Using spatial uncertainty of prior measurements to design adaptive sampling of elevation data.

ABSTRACT

Field sampling can be a major expense for planning within-field management in precision agriculture. An efficient sampling strategy should address knowledge gaps, rather than exhaustively collect redundant data. Modification of existing schemes is possible by incorporating prior knowledge of spatial patterns within the field. In this study, spatial uncertainty of prior digital elevation model (DEM) estimates was used to locate adaptive re-survey regions in the field. An agricultural vehicle equipped with RTK-DGPS was driven acr oss a 2.3 ha field area to measure the field elevation in a continuous fashion. A geostatistical simulation technique was used to simulate field DEMs using measurements with different pass intervals and to quantitatively assess the spatial uncertainty of the DEM estimates. The high-uncertainty regions for each DEM were classified using image segmentation methods, and an adaptive re-survey was performed on those regions. The addition of adaptive re-surveying substantially reduced the time required to resample and resulted in DEMs with lower error. For the widest sampling pass width, the RMSE of 0.46 m of the DEM produced from an initial coarse sampling survey was reduced to 0.25 m after an adaptive re-survey, which was close to that (0.22 m) of the DEM produced with an all-field re-survey. The estimated sampling time for the adaptive re-survey was less than 50% of that for all-field re-survey. These results indicate that spatial uncertainty models ar e useful in an adaptive sampling design to help reduce sampling cost while maintaining the accuracy of the measurements. The method is general and thus not limited to elevation data but can be extended to other spatially variable field data.

Keyword: Adaptive sampling; Digital elevation model; Sequential Gaussian simulation; Spatial uncertainty.