Autonomous Extraction Systems

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Goal / objectives:

FWPA: review of remote control / autonomous systems for forestry

- Forestry companies interested in developments.
- Australian manufacturing opportunities for forestry equipment.
- Identify pathways for ‘realistic’ development.

“The future of timber harvesting systems will certainly be robotic. The question is, how will we get there?”

BARBRO-Autonomous-Harvester, Fredrik Ausinsch, Umea Sweden
Robots in the forest?
Definitions

**Automation** - operating a process by highly automatic means, as by electronic devices, reducing human intervention to a minimum.

**Robot** - a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer.

**Autonomous** - having the *freedom to act independently*; navigated and maneuvered by a computer without a need for human intervention under a range of driving situations and conditions.

**Slave (machine)** - machine or component controlled by another machine.
Robots…

- Just celebrated its 50th birthday!
- ‘Old’ Robots? – allowed people to avoid doing “dirty, dull or dangerous” tasks.
- ‘Modern’ Robotic / Autonomous machines?
  → “economic growth, improved quality of life and empowerment of people” (Christensen, 2016)
- Forestry? plenty of exciting possibilities, BUT almost complete absence of any ‘productivity’ / cost information!
Semi-autonomous? Yarder example

Computer control / automated carriage movement.
→ no operator and or operator free to undertake other tasks.
Semi-autonomous
- Konrad ‘Pully’

Semi-autonomous, but guided by cable!
Designed for slope, shuttle between harvester and roadside / landing area
Results? Autonomous opportunities by Harvesting Task

**Felling:** most exciting – but least likely! Best suited to teleoperation for niche requirements.

**Extraction:** Most realistic – technology required is mature & working environment is suitably constrained (BUT: loading and unloading!)

**Processing:** lends itself to higher levels of automation IF work tasks and environments become more defined

**Transportation:** Will align itself with transportation on public road - but more immediate opportunities for slaves
Autonomous felling?

- Hardware is there – technology exists
- Software is not – hard to see the trees!

Output from the OSU / USFS tree identification vision system: Lucas Wells & Woodam Chung
Felling – use ‘slaves’

- For ‘security’ & social acceptability
- 1 operated + slave machines cutting multiple rows
Best Opportunity?

Autonomous Extraction

- Most logical + largest commercial opportunity
- Forwarder / skidder, shuttle logs / stems from harvester to ‘landing’
- GPS control + sensors

*Picture: Ola Ringdahl, 2011*
Autonomous ‘Extraction’ - from Agriculture

Tractor Drone
- Already advanced - for harvesting crop (e.g. grain)
- Aligns with harvester using GPS + sensors
- Returns to unloading area by GPS
Robotics in Agriculture

Similarity?

They have adv. of both scale and more homogenous operating environments.

- $240b market opportunity,
- $45b for small driverless tractors (*Economist*)

![Purpose built autonomous farm tractor](image)
Purpose-build design..

Manufacturing opportunity = Cableless!

- Monitored and controlled via a desktop computer or portable tablet interface.
- Cab on forestry machine ≈ $100k - $150k ≈ $30/hr
- Many improved design options – e.g. simplified under-carriage design without cab (e.g. steep slope)
Prototype Design

Movement System
- Twin 1000W electric motors propelling and skid steering the prototype

Safety System
- LiDAR for collision avoidance
- Emergency stop feature

Navigation
- RTK GPS navigation system
Control Systems

Front & rear camera transmit live video feed to a remote operator, via:
- Video feed transmitted through local WIFI network
- Mobile networks if in coverage

Machines stop when obstacle detected, remote operator decides

GPS System

- Tracking unit placed on the forwarder prototype
- Constant checking of vehicles position with respect to pre-mapped tracks
- Base station on a vantage point near landing to provide error corrections for increased accuracy
- Potential for increased coverage through multiple base stations distributed around the forestry environment
Autonomous Extraction?

- YES!

- Exciting developments and autonomous technology will become ‘common’ in forestry.

- ‘New’ opportunities for (also NZ!) machine manufacturers.

- BUT! In stages and can expect societal push-back.

- For success, forestry needs to integrate social acceptability, esp. regional employment factors.