

Computer Vision for Tree Fruit Production – a new ARS program

Automation and decision making processes

- Automation of many fruit production systems require a computer to do the reasoning work that humans do so easily. For example:
 - Given an image, is there a piece of fruit in the image? Where?
 - Given the data from various sensors, does the irrigation system needed to be turned on? When does it need to be turned it off?
 - Where should this piece of fruit be placed? How should the machinery be moved so as to not injure the fruit or the machinery?

Computer Vision

- The field of computer vision seeks to understand how computers can be used to do visual reasoning without human intervention.
- The most successful applications of computer vision have occurred when the environmental conditions are tightly controlled, such as:
 - Factory product inspection
 - Factory robotics
- Open problems that still generate a lot of attention:
 - Human face recognition
 - Human activity recognition
 - Autonomous navigation in unconstrained environments

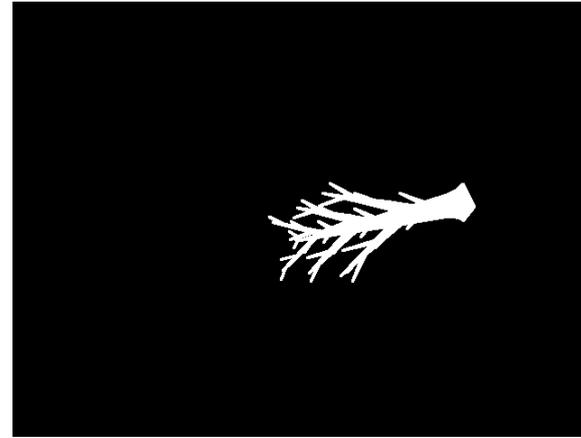
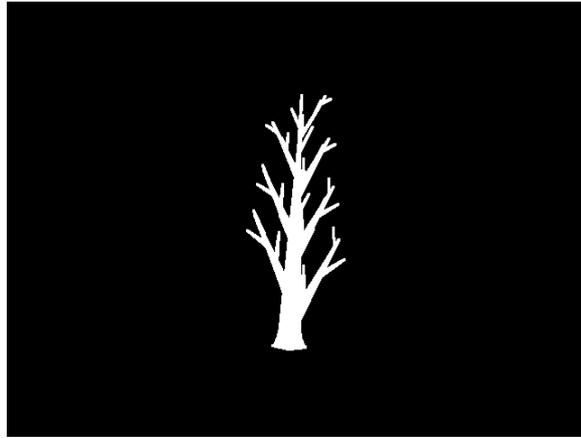
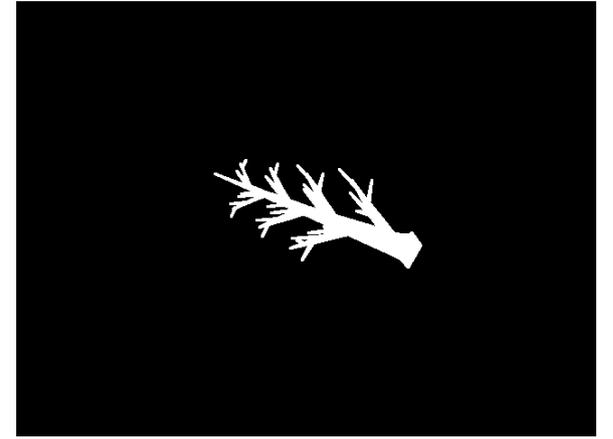
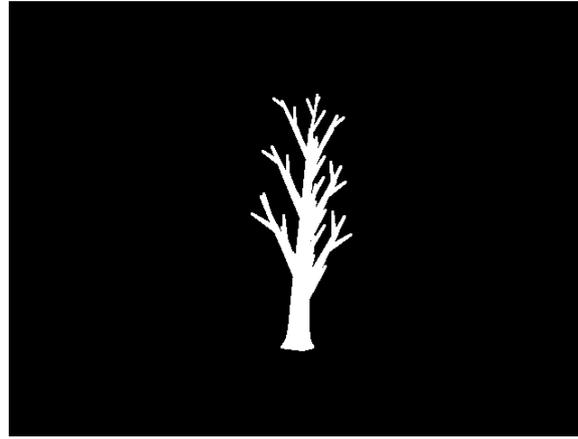
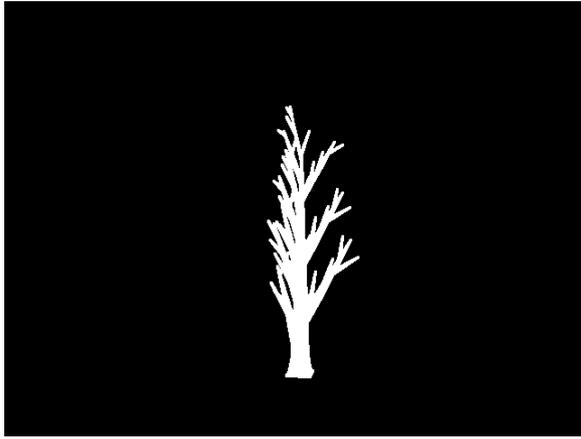
Computer Vision applied to Fruit Production Systems

- We are currently working on automated dormant pruning.
- Pruning is done when the leaves are absent. The shape of the tree without leaves is the simplest that it will be all year, making automation of pruning feasible.
- Once branches are pruned, they do not have to be treated gently or in any particular manner, unlike when fruit are harvested.

Outline of steps needed for automated dormant pruning

- 1. Take photographs of the trees with digital cameras.
- 2. Generate a three-dimensional model of the tree given the photographs of step 1.
- 3. Select the pruning points according to the criteria specified by horticulturists.
- 4. Use a robot to cut branches at the points specified.

Step 1: Acquire photographs of the tree



Digital images of the tree from various different positions and angles are acquired.

Step 2: Generate a 3D model of the tree from the images

- The tree to the left shows the 3D model of a tree that generated the images on the previous slide (simulated data).
- Ongoing research is dedicated to generating the 3D model accurately.
- A question associated with this work is what level of precision is necessary in the model in order to make pruning cuts that are acceptable to growers.



New equipment for this program in 2010

- 20 color cameras
- 5 NIR/color cameras
- 2 robot arms and controllers, one for laboratory use and one for field use



Example of computer vision usage in your home

Kinect (Microsoft) works using an RGB camera, depth sensor, multi-array microphone and a custom processor running proprietary software.

The camera looks for your body, locks onto it, measures the three-dimensional positioning of 48 key joints in your anatomy and ignores everything else.



Is this work being done on grape?

- Robotic pruning is currently being done on winegrapes by a company in California.
- They use a different approach for the 3D model generation.
- This is good because now two different approaches for 3D model generation are being tested on agricultural objects.
- 3D model generation of agricultural objects is a hard problem not currently dealt with by the state-of-the-art in computer vision. Once a solution is found, however, the methods developed in this project can be applied to other agricultural applications.

Questions or Comments