

The potential of intelligent operator assisting systems in different phases of mechanized loggings

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Abstract:

Cut-to-length (CTL) harvesting with the sophisticated forest machines in European logging conditions is highly demanding and requires high expertise and skills by the operators. In order to reach the top performance of each operator's skill level in working with forest machines training time can take 1 to 2 years. Intelligent operator assisting systems could ease and improve the work in logging operations especially for inexperienced operators as well for other operators with varying experience level. Operator tutoring system in varying logging situations and conditions is an instrument for a) decreasing decision making strain and uncertainty of operators, b) assisting cost- and economy efficient working models and techniques, and c) guiding the efficient use of machine without loading the machine system and its components needlessly.

The objective of the study was to point out the potential of computer-based assistance in divided elements of the whole harvesting operation - both in cutting and forwarding. A questionnaire-study was executed for forest machine operators, logging entrepreneurs, as well as students and teachers from vocational schools educating mechanized harvesting. According to the questionnaire study, forest machine operators were fairly willing to receive intelligent assistance and guidance while operating. By extracting the three most potential factors to be included in tutoring, harvester operators needed tutoring and guidance in locating protected areas inside logging sites, locating cutting borders and monitoring harvesting damages. Forwarder operators needed guidance in the location of roadside storages, the trafficability support for strip road network and the location of cut timber at the site.

Keywords: CTL-harvesting, operator-tutoring system, forest machine operator, inquiry

1 Introduction

The CTL-harvesting with the sophisticated forest machines in European logging conditions is highly demanding and requires high expertise and skills by the operators. Mechanized loggings require long working experience in order to gain on operator's final skill level. Productivity differences between inexperienced and experienced operators can be somewhat 200 to 300 percents (Ylimäki 2011, Kariniemi 2006), but even among experienced operators with several years logging career the difference can be 50 % or even more (Sirén 1998, Väättäin 2005, Ovaskainen 2009).

Currently the compensations in mechanized loggings between contractors and forest industry are negotiated to level corresponding to the productivity levels of experienced, well-practiced operators. Ideal situation would be to recruit always skilled and productive operators. However, especially young inexperienced operators starting their career call for long learning period in order to get adjusted in practical conditions and to operate enough productively (Purfürst 2010). According to Purfürst (2010) and Ylimäki et al. (2011) learning period for beginners can last 0.5 to 2 years.

Operator tutoring accomplished by experienced tutoring operators has been experienced to be important and necessary for young operators while facilitating the beginning steps of their career. Nevertheless, logging contractors do not have enough resources to transmit good practices by tutoring inexperienced operators personally while working.

At the moment, modest CTL-logging machines record vast amount of machine-function and process data. In addition, spatial a priori information available on logging conditions together with precise and accurate machine positioning, in principle, enable developing an operator-tutoring system. A system, which assist the driver for conducting efficient techniques during loggings. Currently, the process data, available from harvesters and forwarders, have not been utilized efficiently for the operator-tutoring purposes in logging operations.

As a comparison, other industry branches such as the car industry, aviation and mining industry, intelligent operator tutoring systems have improved productivity, safety and quality thus decreasing the overall costs of operations. As a simple example, a car navigator guides a driver by showing the shortest or quickest way to destination thus diminishing driver's false routing decisions while driving.

The main objective of the study was to investigate the potential and the necessity of operator-tutoring systems for mechanized CTL-harvesting in Finland. In addition, main problems hindering the effective logging operations were clarified.

2 Material and Methods

The potential and the necessity of operator-tutoring systems in mechanized loggings were investigated by accomplishing an enquiry for forest machine operators, contractors, as well as teachers and students from vocational schools educating mechanized harvesting. The number of returned questionnaires was 208 from forest machine operators, 47 from contractors, 39 from pupils and 26 from teachers. Replying percentages of the inquiry were 26 for machine operators and 17 for contractors. Questionnaire was divided into three different sections: i) background information, ii) most significant problems hampering logging operations and iii) the necessity/need for tutoring systems in logging operations. In addition, the perceptions of the form and the style of tutoring were asked by phone inquiry from 20 operators (10 harvester and 10 forwarder operators). Operators and contractors involved in the query represented well the whole operator/contractor population with respect to age, working experience, areal distribution and fleet size. Therefore the study results can be generalized.

