Introduction
Pruning is a labor-intensive operation constituting 20% or more of annual pre-harvest production costs of crops such as apples. Automatic pruning has a potential to reduce labor use and costs and increase the long-term sustainability of the tree fruit industry. In this work, a machine vision system is proposed for pruning point identification in apple trees.

Objectives
- To design a sensing technique to develop a 3D model of an apple tree.
- To identify unwanted branches and locate pruning points.

Methods
- Data:
  - 3D and color images of apple trees in dormant season.
- Canopy Architecture:
  - A central leader-based fruiting wall.
  - Features:
    - Closely spaced central trunks.
    - No secondary branching.
    - Simpler pruning rules.

Methods
- Sensor:
  - 3D Camera from PMD Technologies, Siegen, Germany.

Features of 3D Camera:
- Provides 3D coordinates images.
- Additional information includes intensity, amplitude and flags corresponding to each 3D point.

Skeletonization
- Algorithm: Medial axis thinning algorithm
- Input: Point clouds in 3D space

Skeleton Analysis
- Trunk Identification Algorithm (TIA)
  - Input: Junction points in 3D skeleton.
  - Analysis: Connected maximum gradient points.
  - Output: Junction points defining a trunk.

- Branch Identification Algorithm (BIA)
  - Input: Junction points and trunk points.
  - Analysis: Depth first search at each trunk point to find the longest branching from the trunk point.
  - Output: Branch points for each branch.

Results
- Skeleton maintained the medial axis and connectivity of the 3D point cloud.
- TIA and BIA: Successfully detected all the trunk points.
- Successfully detected 18 out of 19 branches.
- Pruning point detection: Successfully detected all the pruning points based on the simplified pruning rules.

Summary and Future Work
- 3D machine vision system is promising for locating pruning points in apple trees.
- Further experiments are underway for calibration and statistical evaluation.

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