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Low-cost 3D modelling of crop-weed interactions

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Background

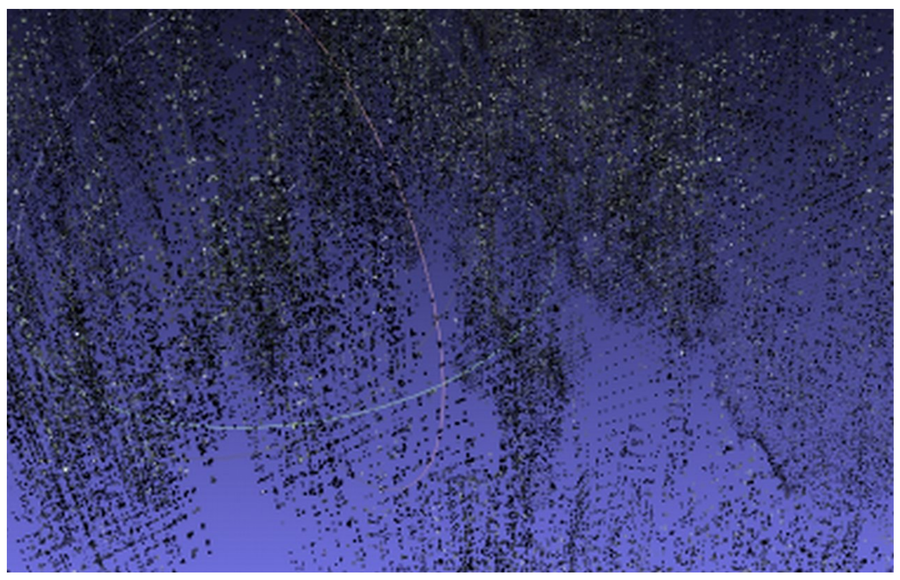
3D imaging systems, computer vision, photogrametry of high resolution RGB images and machine learning can create geometric models of plants.

Fig. 1 Microsoft Kinect V2 (Microsoft, Redmond, WA, USA), a low budget RGB-D sensor for 3D modelling

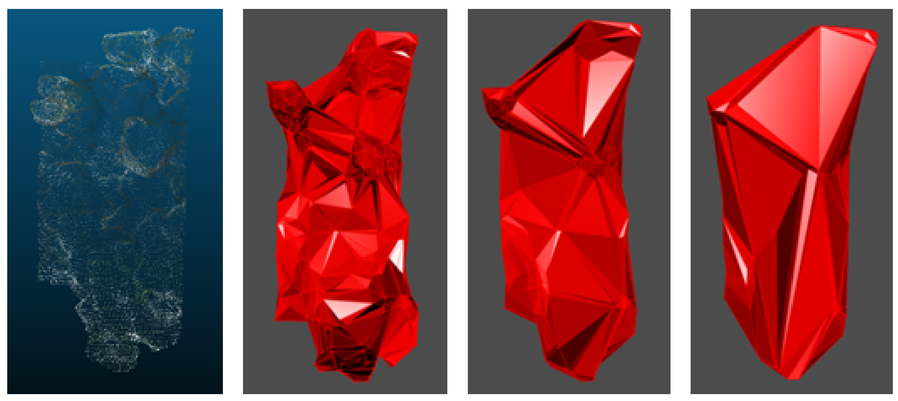
Methodology

RGB-D cameras (Fig. 1) capture both color and depth information, enabling a more detailed analysis ob objects.

The sensor was hand held pointing out the field samples from top view. 3D development (Fig. 2) was done by:
- point cloud generation
- reconstruction of large regions
- fusion of different overlapped depth images
- construction of alpha shape or volume that enveloped the set of 3D points.



(a)



(b) (c) (d) (e)

Fig. 2 Point cloud (a) generation and alpha shape of a point cloud section (b) using alpha= 0.1 (c), alpha= 0.2 (d) and alpha= 0.4 (e).

