TREE CANOPY DENSITY AND VOLUME MEASUREMENTS FOR PRECISION SPRAYING

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BACKGROUND

- Conventional sprayer – only deposit ~30% spray to the target tree canopy while reminder is lost

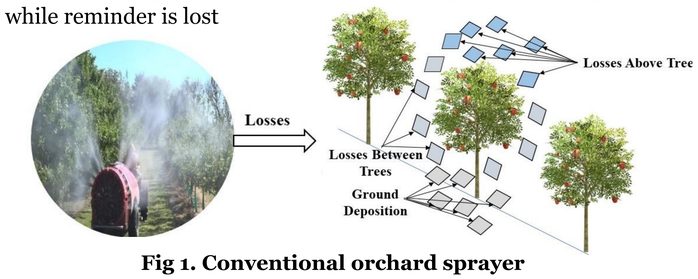

Fig 1. Conventional orchard sprayer

- Precision sprayer – target spray on tree canopy, reduce chemical usages
- Accurate tree canopy density and canopy volume information is required

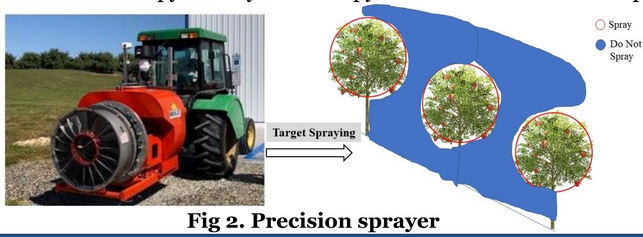

Fig 2. Precision sprayer

EXPERIMENTAL SETUP

Fig 3. Scanning tree from both-sides using a LiDAR

- A tree canopy density measurement system was developed by integrating a VLP-16 LiDAR scanner, an interface box for data transmission and power conversion, and a laptop computer

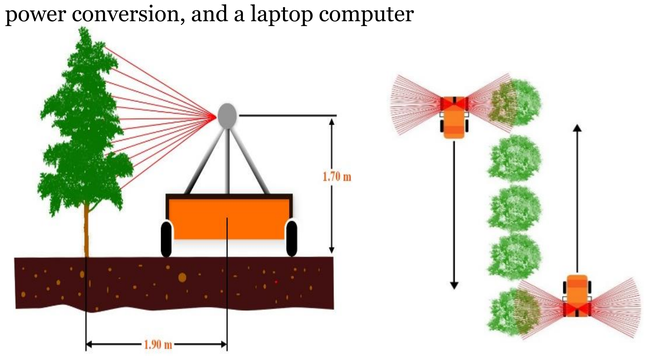

Fig 4. Scanning tree from both-sides using a LiDAR

- Apple tree canopies were scanned from both-sides using a LiDAR sensor to calculate leaves density and canopy volume

METHODOLOGY

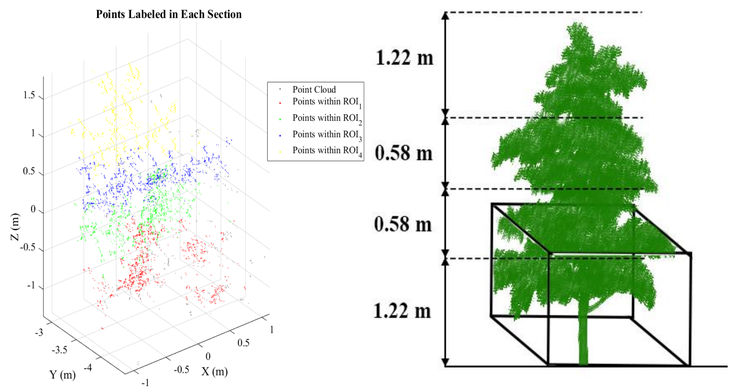

Fig 5. Tree divided into four sections for canopy density

- Scanned trees were divided into four sections according to the positions of trellis-wires
- Canopy density was calculated from each sub-section, to control the corresponding nozzles facing each section
- Canopy volume was measured to document the size and shape of the individual trees

RESULTS – Point Cloud

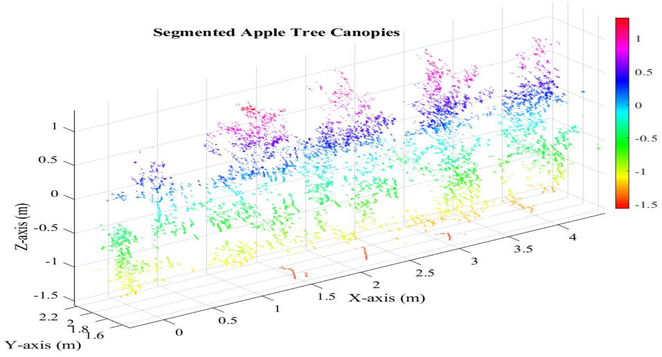

Fig 6. Identified tree canopy points (without tree trunk, trellis wire, and support pole)

- Unnecessary points from the trellis wires, poles, and tree trunks were removed to represent the canopy foliage for calculating density and volume

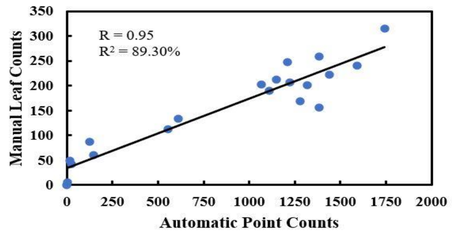

Fig 7. Correlation between automatic point counts and manual leaf counts in orchard

RESULTS- Density Maps

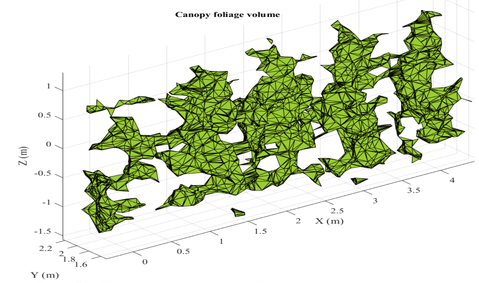

Fig 8. Tree canopy volume measurement

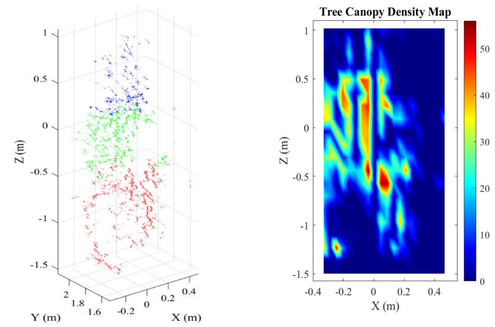

Fig 9. Tree canopy density map

- Tree canopy density map was generated from the acquired points and the estimated number of leaves. The color bar used in the map provides information about the number of leaves per 0.005 sq-meter (i.e., area of one grid) area.

CONCLUSIONS

- Results reported a strong correlation of 0.95 between manually counted leaves and acquired point cloud data from a LiDAR sensor using Fuji apple tree data
- Canopy volume measured by using the alpha shape algorithm showed a strong relationship of 0.98 with manually counted leaves
- Canopy density map can pinpoint high, moderate, and low density, and no leaf regions within the apple trees
- The canopy density information will be used for precision spraying operations for adjusting the nozzle flow rates based on the appearance of the canopy in each section of the tree

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