MAARATECH NEWSLETTER

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SUMMARY

The challenges have continued this year, as you will have found, last year was not the end of pandemic disruption. Our team is doing well regardless and doing what they can and communicating across the country using our tool set, such as Zoom, Slack, Github, and Google drive. And fitting in field work between lockdowns when we can. It's a little more challenging because there are a couple of Phd students (David and Ans) who started work on the project from overseas and are continuing to work as well as they can remotely. We are desperately trying to get them into NZ, however understandably there are strong restrictions on this at present, and a lot of others want the same thing. Henry is taking a bit of time for some important family health issues, and the rest of the team is working together well to keep the project going and keep the team talking and sharing well.We did manage to get together in Christchurch in February for a full team planning meeting for our 2021 work, although the Auckland team suddenly had to stay home and zoom in due to the instant lockdown, while Bruce was already down there with family over the weekend and could chair the meeting in person. Still quite a chore for the Auckland people to zoom in to 2 days of discussion and planning. The plans include substantial workshopping with the industry, and substantial field trials with our growing set of robotic systems

SUMMARY CONTD..

Updates below summarise the recent progress on designing and building the systems we need to trial in the field, and also the ongoing social science research about the adoption of this technology by people and communities. We are very proud of our excellent team, see the highlight on Catherine below for example.

Our industry advisory group meeting was postponed late last year and people were understandably busy earlier this year, thanks to Shobha's organisation and everyone's feedback we now have a date for it on March 17 by Zoom.We are looking forward to updating on what we have been doing and plans, and hearing about how the industry is doing and thinking about the project.

It's good to see the MaaraTech project being noticed for example for the Agritech meeting in Blenheim, which had to be postponed from Feb to May.

Many of the team have been busy recently developing research proposals for future work, in a range of robotics areas, and this work will further enhance the capability in NZ in the areas addressed by Maaratech, in both Agritech and in manufacturing sectors.Do let us know your feedback about the project; that is an essential part of the project and our work.

TEAM MEMBER SPOTLIGHT

Catherine Downes (Ngati Awa, Ngati Tuwharetoa) leads the design and build of the autonomous orchard vehicle, which will be equipped with scanning equipment and custom end effectors. In 2021, this prototype vehicle will be trialled in apple orchards. The initial plan is to drive the vehicle with remote control, and is followed by fully autonomous capability. She is being featured next to the current progress of the vehicle below and she is currently a Master of Engineering Student at the University of Waikato. Once her degree is completed, Catherine plans on going back into industry.

SOCIAL SCIENCE UPDATES

The Community Technology Adoption team based out of the University of Otago's Centre for Sustainability has published our first paper based on our research in the MaaraTech Project:

Legun, Katharine, and Karly Burch. 2021. "Robot-Ready: How Apple Producers Are Assembling in Anticipation of New AI Robotics."*Journal of Rural Studies*82:380–90. doi: 10.1016/j.jrurstud.2021.01.032.

We are now turning our focus to further data analysis and writing, and have two postgraduate team members we are excited to introduce: PhD student Angella Ndaka and Masters student Mira O'Connor.

Angella's PhD will explore how we might integrate aspects of environmental sustainability into technology design projects in New Zealand. She hopes to interview team members, farmers, industry representatives and policy makers to better understand the environmental dimensions of technology design, and to imagine what sustainable technology design might look like. Mira's Master's thesis will focus on agricultural labour. She hopes to interview agricultural labourers to better understand their working experiences and thoughts on new agricultural technologies. Both Angella and Mira hope to begin their fieldwork sometime in 2021.

