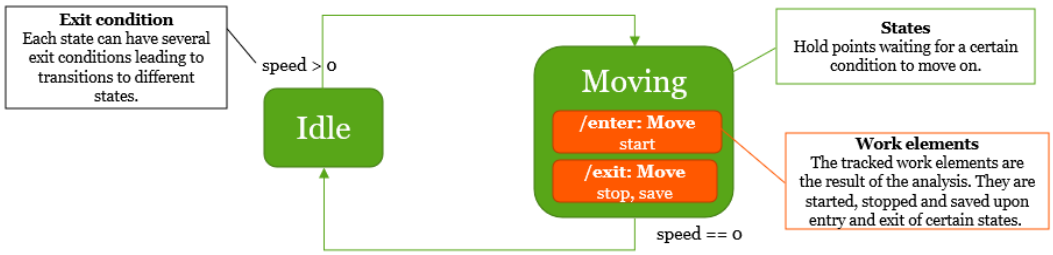
Stakeholder-oriented article

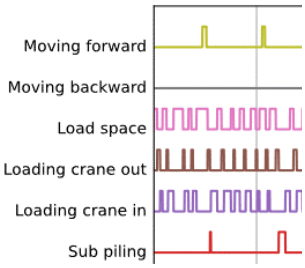
Automatic detection of work elements of forestry machines

Identifying what the machine does, the work elements, is the basis for further analysis of operator performance. The basis for this identification is sensor data that is available to the machines. Modern forestry machines are equipped with many sensors to support different functions. Examples of such sensor information that is available to the machine are crane joint angle, mass of the load in the grapple and angle of the delimbing knives and saw bar on the harvester head. For this work we have used data from a real-time forestry machine simulator.

How can work elements be indentified by using data that is available to the on-board computer.

The algorithms are developed using the concept of finite state machines, which is a theoretical concept for modelling states, transitions and events. Two state machines are used to keep track of the work elements of the forwarder and three for the harvester. The figure below is an example of a state machine. It has the job of keeping track of if the machine is moving or not and register that into the work element “Move”. The other state machines are more complex.





Two state machines are used to keep identify the following work elements of the forwarder; Move, Loading crane in, Loading crane out, Unloading crane in, Unloading craned out, Load space, Sub piling. Three state machines are used to identify the following work elements of the harvester; Move, Crane out, Crane in, Fell cut, Cross cut, Processing. 3 state machines. The figure to the left is an excerpt of 300 seconds of work while loading a harvester. When the line is raised it means the corresponding work element is identified. The state machines can be run continuously while the forestry machines are operated.

The algorithms can be used for further analysis of the work practices of operating the forestry machines as was the purpose in the AVATAR project. With a digital feedback coach, analysis of the work elements can be used to measure the effect of the feedback. They can also find further use in forestry technology research as an alternative to manual time studies.

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