3 Results

In the order of importance, the five most significant factors hampering the cuttings were 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 and 5) difficulty of estimating the distance between strip roads. Correspondingly, the most significant factors in forwarding were 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 and 5) inefficient directing of strip road network.

According the forest machine contractors, the five most significant factors hampering logging business were 1) poor availability of competent operators, 2) low level of productivity by the beginners, 3) low harvesting quality by the beginners, 4) big productivity differences between beginners and experienced operators and 5) laborious guiding and mentoring of beginners. In addition to the factors presented here, there are several other challenges where operator tutoring systems could give help for the operators while working.

According to the inquiry results, harvester operators needed most tutoring and guidance in locating protected areas inside logging sites, locating cutting borders, monitoring harvesting damages, assisting distances between strip roads and guiding most efficient working techniques (Figure 1). Correspondingly forwarder operators looked-for guidance in locating roadside storages, trafficability and mobility support

for strip road network, locating cut timber at the site and efficient driving direction and driving loops for the each load (Figure 2).

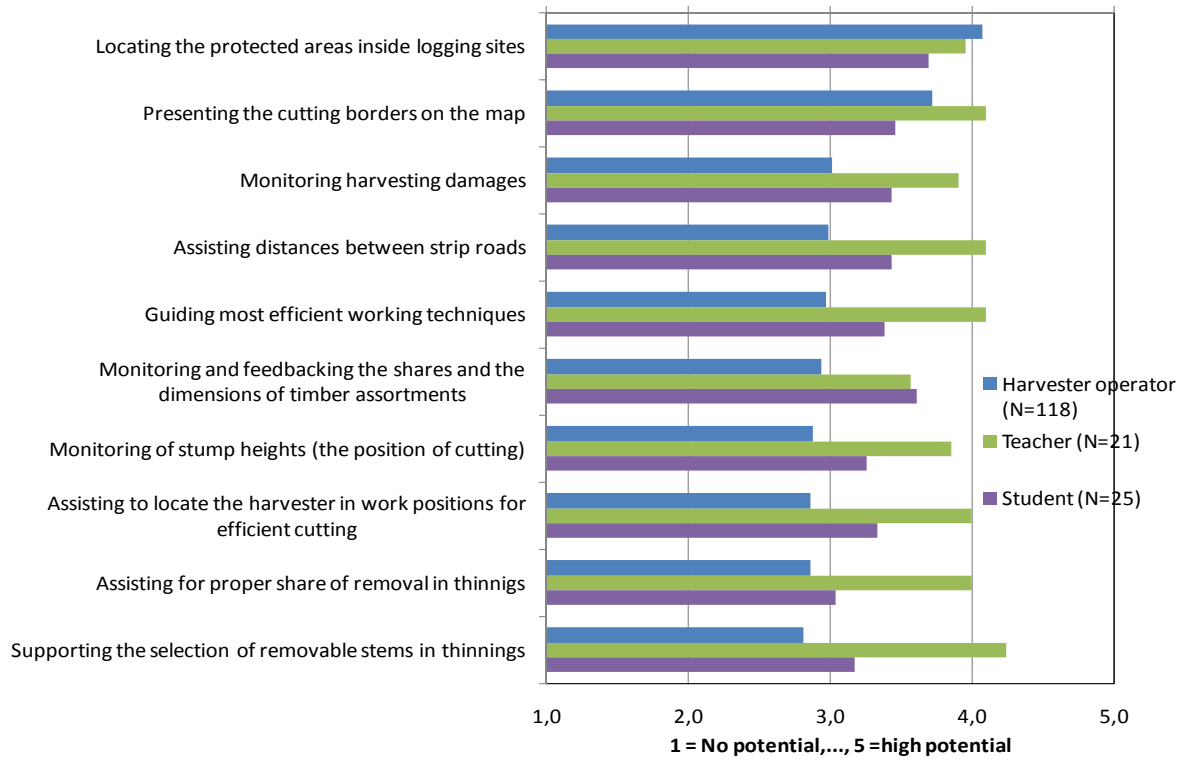


Figure 1: Potential and necessity of intelligent operator tutoring in CTL-cuttings

