The potential of intelligent operator tutoring systems in mechanised loggings

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Intelligent operator-tutoring system in this context:

A system, which generates machine-process or monitoring data into a form, which guides, assists and tutors the operator

System, which...

a) eases the decision making process of the operator
b) guides the operator to utilize effective working models and techniques
c) assists the operator to work with the machine economically efficiently without overloading the machine and its components needlessly
Few facts

WHY and HOW?

a) Operating in mechanised loggings is highly demanding and takes time to become expert
   ▪ Learning takes 1-2 years in order to reach the performance capacity of each operator (Prufürst 2010, Ylimäki 2011)
   ▪ 2 to 3 fold productivity difference between unexperienced and experienced (Ylimäki 2011)

b) Forest machines monitor and record wast amount of machine function, work element, performance and spatial work condition data
   ▪ How to compile a manual for utilizing "building blocks" of machine data?
Operator tutoring systems in other industry branches

- Development has started in aviation, cargo shipping (autopilot, -navigation) and in military industry
- Car industry has been concentrated in safety, usability and navigation issues in last two decades
- Recently utilized more and more in heavy mobile machinery such as excavators, material handling machines, carriers in mining etc.

- According to the studies, the use of driver/operator supporting systems have reached:
  - Productivity, safety and quality improvements
  - The overall production costs have been decreased
  - According to the truck and heavy machinery operators, the uncertainty while operating has decreased and thereafter productivity levels have been increased (Huang et al. 2005, Meriläinen 2010)
Objectives:

- To obtain users opinions of the potential and the need of the operator tutoring systems in mechanized loggings
- To classify main problems hindering the logging operations

Material of the questionnaire based study:

- Harvester and forwarder operators (208 responses)
- Logging contractors (47),
- Teachers (26) and students (39) of forest machine schools
RESULTS

- **Factors hindering efficient cutting (top 5):**
  1) under-growth disturbing the cutting
  2) unclear border-marking of the cutting site
  3) deficiencies in cutting orders
  4) poor bearing conditions of the terrain
  5) difficulty of estimating the distance between strip roads

- **Factors hindering efficient forwarding (top 5):**
  1) insufficient space for roadside storages
  2) poor bearing conditions of the terrain
  3) low bunching quality of log assortment bunches
  4) too narrow strip roads
  5) inefficient directing of strip road network
Potential and need of the operator tutoring systems in mechanised loggings

RESULTS

Main problems in wood harvesting hindering contractors’ business

1 = not a significant problem, ..., 5 = remarkably significant problem

- Availability of competent operators
- Productivity remains too low for the beginners
- Harvesting quality remains too low for the beginners
- Productivity differences are too big between beginners and experienced operators
- Guiding and mentoring of beginners is difficult and consumes too much resources
- Planning of work differs widely among operators
- Season-based working hinders the employing of operators year round
- A priori info (such as trafficability) from the site do not match the reality
- Motivation to work is low for the beginners
- Removal intensity (too high/too low) do not match the target in thinnings
- Remaining stumps are left too high
RESULTS

Potential and need of operator tutoring in cutting operations

1. Locating the protected areas inside logging sites
2. Presenting the cutting borders on the map
3. Monitoring harvesting damages
4. Assisting distances between strip roads
5. Guiding most efficient working techniques
6. Monitoring and feedbacking the shares and the dimensions of timber assortments
7. Monitoring of stump heights (the position of cutting)
8. Assisting to locate the harvester in work positions for efficient cutting
9. Assisting for proper share of removal in thinnings
10. Supporting the selection of removable stems in thinnings

1 = No potential, ..., 5 = high potential

Harvester operator (N=118)
Teacher (N=21)
Student (N=25)
Potential and need of the operator tutoring systems in mechanised loggings

RESULTS

Potential and need of operator tutoring in forwarding operations

1,0 1,5 2,0 2,5 3,0 3,5 4,0 4,5 5,0

Pointing the locations of roadside storages at the map
Guidance of the trafficability of thinning tracks
Alarming, if site is not finished (e.g. timber under snow)
Navigating to the closest timber storage at the road side
Assisting the efficient hauling techniques per each loop of track network
Reporting of locations of timber at the site
Guidance of hauling "urgent" timber assortments at first
Guidance of maximizing load capacity by taking into account strip road trafficability
Assistance in minimizing rutting during hauling timber
Presenting strip road network on the screen

1 = no potential, ..., 5 = high potential

Forwarder operator (N=82)
Teacher (N=18)
Student (N=18)
Key findings from the operator interviews:

- Logging maps together with GPS-positioning have been experienced to be a big step forward.
- According to operators, valuable additions would be:
  - Pre-information of terrain mobility, soil trafficability in the stand (bearing of soil, terrain steepness)
  - Volumes of assortments distributed in the strip roads
- Operators with long logging experience were not so interested to have tutoring:
  - Still the need to acquire some feedback from their performance was risen
- Audio-visual tutoring was estimated to be functional:
  - Beep-sound would inform operator to check the monitor
Concluding remarks

- Forest machine operators were stressed in the inquiry results (perceptions of others are important also)
- Harvester operators were slightly less willing to have tutoring than forwarder operators
  - Monitor-based decision support and information flow during cutting is already high
  - Timber forwarding could be improved by utilizing spatial cutting data produced by the harvester
- Substantial benefits are expected with intelligent tutoring systems in the future
  - By boosting the learning and education
  - Improving the overall performance in mechanized loggings
Potential and need of the operator tutoring systems in mechanised loggings

Hauling support system

Strip road network and wood assortment bunches
EffFibre-project “Intelligent operator tutoring systems in wood harvesting” – What it’s all about?

1) Collecting background information of operator-tutoring systems used in other industry branches
   - Benefits, challenges, experiences

2) Clarifying the potential and the need of intelligent tutoring systems among forest machine operators and contractors
   - Where to direct the development?

3) Developing demo applications for testing features for tutoring systems and for acquiring operator feedback

4) Exploring the potential of different tutoring systems in wood harvesting
   - Tests and field surveys in order to magnify benefit potential

5) Further development studies of operator tutoring applications together with partners (Ponsse, Creanex)
Thank you