Improving Surface PSD Using a Random Tool Path

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Abstract: We present a random unicursal tool path for sub-aperture polishing and compare polishing with the random and raster tool paths. This new complex tool path is useful for reducing mid-spatial frequencies in polished surfaces.

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1. The random unicursal tool path

The unicursal pseudo-random tool path was first developed to address the problem of mid-spatial frequencies that may be left on a surface by periodic tool paths such as raster or spiral patterns. The *Precessions* process performs prescriptive polishing with the use of a dwell time map combined with a tool path. Because the raster or spiral tool path never crosses itself, the velocity of the tool can be varied along the path to produce the dwell time specified at each point on the dwell time map. The unicursal random tool path can also be used with a dwell time map because it does not contain any crossing points.

The unicursal random tool path is generated in NURBS space. The patterns are defined on a plane one arbitrary unit square, and then projected onto the curved surface using NURBS software. Generation of the pattern begins by defining the boundaries of the region to be polished, which may include interior holes. Random tool path patterns can be generated to fill any continuous surface, including those with interior holes, and a completely different pattern is produced every time the algorithm is run. An example of a random tool path is shown in Figure 1.

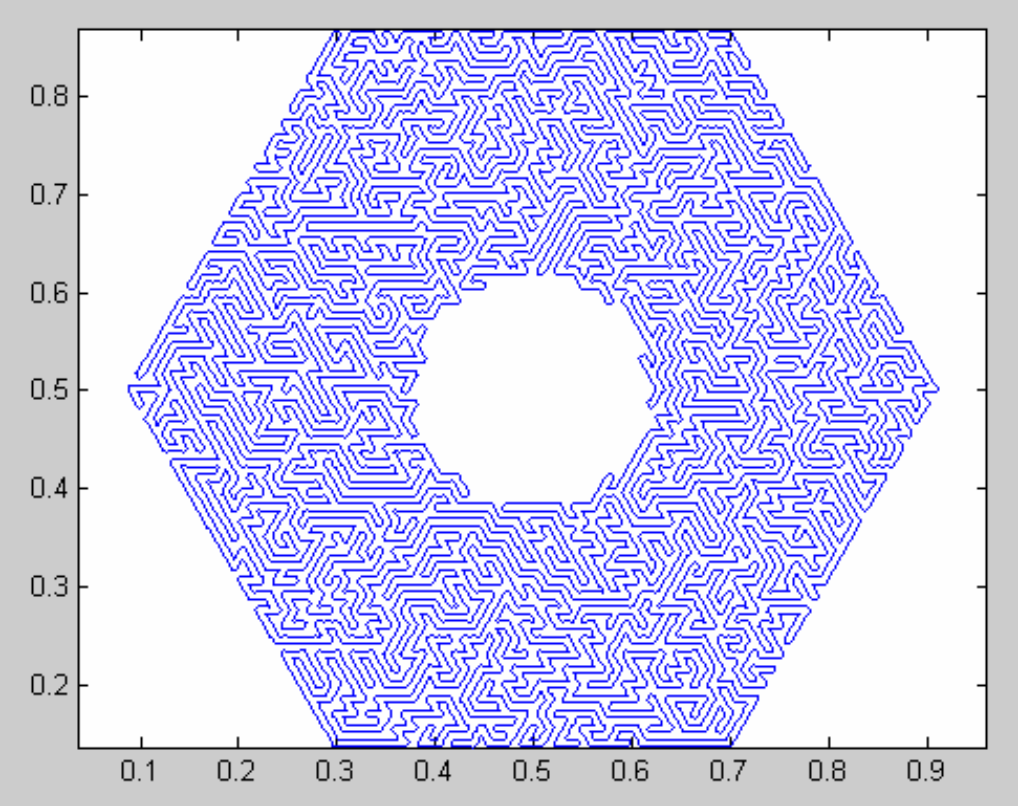

Fig 1. Example of a unicursal random tool path

2. Comparison of surface PSD resulting from raster and random polishing

Two 20 mm diameter circular spots were polished on a flat glass part. One region was polished using the random tool path and the other was polished with the raster tool path. All other parameters were the same. The regions were measured using a stitching white light interferometer to compare surface texture. These two measurements are shown in Figure 2.

