Massey University
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Robotics in Horticulture

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Southern Cross Robotics Ltd.

RoboticsPlus Ltd.

We need horticultural robots

- Horticultural tasks are arduous, expensive and it is difficult to get and retain labour

- Industrial robots are common, agricultural ones are not (except the automatic field harvester)

Existing robotic fruit/veg pickers

- Greenhouse robots
  - Pick cucumbers (45 s), mushrooms, lettuce and strawberries (10 s)
  - Stationary robotic fertilizer & sprayer with moving potted plants
  - None commercially viable except Romobility Youto strawberry picker (Japan)
  - http://www.youtube.com/watch?v=Fcvhtn7I2qw&feature=related

•Orange-picking robot (Italy early 1980's)

- 2 tonne tracked vehicle

- telescopic arms with camera and blade mounted in the gripper

- manually driven to start of grove

- uses GPS way points to navigate along the grove

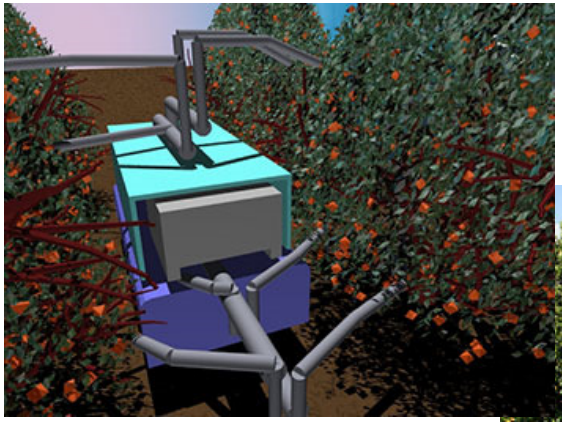
- pick time 8.7 seconds (no wind), % picked unknown

- fruit placed in bin?

- Apple-picking robot (Belgium, 2004)
  - manually driven tractor drives Panasonic robot to tree, stabilizes robot platform, shrouds tree
  - suction cup with camera at centre picks apples
  - harvests 80% of apples with pick rate of 9 seconds
  - manual handling of picked fruit

Massive Financial Support

- Vision Robotics (San Diego, 2002)
  - Scout robot forms a 3D map of the location and size of fruit (oranges)
  - Picking robot with 8 arms
  - Design phase only
  - $5M



- US Dept. of Agriculture

-$10M funding in 2008 to Carnegie Mellon University for research into robotics for apples ($6M) and oranges ($4M)

-Goal: to navigate rows and recognize fruit in 3 years

The Problems

- navigation (to the orchard, within the orchard) – GPS, intelligent computer vision
- chassis design – robust, cheap, all terrain, all weather, all tasks
- intelligent vision which makes sense of the target (fruit, trunk,etc.) obscured by other fruit or foliage
- sophisticated design of the robot arm and end effector/gripper
- intelligent produce handling
- robot must perform many different tasks (pick, prune, bud count, pollinate, fruit count)
- general intelligence – re-fuel, load/unload bins, function autonomously (end of row, stump in the way, dirty camera, rain, light level)

The autonomous kiwifruit picker

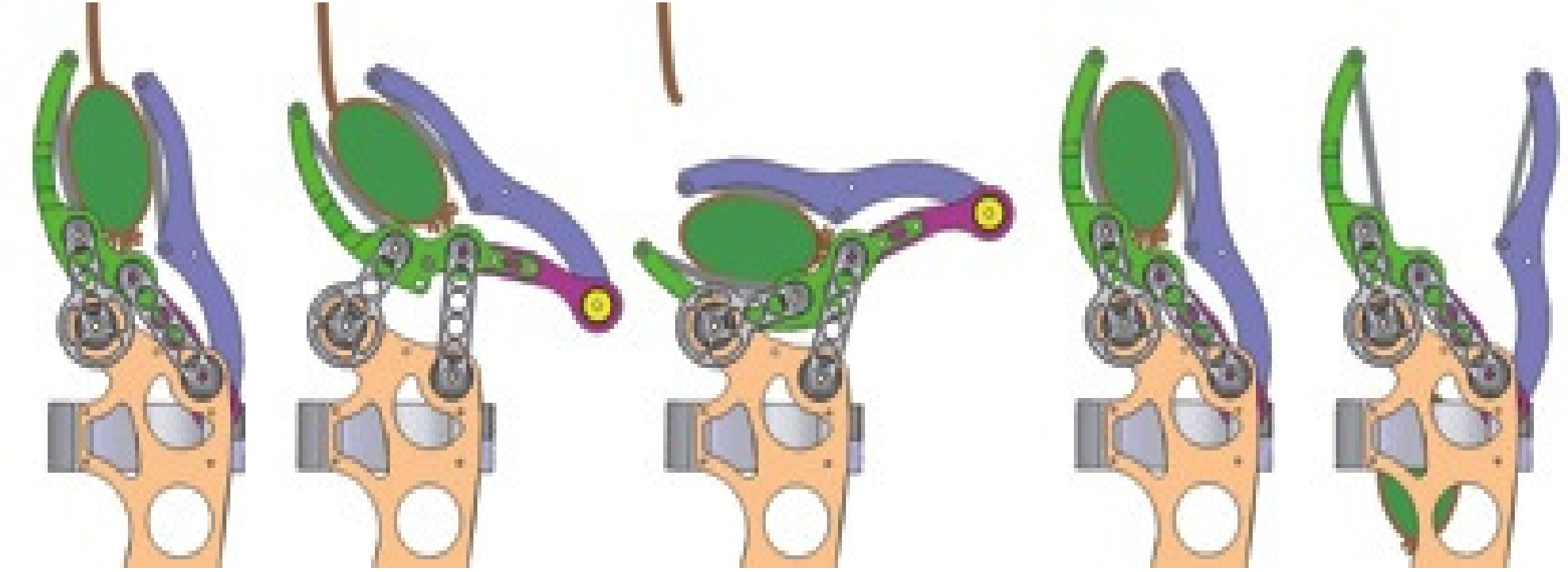
Navigation

- GPS to navigate to orchard
- Computer vision to:
  - recognise poles and walk along the avenues picking
  - 3-point turn to pick both sides of the row
  - navigate around the ‘dead man’ at the end of the row
- Maximum speed 5km/hr

