

Introduction

The literature is currently inundated with accuracy studies for the scanning and reproduction of 3D printed models. Generally, these studies use a control that is digitally compared to other model scans or scans using digital inspection software (Geomagic Control, 3D Systems).

The software's performance relies on an approximation algorithm or best-fit algorithm and may therefore vary from the true absolute values. Also, there may be errors in the scanner's registration due to the variable surface topography.

We believe that the use of distinct data points generated by fiduciary markers on printed models might be more reliable than the variable surface topography for alignment and measurement of the accuracy of scanned printed models to the digital master.

Methods

A master print model/ STL file was designed that includes four spherical balls and a column in the center of the palate of the model which are used as a control for measuring the accuracy of the print. The master STL file was used to print 20 models which were then scanned by a Straumann Cares (Straumann, USA) desktop optical scanner. The resultant scan was aligned with a "best fit" algorithm to the .stl master file in the first group using fiducial markers and in the second group using teeth. Then the distances between surface data and all points were converted to root mean square (RMS) values which are a general method to assess the mean value of errors, using Geomagics Control X software (3D systems). An z score calculation was done to compare the RMS values of the two groups ($p < .05$).



Figure 1: Straumann Cares Desktop Optical Scanner

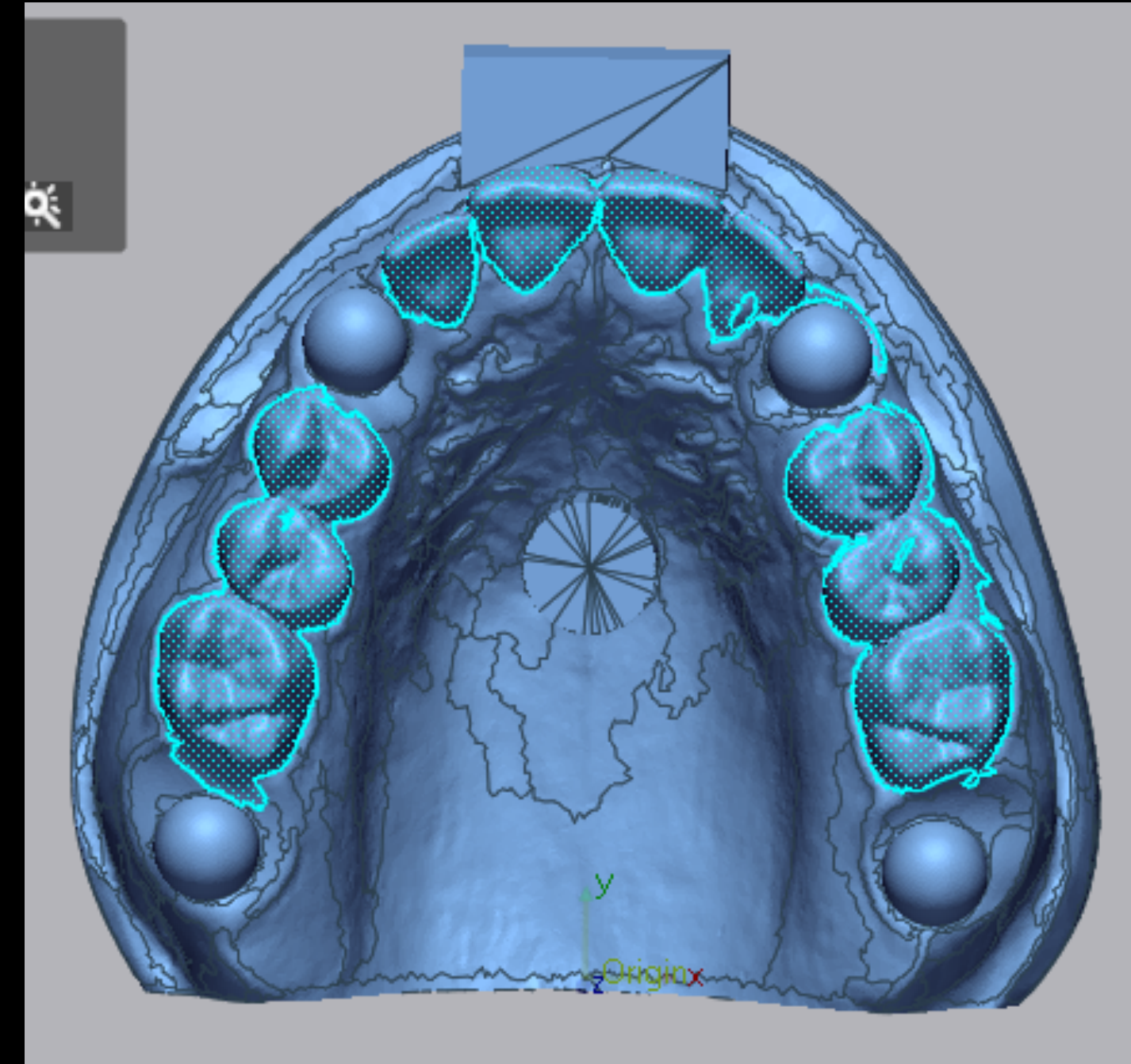


Figure 3: Best fit alignment of the teeth arch

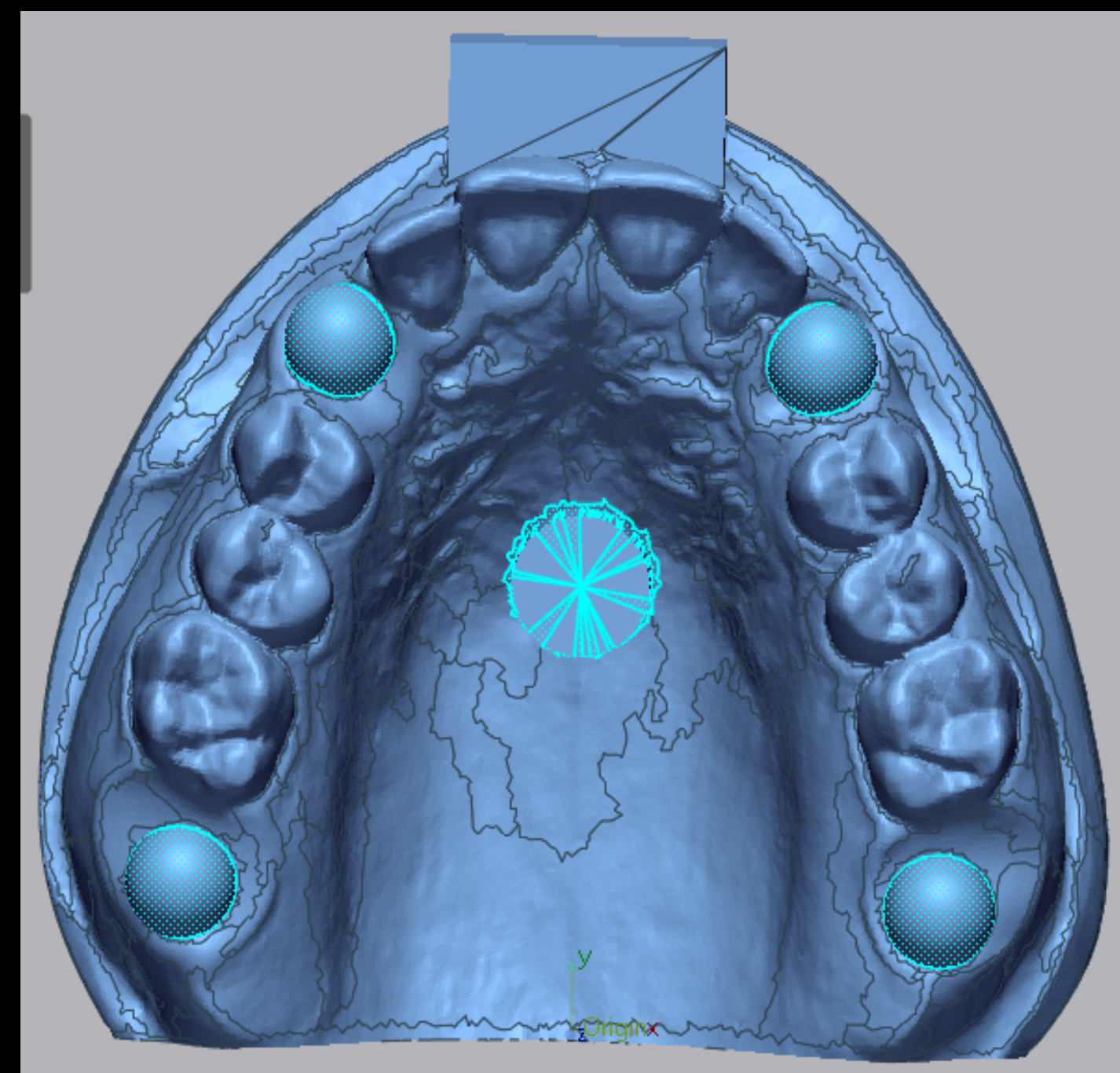


Figure 2: Best fit alignment of the fiducial balls and center column

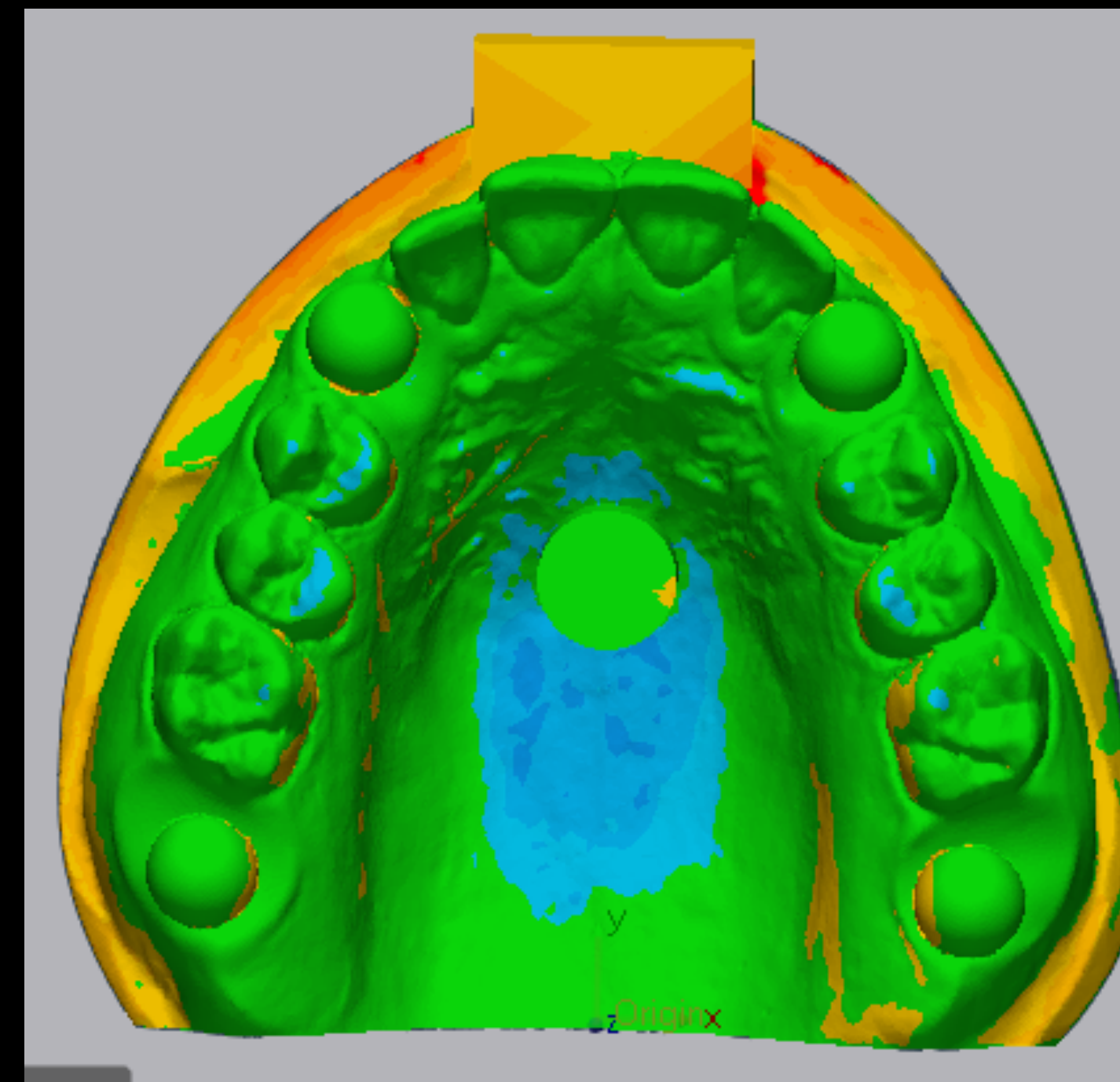


Figure 4: A 3D comparison of the original file to a scan file

Results

SAMPLE	RMS Fiducial	RMS Teeth
1	0.1146	0.1082
2	0.158	0.1533
3	0.1228	0.1192
4	0.1285	0.124
5	0.1321	0.1267
6	0.1268	0.1219
7	0.1173	0.1113
8	0.1062	0.0999
9	0.1056	0.1017
10	0.1065	0.1036
11	0.0982	0.0952
12	0.1021	0.0984
13	0.1092	0.1054
14	0.1095	0.1069
15	0.11127	0.1097
16	0.0757	0.0749
17	0.081	0.0818
18	0.0753	0.791
19	0.0799	0.081
20	0.869	0.0827
Average	0.107445	0.10447

A Z score Calculation was used to compare the averages of the categories to the sample.

z value: 0.0306,
p value of 0.97606
The results are **NOT** significant at a $p < .05$

Conclusions

It is demonstrated in this study that the error in accuracy is same irrespective of surface topography as the software relies on a approximation algorithm to get a closest possible fit. Also, the software gives a color map for discrepancy in compared models but cannot provide absolute error values in along each axis in 3D space.

References

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- Taft RM, Kondor S, Grant GT, Accuracy of Rapid Prototype models for head and neck reconstructions, J Prosthet Dent 2011 Dec;106(6):399-408
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