Agricultural Crop detection, Localisation, and Pose Estimation

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Motivation

Problem: The global population is expected to pass 9 billion by 2050 requiring dramatic scaling of agricultural practices that are difficult with current methods.

Solution (or part of): Agricultural robots (AgBots) are expected to fit into a broader picture in which crop breeding, planting, and harvesting practices are refined to allow greater levels of automation.

Key Roadblock: AgBots require advanced sensor data processing to identify target crops at high speeds.

Aim

To apply the latest advances in robotic vision to the problems of detecting, localising, and estimating the pose of target crops, and to implement our approach on a robotic platform for selective harvesting.

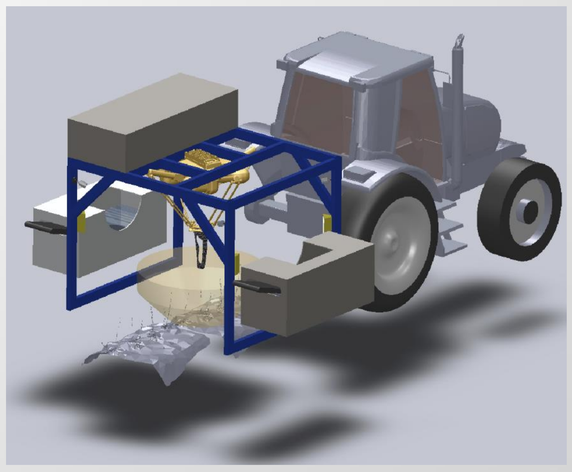

Fig 1. Robotic harvester mounted to tractor

Multi-Camera Data

We have a fixed setup, so let's use it!

Fig 2. Multi-camera input

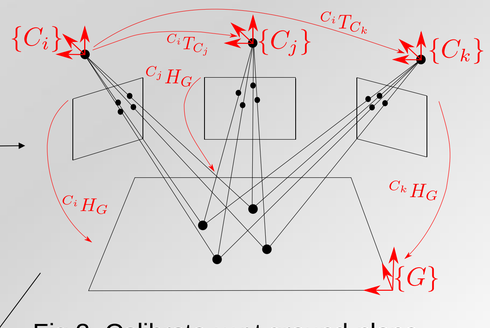

Fig 3. Calibrate w.r.t ground plane

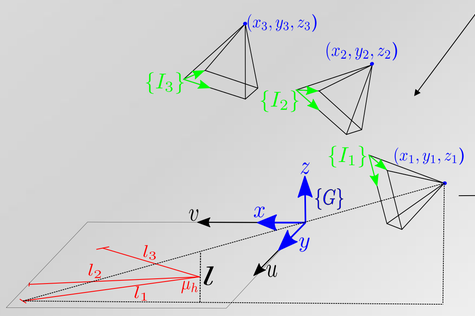

Fig 4. Homography projection to ground plane

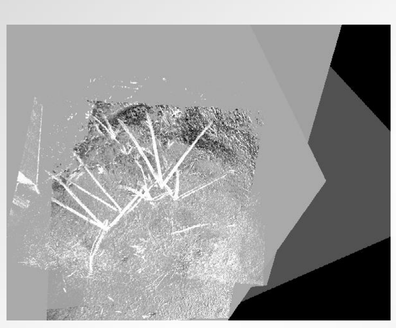

Fig 4. Treat ground plane as image

Calibration

For successful harvesting we need a multi-camera system calibrated with a robotic manipulator.

