



AUTOMATIC CALIBRATION OF PROJECTOR CLUSTERS

Many projection scenarios – like trade fair booths with curving walls showing digital videos, virtual stage sets and 3D or dome cinemas – can only be realized with a group of projections formed in a cluster. The particular challenge in such scenarios is creating an easy method of calibrating the images of the individual projectors so that they join together seamlessly to give one single uniform main picture. Within its player technology Fraunhofer FIRST has developed software that automatically calibrates projector cluster images to fit any shape or size of screen and that doesn't just synchronize individual frames but also offsets differences in color and brightness.

Automatic Calibration

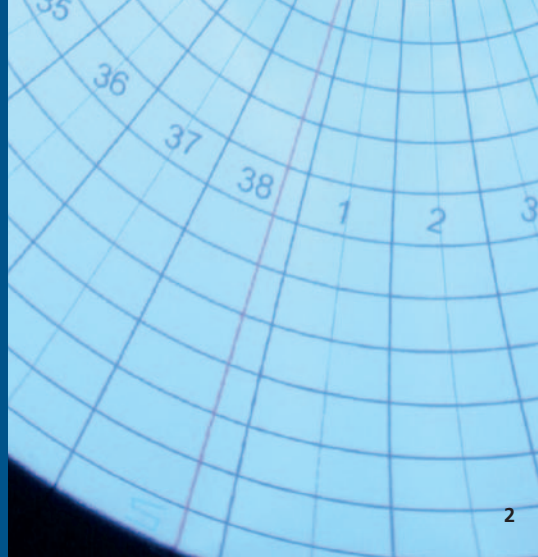
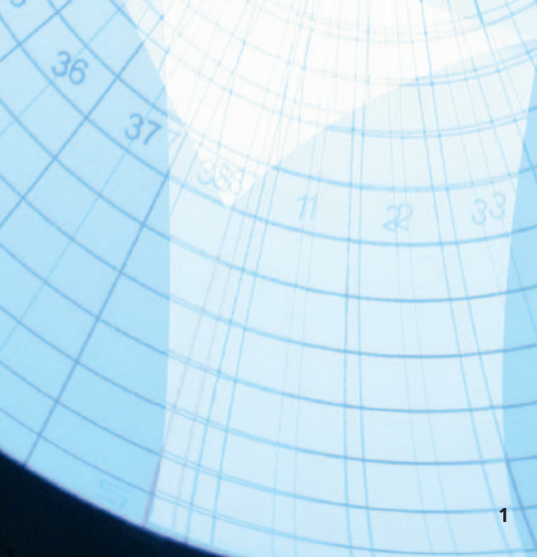
There are many good reasons to use projector clusters: 3D stereo projections need two superimposed frames, one for each eye, while superimposed frames can also

enhance the projection's luminosity. When screening on a large-scale surface, distributing the overall image across a cluster of projectors is also a good way of increasing image resolution. And use of several projectors for screening on a curved surface also makes sense when part of the surface hides another part, or when any kind of object stands between projector and screen. The difficulty in all these scenarios is that all the projectors need to be rapidly coordinated with one another to give a uniform picture. Manual methods are far too time-consuming and inflexible. Either the projectors are adjusted mechanically which means that a precise pixel setting is no longer possible, or the projector images are electronically distorted to fit in with one another. Yet this requires precise measurement of the projector's position relative to the screen and of the size of the screen itself. And it also means that no later changes can be made without resetting the parameters and recalculating

the distortion ratio of the picture. Against this background, Fraunhofer FIRST has developed an automatic calibration method distinguished by its high flexibility and speed which enables extremely rapid and precise calibration of a roughly set cluster of projectors.

Geometry

Fraunhofer FIRST offers an automatic calibration method for projection on any shape or size of surface which automatically calibrates projection geometry, color and brightness. Geometric calibration first involves creating a virtual model of the screening surface on the computer. Users feed the calibration software with data about the geometry of the screen, the number and position of the projectors and the dimensions of the areas where projector images overlap. Then test pictures shot by one or more digital cameras are



1 The projected image before automatic calibration...
2 ...and after. Differences in color, brightness and geometry are adjusted, a uniform overall image is generated.

projected onto the screening surface. The software uses image processing algorithms for millimeter-precise detection of projector image alignment to the screen. The individual images are then distorted and configured to the screen to render one single seamless high resolution picture. Any overlap of part images is automatically corrected to give seamless joins. And should the position – and thus the projection – of a projector shift, the calibration process simply starts anew and the projection is automatically readjusted to fit in with the overall picture.

Color

Apart from calibrating the geometry of projector cluster images, the Fraunhofer FIRST software can also automatically adjust the color of the projection. Such adjustment is necessary when each of the various projectors in a cluster has its own color tints, for instance, or when wearing effects mean that one projector image is less bright than the others. As with geometric calibration, the luminosity or pixel brightness of the image is measured by a camera and automatically corrected by the software. The chrominance or color hue and saturation of the image is measured by a spectrometer and automatically calibrated.

Hardware requirements

Automatic calibration can be simply done using only standard hardware like a conventional PC with a standard version

of Windows. It supports every kind of customary projector; the number of projectors the software calibrates only depends on the specific requirements for the particular screening scenario in terms of brightness, resolution and visual quality. The length of time the calibration process takes depends on the complexity of the set up but is never more than a few minutes: for instance, calibration of the six projectors used in Fraunhofer FIRST's test dome takes about five minutes. Projections on screens and domes have a resolution of up to 8k x 8k.

Application areas

Automatic calibration is ideal for all types of situations where digital projectors are used – from cinemas, planetariums, and amusement parks to multimedia events, simulators and product presentation systems. Automatic calibration can be used embedded in Fraunhofer FIRST's player technology, or as licensed software it can be integrated into an existing visualization system.

Media Player for Active Stereo 3D

FIRST's Media Player was developed in close cooperation with Carl Zeiss. It can now be applied to both passive and active stereo 3D projections. For active stereo 3D projections, only half of the projectors compared to passive stereo setups are needed. This can mean a saving of costs for users. The image refresh rate of the projection amounts up to 120 Hz.

At a glance

- Projection for any shape or size of surface
- Versatile combinations for any number of projectors
- Image restitution and blending in real-time
- Calibrating process takes only a few minutes
- Resolution of up to 8k x 8k
- Calibration of both active and passive stereo 3D projections

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