Auckland (JHMRC): We have employed a new staff member, Dr Moana Nepia, as a research fellow for the project. Dr Nepia is coordinating interviews with Wakatu that were postponed due to recent Auckland Covid-19 lockdowns. Dr Nepia has been brought up to speed with the relevant literature pertaining to the study. The JHMRC team (Marama, Moana, Nick) are working with social scientists in the project to write a transdisciplinary codesign article. Assoc Prof Marama Muru-Lanning is now the chair of the Waikato-Tainui endowed college, which has relations with Te Mana Raraunga - Māori data sovereignty network and multiple industry partners in the Waikato region

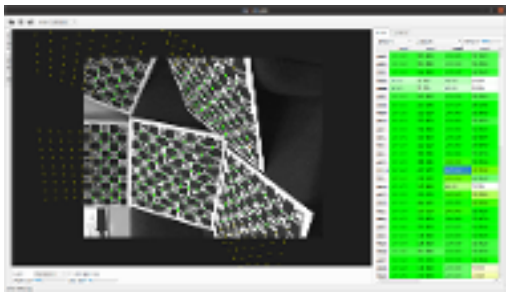
UPDATE ON TECHNOLOGY

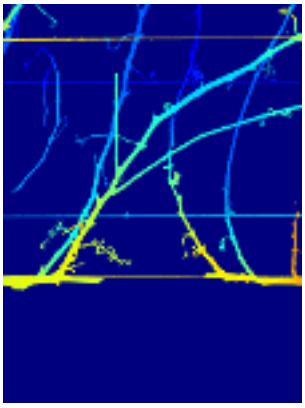
Canterbury update

Work continues on photometric reconstruction - to be used as a pseudo ground-truth for improved stereo matching. Current progress is around expanding robustness in different camera configurations (for example the difference between a 6-camera rig and a robot arm stereo scan)

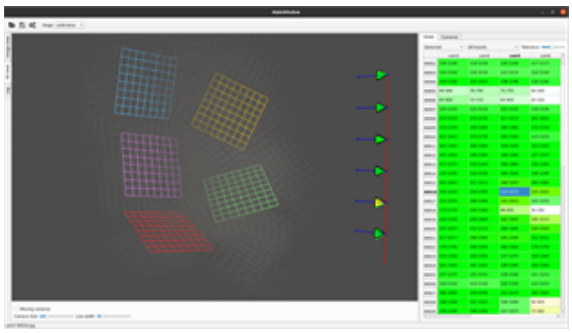
A calibration system for multiple cameras has been implemented to more effectively calibrate 6 camera rigs with rolling shutter compensation.

The small vehicle 'Conan' the tracked vehicle is undergoing upgrades and will be an equivalent system to Archie-Junior with a UR5 arm on the back and a 6 camera scanning system on the front. A synchronized strobe light (20x100W LED) is being trialled for more consistent lighting.





A new PhD student Max Andrew has come on board who will work on alignment between scans, initially as the robot scans one side. Then afterwards aligning scans taken from both sides, which will involve/require recognition of key scene structures (for example wires) which can be seen clearly and don't move.



Waikato update - Apple fruitlet thinning (FOUR PETALS MARK 2)

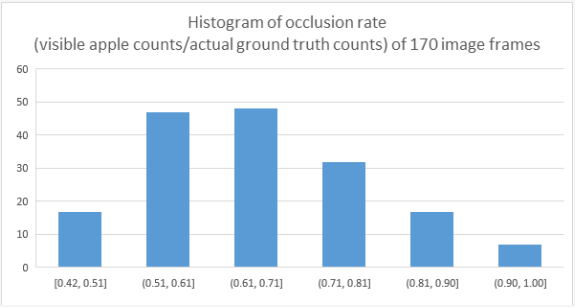
Apple fruitlet thinning has undergone two years of development and has been extensively tested in field trials in Nelson and Napier (Dec 2020 - Jan 2021). The semi robotic gripper was tested on various varieties and can be used on royal gala and rockit. The gripper is now in its third year of development with the focus being on the control aspect such as development and implementation of path planning.

https://youtu.be/jPJYdi5gu84- Nelson and Napier field trials

UPDATE ON TECHNOLOGY

Lincoln Agritech update

In a complementary, SFFF funded project trial (advanced crop load management, with NZAPI and AgFirst), we analysed 170 images from 2 orchards with 3 apple varieties and compared the predicted apple counts with the ground truth counts.It shows that the average visible rate is around 68% but it varies drastically from 40% to 100% (see plot below).



The above study shows that occlusion is the biggest source of error in machine apple counting in an orchard setting. In the December MaaraTech trial we have conducted several approaches to reduce the occlusion by leaf canopy, namely active leaf movement and microwave imaging. Both approaches are discussed in the following sections.