Results

- The 3D reconstruction systems created different weed models (Fig. 3).
- The models in all cases were similar to reality, with very small errors.
- Kinect v2 measurements were more inaccurate than by photogrammetry
- The interaction between weeds and crop was also characterized by a height-based protocol within the 3D models.
- The results demonstrate the feasibility of using low-cost tools to reconstruct weed plants, with good accuracy and high resolution

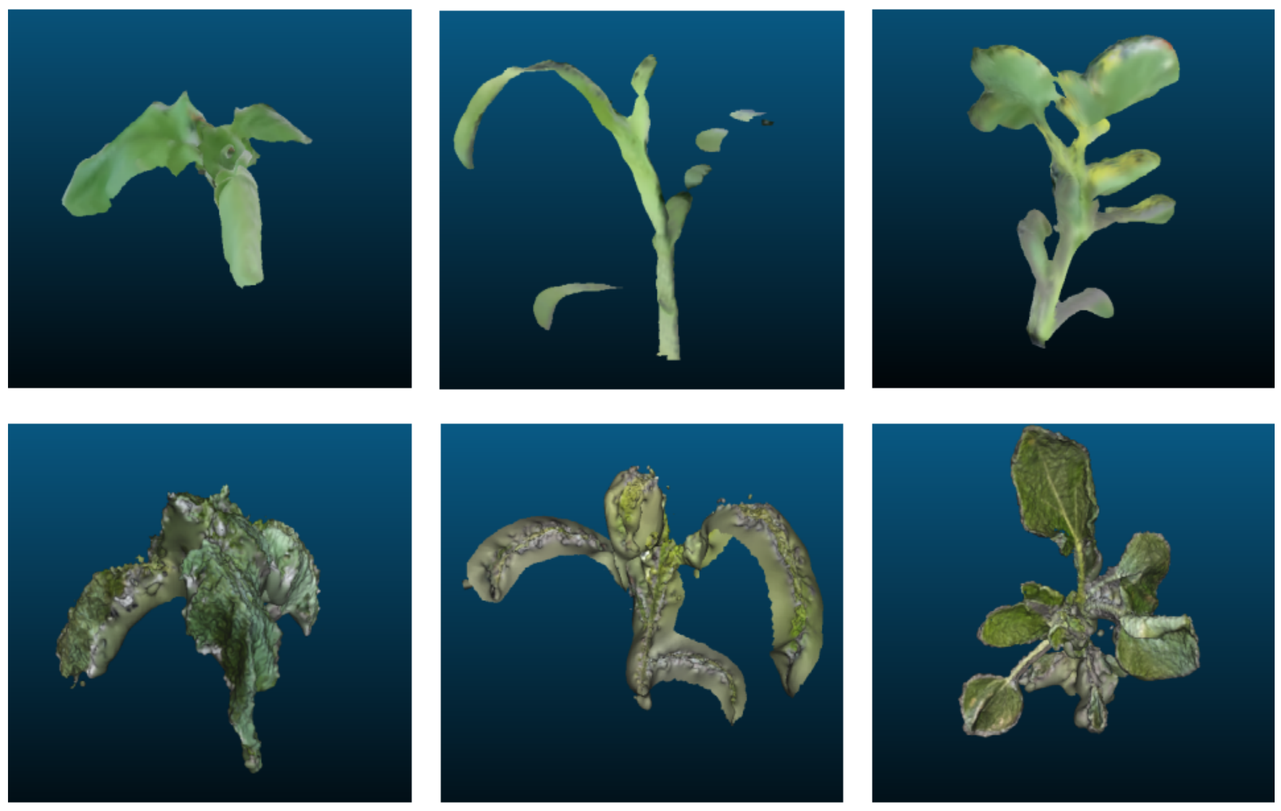


Fig. 3 Different examples of weed plants reconstructed from different viewing angles using Kinect-based systems (top) and photogrammetry (bottom)

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