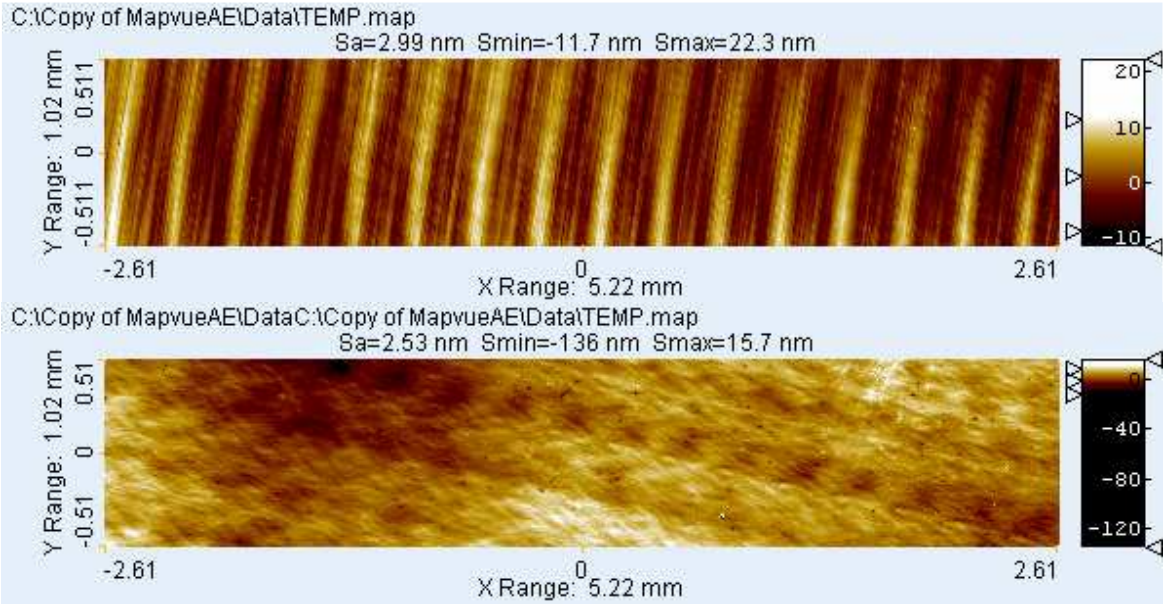

Fig. 2. Profilometer measurements of a raster polished region (top) and random polished region (bottom)

In Figures 3 and 4, we plot profiles of these surfaces to show the periodic feature present in the raster polished sample that is absent in the random polished sample.