Keeping an eye on the fruit

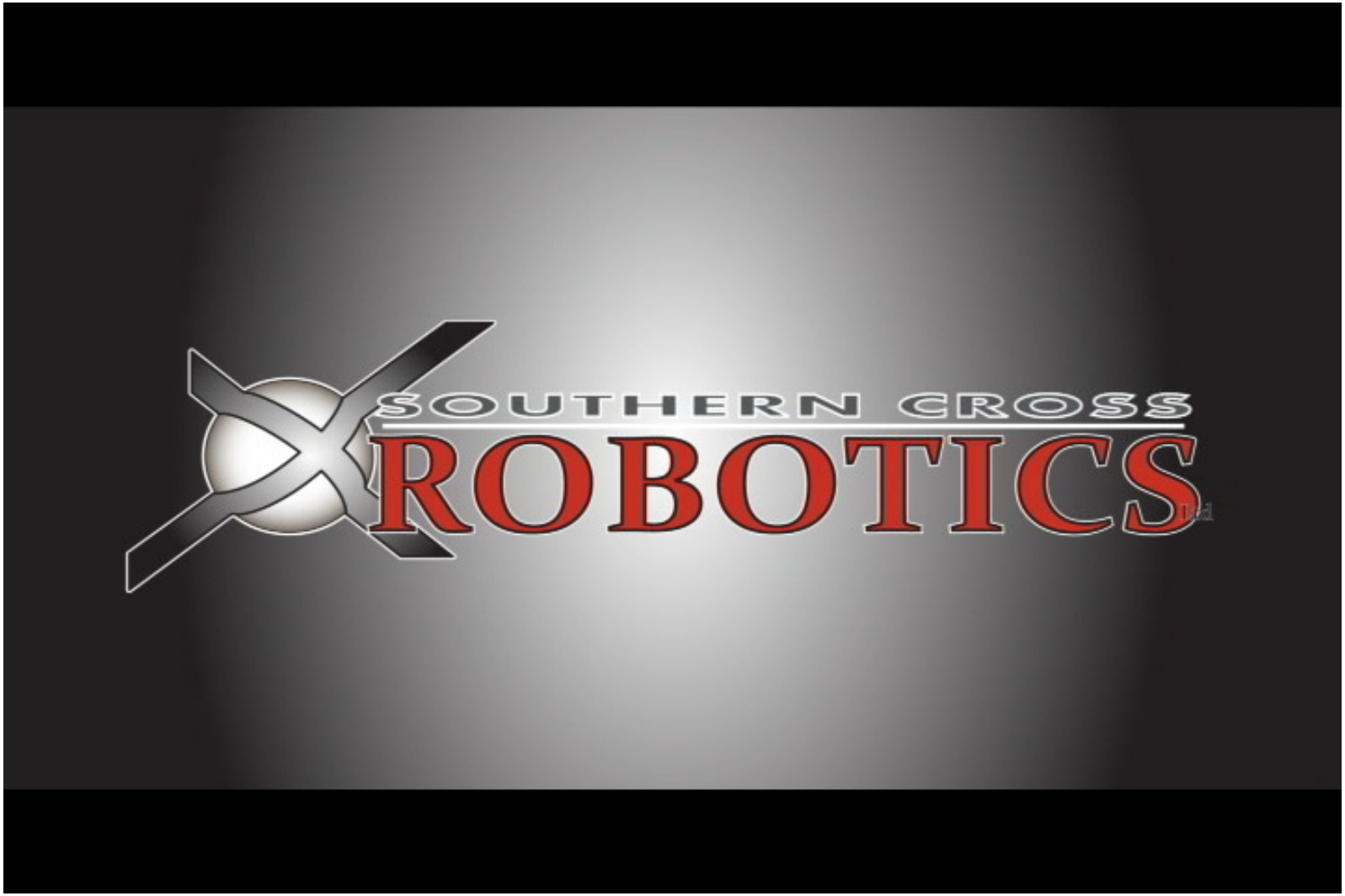
- 8 colour webcams, auto-iris lenses and framegrabbers look at the canopy and use stereopsis to get the coordinates of the fruit.
- 2 webcams look at the bin and map its surface height

Picking hand



Robot arms

- Off-the-shelf robot is too expensive, too heavy and too unfriendly
- Custom-designed arms (4) are light, simple, cheap.
- Programmed to do a ‘go to’ move and a ‘pick’ move
- Pick time 1 second (each arm), ¼ second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The Future

- Pick for the 2010 season
- Extend intelligent vision – only pick fruit of the correct size and shape, discard defective fruit.
- Collect data on harvest rate, fruit damage, orchard yield, percentage ‘good’ fruit, etc.
- Interact with packhouse – communicate the quantity, size and quality of fruit as it is being picked. Receive instructions from the packhouse on what to pick.
- Implement other applications: pruning, pollination, bud count, fruit counts