

8.0 Conclusions and Recommendations

This research provides a reasonable solution to the problem of geometrically trimming surfaces by using a curvature-based optimization technique to define a new B-spline surface patch approximating the untrimmed region of a given surface. At the outset, the objectives of this thesis were defined as:

- Trim surfaces and provide a mathematical identity to the trimmed patch.
- Optimize the data point set used to describe the trimmed patch by filtering only those points, which meet certain curvature criterion and use those points for describing the trimmed patch.
- Develop a tool kit for visually displaying the results.
- Perform an error analysis on the resulting surfaces.

As seen from the visual analysis, the procedure is able to successfully generate trimmed patches as individual surface entities that faithfully adhere to the boundary specified by the trimming criterion. Also, the procedure provides with a good replication of the geometrical features of the original surface on the trimmed patch, thereby, ensuring a close approximation.

The error plots reflect the deductions made from the visual analysis. In general, it is seen that the percentage of maximum error is less than 0.1% for all cases considered. The percentage of error is least for the trimming curve, which is perpendicular in parametric space (case 1 in Fig 7.1), and the magnitude of error progressively increases, as the trimming curve deviates from being perpendicular. This is a direct effect of the continuity constraint based inversion algorithm, where only parametric u -direction continuity constraints can be specified at the trimming curve in order to not disrupt the overall continuity of the remaining surface. It is found that triangular patches obtained from the degeneration of quadrilateral geometry are the least accurate among the trimming curve cases.

In comparison to the non-optimized trimmed patches, the optimized trimmed patches are able to match their counterparts to a very high degree in terms of the percentage of errors. As seen from the error plots, the optimized trim patches give the same results of approximation as that of the non-optimized trimmed patches, for cases of the trim curve that is perpendicular in parametric space. The error tends to increase as the trimming curves deviate from being perpendicular (case 5 in Figure 7.1). This can be attributed to two reasons:

- As seen from Figure 5.9 in chapter 5, though a good approximation is obtained of the original curve by an approximating curve fit between curvature maxima and minima points of the original curve, it still is not an exact replica of the original. There are approximation errors that still need to be taken care of.

- As the trimming curves deviate from being perpendicular, a situation arises when the iso-parametric curves considered for surface interrogation are more closely spaced at one end and placed far from each other on the other end of the surface. Figure 7.38 from chapter 7 shows the extreme case of such a situation. This amounts to large portions of the surface left unconsidered for surface interrogation. And this shortcoming in the surface interrogation process reflects on the error plots as increased percentage of error.

It should however be noted that these results for the optimized trimmed patches are obtained by considering lesser number of data points to describe it. (In the cases presented, the number of points required to describe the surface range from 40 to 90 depending on the case as opposed to a constant number of 105 points for the unoptimized patches irrespective of the case considered). Also, the approximation is much smoother than for the non-optimized case and the geometry of the error plots reflects this fact. A tradeoff can thus be made between accuracy and computational speed depending on the requirement of the particular design situation.

For future research in this area, emphasis should be on finding a better means of characterizing the curve/surface other than considering the curvature maximas and minimas for approximation.

In this research, the iso-parametric curves are constructed keeping the trim curve as the reference and progress towards the boundary. A new set of basis functions different from

the original set is also used. It would be worthwhile to look at the possibility of constructing iso-parametric curves with the original boundary curve as reference and by using the original set of basis functions. This amounts to having the iso-parametric curves perpendicular in parameter space up to a certain region on the trimmed surface. For the remaining region, another set of iso-parametric curves could be constructed based on the procedure followed in this research. This finally amounts to having exactly the same description as that of the original surface for certain portion of the surface and thus, limit the approximation errors to a very small region of the trimmed patch. This would also take care of the second reason to which the increase in error is attributed to, in the present approach.

In addition, research efforts can be channeled towards integrating the Error Visualization Tool developed in MATLAB with the Visualization Tool Kit developed in the C programming language.