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.



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.

<u>**Autonomous**</u> - having the <u>freedom to act independently</u>; 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.

 \rightarrow 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



Autonomous carts (tractor-pulled trailers)

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

Purpose-build design..

<u>Manufacturing opportunity = Cabless!</u>

- Monitored and controlled via a desktop computer or portable tablet interface.
- **c** Cab on forestry machine \approx \$100k \$150k \approx \$30/hr
- Many improved design options e.g. simplified undercarriage 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 stops 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?





- 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.

