Project title:	Soft fruit detection and shape estimation using 3D information and machine learning
Project number:	SF/TF 170
Project leader:	Grzegorz Cielniak, University of Lincoln Charles Whitfield, NIAB EMR
Report:	Annual report, 2020
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Key staff:	Justin Le Louedec
Location of project:	University of Lincoln
Industry Representative:	Berry Gardens Growers
Date project commenced:	September 2018

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AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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GROWER SUMMARY

Headline

This project provides a study to understand the key information for using 3D information and 3D sensing technologies in robotics applications for autonomous soft fruit farming.

Background

Autonomous harvesting is becoming an important challenge and necessity in agriculture, because of the lack of labour and the growth of population needing to be fed. Perception is a key aspect of autonomous harvesting and is challenging for example due to difficult lighting conditions, limited sensing technologies, occlusions and plant growth. 3D vision approaches can bring several benefits for example localisation, size estimation, occlusion handling and shape analysis. To select and pick a ripe fruit from a plant is a simple task for a person, but immensely complex for a machine to replicate. For an autonomous system to achieve this task it must first be able to reliably detect, differentiate, and track fruit in a complex 3D space. This research connects to other work in this and other research groups developing systems for the deployment of robotic platforms in strawberry farms. The overarching objective is to develop systems that can assist pickers, agronomists, and farm managers for a multitude of tasks.

The focus of this work is to study and develop the vision system of robots specifically for the soft fruit industry. This project opens the door to various applications which rely on 3D information. Applications such as improving differentiation and fruit picking, providing more fruit information (e.g. yield and quality) to the growers, recording phenotype information by an autonomous system.

Summary

This project provides preliminary results indicating improvements are needed in current computer vision technology. We developed a method using 3D information for detecting broccoli heads as a model plant based on Convolutional Neural Networks (CNNs). We have completed extensive studies in the field to evaluate sensing technologies and algorithms. Doing so we have found significant limitations in the current sensing technologies while proving the usefulness of our own methods utilising 3D information. Our findings confirm that 3D structure information could be useful for autonomous detection of fruit. We also provide a significant contribution in describing fruit shape information using spherical harmonics. We developed 3D shape descriptors which a machine can use for phenotyping applications. This

work paves the way for advances in automatic phenotyping and will be investigated later in the project.

Financial Benefits

This project is part of a much larger programme to develop robotics for the horticultural industry. The exact financial outcomes of such investment in robotics and computer science is unclear at this early stage. However, it is expected that a fully working robot picker would alleviate labour cost for picking, transporting, and analysing fruits in the grower facility, with an initial investment in the robot.

Action Points

There are no clear action points at this early stage of the project, however investigating new sensing technologies with relevant companies and laboratories to provide better performances of 3D sensing technologies in the field, would provide tremendous assets for future projects and applications in agriculture/horticulture and other fields.