Estimate optimal harvest time by cross-scale assimilated digital broccoli farmland

The broccoli head is an important component in the vegetable market. But harvesting at a non-proper time will lead to non-standard size for market shipping and be wasted. Compared to the one-time mechanical harvest, the conventional method selectively harvests by hand several times to decrease such waste, but the heavy labor cost eliminates the profit. Hence, obtaining the full field broccoli head development promptly to estimate the optimal harvest time, has emerged as an interesting research area. Several studies have already applied the close-range remote sensing techniques by drones and ground vehicles to calculate broccoli head sizes by 3D reconstruction. But the complex light condition, leave occlusion, and wind movement in the field, present limitations to achieving high-quality 3D head models. In this study, the high-quality in-field 3D models were generated by cross-scale data assimilation and template matching. Three scales of data were collected and aligned during the growing season. The 3D models of the aerial scale (full field), the ground scale (small sample region), and the indoor scale (individual broccoli), were reconstructed by drone, smart phone, and indoor semi-automatic rotating platform, respectively. Then, the geometry traits on three scales of the same broccoli were linked to find the mapping relationship from field to indoor high-quality 3D models. All the broccoli head 3D models in the field were replaced by the linked indoor 3D model with a slight shape transformation. Finally, the time-series full-field head size results and marketing price were used to build a prediction statistical model for harvesting time. The prediction statistical model was evaluated on the next round of planting.