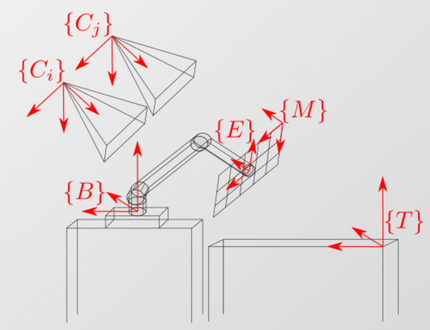

Fig 5. Calibration setup

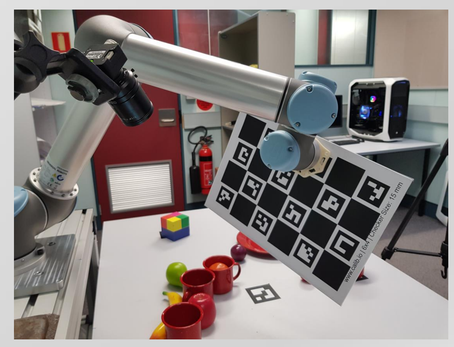

Fig 6. Calibration of UR5 with multi-cameras

Target poses: ${}^{B}X_{E}(\theta_t)$ from forward kinematics

$$^{B}X_{C}(\theta_t) = {}^{B}X_{E}(\theta_t) \cdot {}^{E}X_{C}$$
$$^{B}X_{T} = {}^{B}\bar{X}_{C} \cdot {}^{C}X_{M} \cdot {}^{M}X_{T}$$

Initial Implementation & Results

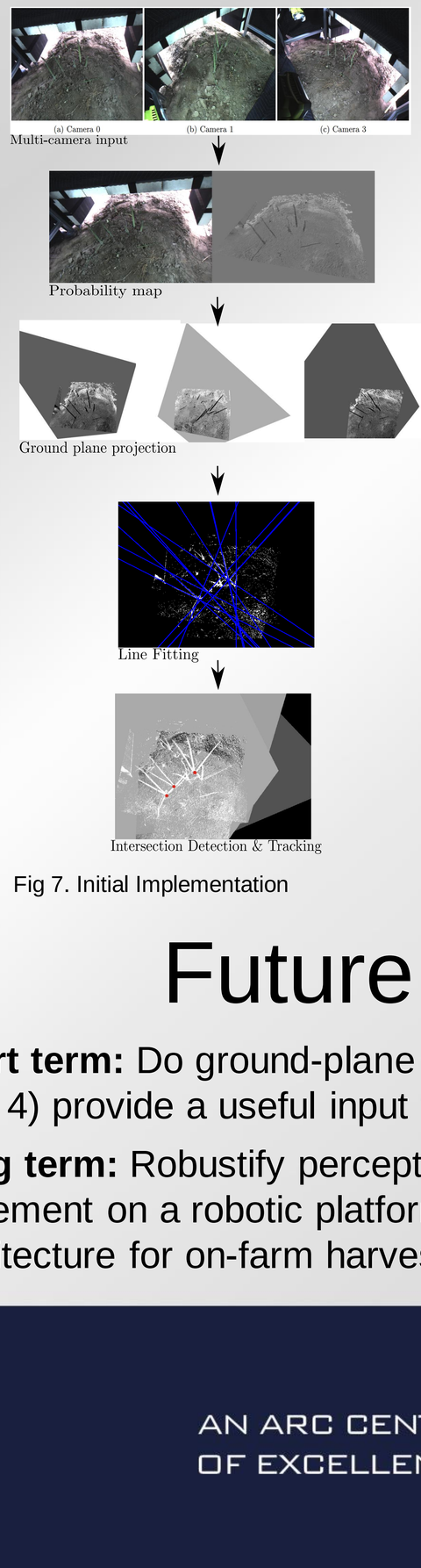

Fig 7. Initial Implementation

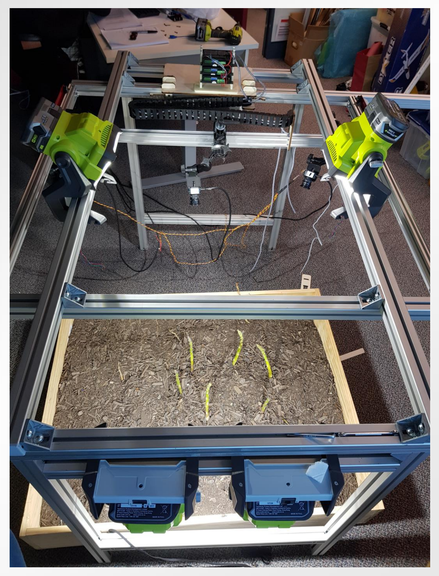

Fig 8. Rig for in-lab testing

Experiment	RMSE (mm)
1	0.137
2	1.829
3	0.128
4	1.778
5	0.207
6	0.333
Overall	**0.735**

Fig 9. Initial in-lab results

Future Work

Short term: Do ground-plane images from multiple views (Fig. 4) provide a useful input to learn crop pose?

Long term: Robustify perception pipeline and implement on a robotic platform via a distributed architecture for on-farm harvesting.