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ANIMAL WELFARE FARM-LEVEL GHG MANAGEMENT PLANS **VIRTUAL FENCING IN PASTURE-BASED FARMING**
ECONOMIC PATH FOR AGRICULTURAL SECTOR RESEARCH INTO GHG MITIGATION TECHNOLOGIES
ADAPTATION TO 190N CAP **COMPUTER VISION AI FOR EARLY FRUIT SIZING**

nzipim NZ Institute of Primary Industry Management

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New Zealand-led agritech – technology for agriculture, horticulture and aquaculture – is making waves in the global fruit-growing community with its innovative real-world applications. This article looks at early fruit sizing and computer vision AI, now being used by some of the largest companies in the world.

New Zealand agritech landscape

In June 2022, the Hon Stuart Nash, Minister for Economic and Regional Development noted, 'Our agritech sector is developing innovative solutions for the primary sectors in New Zealand and the world, increasing their productivity and sustainability.'

Reference was made to the TIN (Technology Investment Network) Agritech Research report which highlighted the growth of the sector. Commissioned by the Ministry of Business, Innovation and Employment and the Ministry for Primary Industries, this report celebrates the success and growth of this dynamic technology sector (see https://tin100.com/product/2022-agritech-report/).

During the past year, the largest 22 agritech companies in New Zealand had a revenue growth of 8% and export growth of 6.4%. Companies with revenue over $200 million grew at a rate of 7.7%, while those with revenue of up to $50 million grew remarkably at about 30%.

UN projections

By 2050, the United Nations estimates that a further 1.6 billion people will need feeding. Projections indicate that to feed this population crop production will need to increase by 60-100%. Although the population is not doubling, more people will be affluent. Add to that the greater focus on plant-based foods and health, and fruit becomes a popular pick.

To meet that future demand growers will need to produce more proportionately from less land, reduce their wastage, and also get more product to market, all at a time when agricultural labour markets are shrinking. Innovation and the use of technology such as computer vision AI will be crucial if the world's producers are to succeed in rising to this global challenge.

Computer vision AI – a photo of a fruit bin gives growers and packers almost instant size data

Computer vision AI

Computer vision is the field of computer science that focuses on replicating parts of the complex human vision system. It enables computers to identify and process objects in images and videos in the same way that humans do. Computer vision is about training a computer to see the world (and objects within it) in the same way that humans see them. Here are some explainers:

- Take a look at your hand and your eyes will see five fingers. Computer vision is where a camera or computer system can give you the same information without you having to count.
- No-one tells a child how to see. If you think of a child's eyes as cameras, they take a picture every 200 milliseconds. So by age three, the child will have seen hundreds of millions of pictures, which is an extensive set of images for our 'human computer' to use for learning. The same happens with computer vision. The computer is fed thousands of images so we can teach the computer what it is seeing.

Computers are first fed relevant images and then with the help of AI (such as machine learning), computer models and algorithms can be used to detect, count and size objects very quickly and accurately – faster than humans could ever do.

Early size data and why it matters

When it comes to fruit production in general there are some key characteristics that affect the saleability of fruit. Flavour, appearance (especially colour and blemishes, firmness, shelf-life and size) are just some of them. Different markets have different requirements, but size is generally a key consideration for all.

Taking apples as an example, when a bin leaves the orchard and arrives at the packhouse size is a key determining factor as to which market that fruit will be sold into. That decision will inform many successive decisions, including:

- When is the best time to sell this fruit into that market?
- How long should this fruit be stored? Apples can be stored in temperature-controlled cool rooms for six months or more
- Which storerooms should these bins go to? These rooms are kept sealed at specific temperatures unless the fruit is needed
- What type of packaging will be required?
- How should the pack line be set up and where should staff be placed for optimal efficiency?
- What freight needs to be booked/managed/cancelled?
- Will the company be able to meet the sales orders it has committed to?

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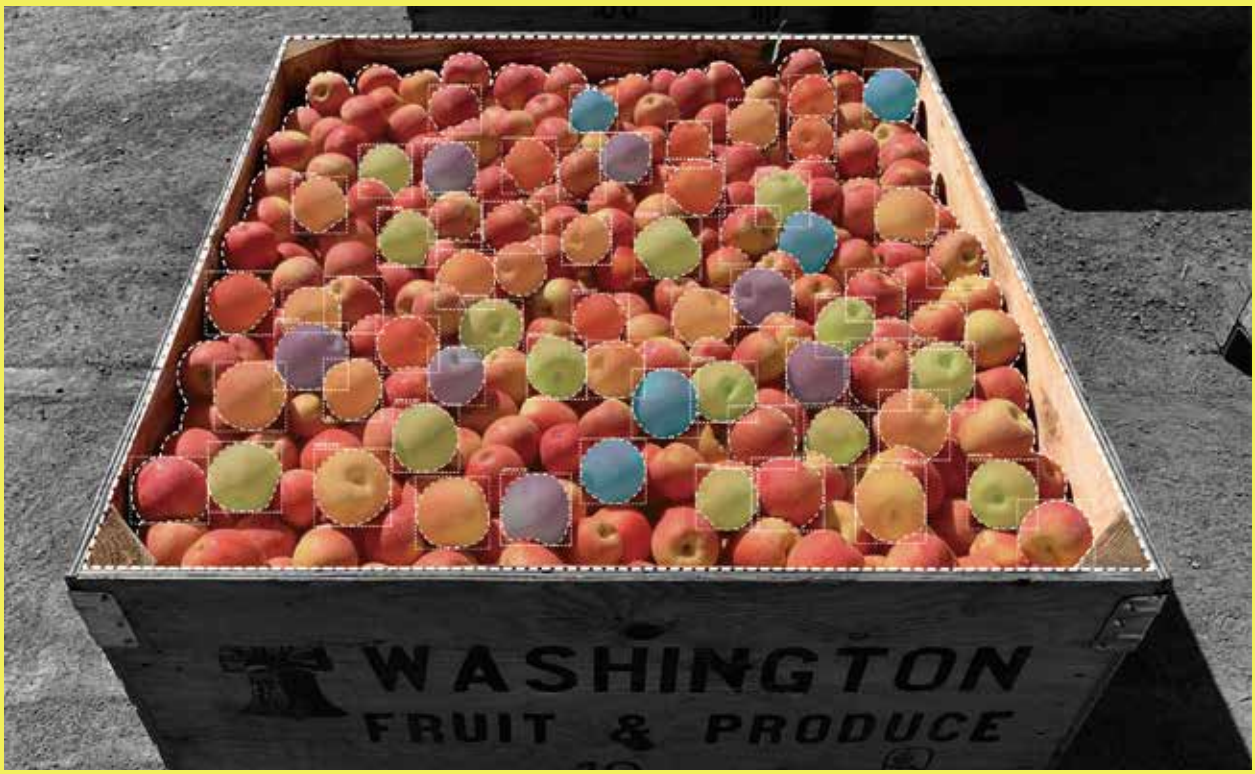

