gamma curve. (Note the equidistant choice of *L128* values.)

Solution



Success

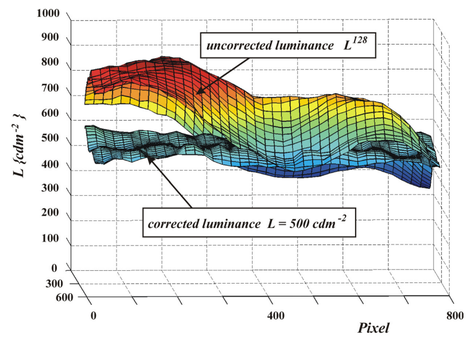


Fig. 5. Efficiency of the compensation. Top and bottom surface show the uncalibrated luminance distribution at grey value 128, and the calibrated distribution at 500 cd/m2, respectively.

Gamma curves

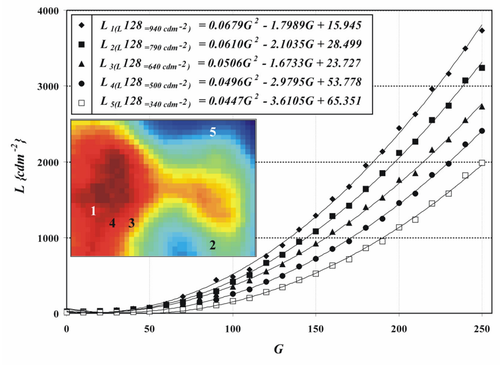


Fig. 3. Gamma curve at five representative screen positions. The positions are indicated in the inset.

On that basis we developed a compensation technique that involves both luminance homogenisation and position-dependent gamma correction.

For fine resolution across the screen, the technique uses *interpolation of gamma-curve coefficients* rather than the luminance interpolation used elsewhere and thus achieves high precision with fewer parameters. Implemented in MatLabTM the calibration can be applied to both images and movies.

Acknowledgements

Deutsche Forschungsgemeinschaft
grant STR 354/3-1 to HS

Thank you for the many hours of measurement!:
Dorothe Poggel
Katrin Schulze
Tino Zähle
Ulrike Bunzenthal
Iris Müller

Long term stability

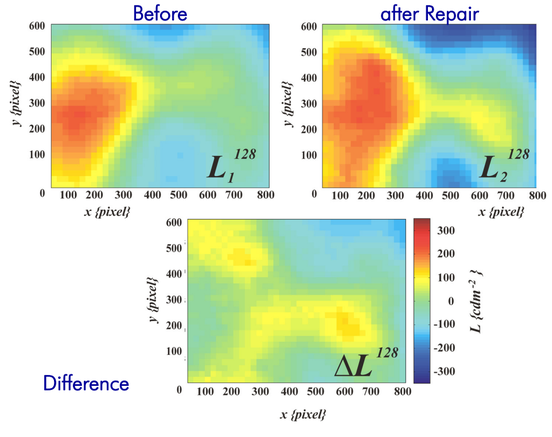


Fig. 7. Long-term stability of the projector's luminance distribution. (a) and (b) show the uncalibrated luminance distribution on the matte screen once and 1 ½ years later, after a maintenance return a bulb replacement + removing the bulb bearing cage). (c) shows the pixelwise difference of the two distributions after equalizing to same mean luminance.

More success