On Pointing a Dynamic Projector System Using the Click of a Mouse

Michael Hornacek and Hans Küffner-McCauley

TU Vienna (IMW-CPS)

December 2021

# Motivation

A particularly cumbersome aspect of working with the dynamic projector system setup at the Pilotfabrik of TU Vienna is the manner in which the pointing of the steerable mirror requires manual steering in the *X*- and *Y*- directions of the steerable mirror system’s coordinate system. A substantially more intuitive way of steering the mirror would be by simply clicking on the desired location in an image of the scene.

The **objective** we set for ourselves is to enable **pointing the steerable mirror system** using the **click of a mouse** on an image acquired by our ‘downward-facing’ camera. Moreover, we intend for this functionality to extend our prior work on spatial AR for planar scenes: we would be able to compute plane-induced homographies not only for pre-determined discrete target locations, but for **all conceivable target locations** across a chosen section of the floorspace.

# Approach

Our prior spatial AR approach for planar scenes derived, for each target location, (i) a **local scene plane**, (ii) the pose of the projector relative to that local plane, and (iii) a corresponding plane-induced homography. The extension we propose here is to enable computing a plane-induced homography for any conceivable target location across a chosen section of the floorspace. This calls for the recovery of a **single scene plane** for the entirety of a chosen section of the floorspace, since we wish to be able to interpolate arbitrary target locations across this section.

## Scene Plane and Calibration Target Location Projector Pose Recovery

For each calibration target location, (i) project pattern to floorspace, (ii) detect corner points in both views of the ‘downwards-facing’ stereo camera, (iii) triangulate corresponding corners. Next, given all triangulated corners, taken jointly across the calibration target locations, (iv) carry out a RANSAC plane fit. Finally, (v) calibrate the projector as in the former approach, but using the single scene plane rather than a scene plane per calibration target location; the output is a single projector calibration matrix (intrinsics) and a projector pose per calibration target location (extrinsics).

## Image-to-Angle Mapping

We need to have recorded the **angles associated with the steerable mirror** for each calibration target location. For each calibration target location, (i) intersect the corresponding **look direction** (derived from its pose) with the scene plane and project to the left view. Next, (ii) compute a **Delaunay triangulation[[1]](#footnote-1)** of those intersections, in the image plane of the left view. Finally, (iii) carry out irregular interpolation (via **barycentric coordinates**[[2]](#footnote-2)) of the angles across the triangulation, with respect to the recorded angles associated with the triangulation’s vertices.

## Angle-to-Projector Pose Mapping

Click on pixel, move the mirror accordingly, project the calibration pattern, detect the pattern in the left view and obtain 3D points by intersecting back-projections of the detections with the scene plane, use resulting 2D-3D correspondences (2D are the corresponding locations in the image given as input to the projector) to calculate pose of the projector.

You now have pose of projector for clicked location and the scene plane -> everything you need to compute plane-induced homography.

1. <https://en.wikipedia.org/wiki/Delaunay_triangulation> [↑](#footnote-ref-1)
2. <https://en.wikipedia.org/wiki/Barycentric_coordinate_system> (cf. especially the Section ‘Conversion between barycentric and Cartesian coordinates’) [↑](#footnote-ref-2)