The Spectre for Apples computer vision fruit-sizing tool begins detecting apples from the top of the bin

CASE STUDY

A New Zealand agritech solution – apples and citrus

During grower and packhouse discussions, the team at agritech company Hectre would often hear about the problems caused by a lack of size data. It soon became obvious this was an issue that was affecting the industry.

The computer vision AI and machine learning solution Spectre for Apples app was initially developed by the company for the apple industry to detect the fruit and size them.

With this technology, apple growers and packers can use an iPad to take photos of, for example, 10 full bins of apples, load them up to the app, and within seconds receive a size estimation based on a sample of 1,250 apples or an average of 125 apples per bin, which equates to a 5% sample size. This technology provides an increase of 4,500+% in sample size compared with traditional manual size sampling and in less time.

This type of computer vision AI has been built with user simplicity to the fore. This is critical when developing technology for industries that are dealing with labour scarcity, and which are often reliant on labour from countries that may have English as a second language (the app is trilingual).

The app helps with the communication chain from the field, to the warehouse and to sales, and is now being used by apple growers and packers in many countries. Sage Fruit and Washington Fruit & Produce in the US, BC Tree Fruits Cooperative in Canada and apple innovator Rockit Global in New Zealand are some of the early adopters of this technology.

Similarly another app, Spectre for Citrus, which makes early fruit-sizing estimations for lemons, oranges and mandarins, is being used by New Zealand's largest citrus distributor, First Fresh NZ. It is also an excellent tool for growers as they can scan bins in real time to ensure adherence to size picking requirements, leaving smaller fruit for a later pick when it will have greater value.

Everything that is of concern for the apple industry is doubly so for cherry growers and packers due to their severely contracted pick, pack and ship timeline.

Traditional approaches

Due to the labour-intensive nature of manual size sampling, and the fast pace of harvest, any estimates undertaken produce insignificant sample sizes and are often not representative of the fruit in the bin. Large packhouses pack hundreds of thousands of bins of fruit each year. Decision-making cannot be optimal if critical data inputs are missing or incorrect.

Before the introduction of computer vision AI technology, when full bins of fruit were arriving at packhouses very little data was available on their size. Traditional size sampling would vary from simply eyeballing the fruit and taking a best guess approach through to manual sampling. Manual sampling involves quality control staff selecting a number of fruit, then using calliper hand tools to individually measure each piece to arrive at estimations of the size of fruit in the bin.

For apples, due to the very time-intensive nature of manual size sampling, often only 25 apples across 10 bins would be measured. Each bin contains approximately 2,500 apples so it is an extremely small sample size of 0.1%.

International cherry market

Global cherry production amounts to more than 4 million metric tonnes p.a. Of that, US cherry production accounts for 350,000 metric tonnes, claiming the position as the second largest producer in the world. Washington state alone produces more than 65% of the US sweet cherry volume.

Fruit quality and size becomes even more critical when exporting produce. The US is the third largest exporter of sweet cherries globally, with exports valued at more than $750 million dollars in 2020. Chile leads the way, with Hong Kong in second position.

For those who are working with premium fruit crops like cherries, the challenges posed by a lack of early fruit size data become even greater. Cherries are often packed and shipped within 24 hours of harvest and there is no time for inadequate decision-making.

Sales teams need to know what size cherries they have so they can confidently secure orders at the earliest time possible. Freight needs to be booked very quickly and mistakes are costly. Packing operations need to be extremely efficient to process the cherries at speed and meet the despatch timeframes.

Everything that is of concern for the apple industry is doubly so for cherry growers and packers due to their severely contracted pick, pack and ship timeline. Gaining early, reliable and significant size data becomes even more crucial.

The future

In addition to the early fruit-sizing applications, this type of technology is also being used in the development of crop counting and on-tree fruit-sizing technology. US fruit packers are looking to take this type of technology to the next level, where further automation will bring even greater efficiency and valuable data to their operations.

There are many companies trying to deliver on-tree, but industry expectation is that it will take quite a few years before there is a viable commercial product available. Hectre have carried out early testing of on-tree detection and counting and the results are very encouraging.

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