Projector DAC Correction with LOESS

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*Abstract*—In order to increase the accuracy of the inverse projector model, a LOESS curve fit is employed in the current implementation. However, in principle any curve fit method can be used to correct the DACS.

# Introduction

After projector calibration has been done to solve for constants that give better accuracy via the inverse DAC calculation curve fitting is employed to correct the DAC values further. For each galvanometer axis, a curve fit is employed.

Let:

be the x-axis DAC value via inverse calculation

be the x-axis DAC value after correction

be the y-axis DAC value via inverse calculation

be the y-axis DAC value after correction

|  |  |  |
| --- | --- | --- |
|  |  | () |
|  |  | (2) |

The goal is to fit the functions and using the LOESS fit in 2 dimensions.

It can be easier to think of and as the error between the calculated values versus the measured values.

Let:

be the measured error in the x-axis

be the measured x-axis DAC command

be the measured error in the y-axis

be the measured y-axis DAC command

|  |  |  |
| --- | --- | --- |
|  |  | (3) |
|  |  | (4) |

The 2D curve fit is performed on with respect to for a calibrated projector.

# Procedure

In order to perform this correction, calibration data must be present. The basic steps are listed:

1. Using known target positions, find corresponding DAC angles
2. Calibrate the projector parameters
3. Perform and inverse calculation to calculate for each target
4. Calculate the difference between the measured and inverted values using Eq. (3) and Eq. (4)
5. Curve fit with respect to

# DAC Correction

After the curve fits have been completed correction is applied to the DAC via addition using Eq. (1) and Eq. (2) after inversion. This is a straight forward calculation however, the transform solving correction is affected in a less straight forward manner.

The underlying problem is that first, the position and rotation of the projector is unknown relative to the targets, therefore an inversion to calculate DAC pairs for each position is not possible with good accuracy.

If we simply use the measured DAC pairs the corresponding output rays will be incorrect since curve fit correction is applied to the DAC value directly. The problem is illustrated in a hypothetical procedure following:

1. Suppose the point is known in projector space
2. An inverse of to obtain is calculated
3. Curve fit correction to obtain allows more accurate projection to point in the forward sense.
4. Use in the forward model to calculate the ray
   1. In the model, the pair generates the perfect ray through
   2. The pair will generate a ray that does not pass through in general, which will add error to the calculated transform

In order to use the best rays to solve the transform, must be recovered from . This means that rays must be generated by adjusting the DACs by subtracting the curve fit functions from the measured values.

Therefore, we estimate the model DACs by using the following equations during transform estimation.

|  |  |  |
| --- | --- | --- |
|  |  | (5) |
|  |  | (6) |

# LOESS Parameters

During trials using LOESS style curve fits, there are two main parameters. Which are the polynomial and the span. It was found that a quadratic polynomial combined with a span of 12% gave the best results.