Occlusion Reduction by Active Leaf Movement

We conducted a few experiments aiming to reduce occlusion of apple fruitlets with leaf moving in the December apple trial in Nelson.

The first experiment was set up to test various hardware designs such as nozzle shapes, nozzle positions/angles, airflow intensities, and camera setup with a robot arm (picture left).

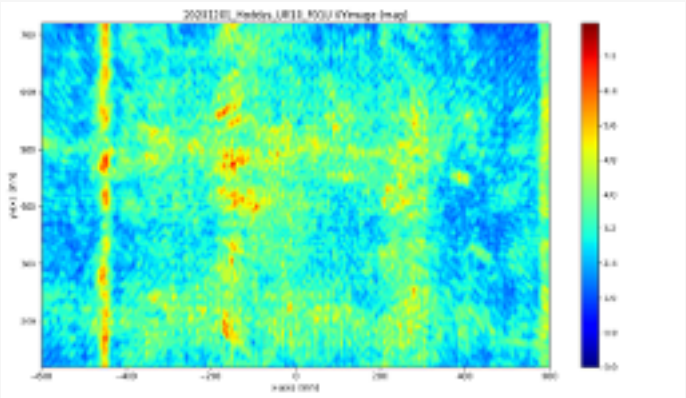
In the second experiment, we investigated the possibility of utilising an existing equipment for leaf moving, i.e chemical sprayer. With help from Kevin Withington (Hoddys' orchard), we have attached a few GoPro cameras on one of their sprayer (picture right) and collected data from different driving speeds (between 4 to 6 km/hr) and fan settings. Following two images shows the effect of the sprayer fan (left: no fan, right fan on), more apple fruitlets could be seen from the image on the right. We are in the process of analysing the captured video-images with our AI -model and comparing them to ground truth data

Microwave Imaging

The motivation of this research is to develop a technology that uses microwave images of the apple tree to detect and count fruitlets. Apple leaves appear close to transparent in microwaves, allowing a microwave imaging device to 'see through' the leaves and find the apples. Research is also being conducted in analysing the microwave images to estimate fruit yield of the apple trees.

To evaluate the developed microwave imaging technique, two different microwave sensors, carried by platforms 'Rover' and 'Robot Arm', are field trialled (shown below). Rover takes microwave images at a wavelength of 10 cm, while Robot Arm takes microwave images at a shorter 1.4 cm, allowing higher-resolution 'radar-imaging'.

The Figure below shows a flattened 2D microwave image of an apple tree bay at Hoddy's orchard taken by the Robot Arm. The two trunks bordering the bay are clearly seen. Apple plant material of rows 2 and can be seen, with more concentrated branches at different locations of the bay.



FIELD TRIPS

Auckland update

In December we had two field trials collecting data from Hawke's bay, North Island and Nelson in South Island. In the Nelson field trial, we had teams from University of Auckland, University of Waikato, University of Canterbury and Lincoln Agritech. The purpose of the field trial was to collect data from apple orchards which would be used in the fruitelet thinning process. In this trial, we used stereo cameras to scan the orchard and reconstruct the environment in 3d space. In Hawke's bay trial in particular we have integrated a linear rail system and robotic arm to capture the scans of the whole tree rather than a partial area which allowed us to have more information on the whereabouts of the fruitlets. We are currently processing the results, to detect the fruitelets as our next step..

UPCOMING EVENTS & ANNOUNCEMENTS

EVENTS:

March 2021: Industry Advisory Group Meeting; Wednesday 17th March; 10 am to 12 noon

March 2021 -April 2021: Co-design workshops for Apples and Blueberries. Dates TBC

Announcements: Mahla has joined the MaaraTech team at University of Auckland. She completed her PhD in Computer System Engineering from University of Auckland and undergraduate studies in Computer Software Engineering and Master in Artificial Intelligence at the Ferdowsi University of Mashhad. During her PhD, she worked on developing the vision system for a kiwifruit harvester, apple harvester, and kiwi fruit flower pollinator. Her research interests lie in designing the vision system by using machine learning and neural networks to identify and localize fruit and flowers in outdoor scenes.