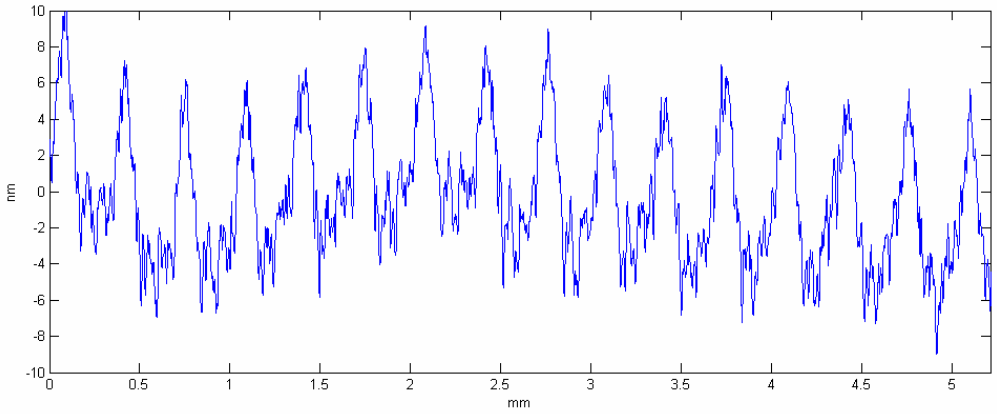

Fig. 3. Profile along raster polished sample

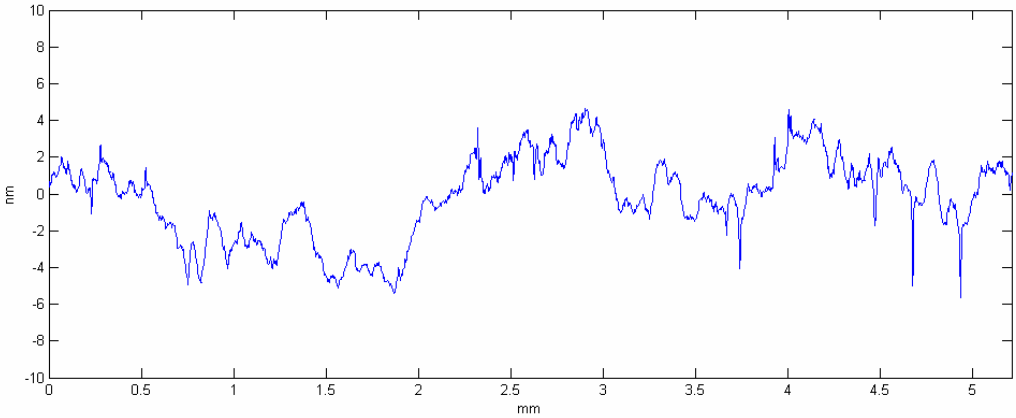

Fig. 4. Profile along random polished sample

We calculated the PSD of both the random and raster polished regions to show the diminished mid-spatial frequencies in the random polished sample, as illustrated in Figure 5.

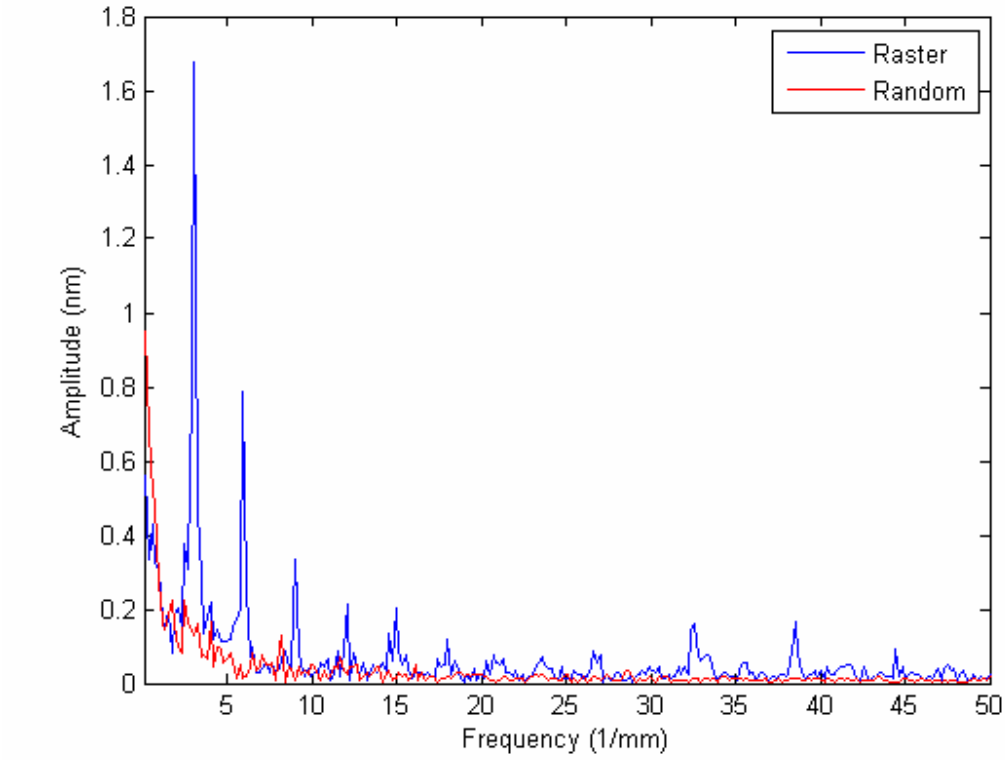

Fig. 5. PSD of raster and random polished regions

3. Conclusions and Further Work

We have demonstrated the ability of the unicursal random tool path to produce a surface with a better PSD profile than a raster tool path with all other polishing parameters held constant. Work on the random tool path will continue with special attention paid to the effect of using a random tool path at the edge of a part.