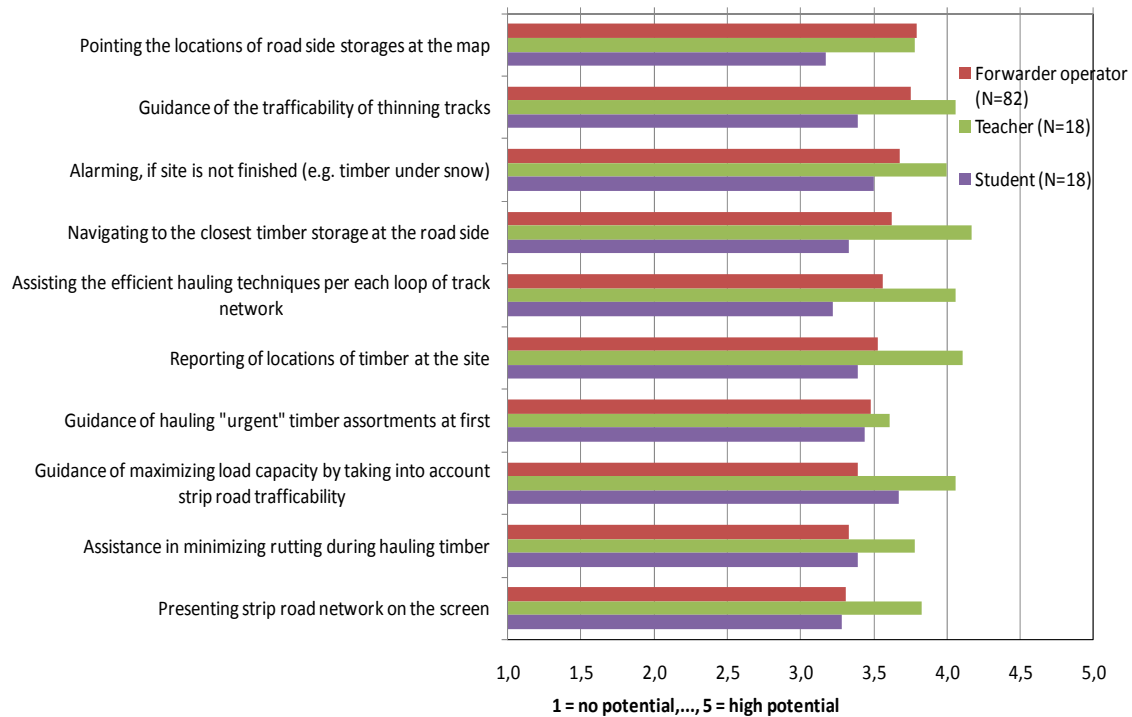


Figure 2: Potential and necessity of intelligent operator tutoring in timber forwarding.

4 Discussion

In this paper, forest machine operators were stressed in the inquiry results. In addition to the perceptions of experienced operators, opinions and perceptions of students and teachers are also important while developing intelligent tutoring systems for mechanized loggings. Operators in the beginning of their career might need guidance in different aspects and phases during loggings than more experienced ones.

In general, forest machine operators were fairly willing to receive assistance and guidance while operating. Harvester operators were less willing to have tutoring than forwarder operators. One reason for this might be constantly high tempo during cutting. Furthermore, monitor-based decision support and information flow during cutting is already relatively high and, therefore, the acceptance in receiving tutoring by information systems remains moderate. Correspondingly, forwarder operators have an impression that timber forwarding could be improved by utilizing effectively spatial cutting data produced by the harvester.

Even though students of forest machine schools did not experience the operator tutoring so important than other respondent groups, teachers' perceptions revealed that there is essential need for operator-tutoring systems. Understandably, teachers of forest machine schools are in the "viewpoint" to obtain the holistic situation of the challenges in education and in real logging operations. In the future it is expected, that substantial benefits will be gained from the intelligent operator tutoring systems by boosting the learning and by improving the overall performance in mechanized loggings.

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