Low cost solutions for increasing the efficiency of automatic log sorting lines in the sawmill industry

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Abstract

Some companies in the sawmill industry, which use logs as the initiating material, are provided with automatic log cutting and segregating lines. The logs that are processed on these automatic production lines are exposed to three stages of processing in various order, which are debarking, length appropriate cutting, and sorting that usually depends on the length and logs diameter. Many producers of both fully automated lines and o their modules, have made many efforts to increase the processing efficiency, which influences the rapidity of processing and the final output. Many ideas focus o the modification of cutting modules, as the cutting is the most time consuming process. This paper presents a solution of the cutting module modifications, which is an alternative to those suggested by the producers. Furthermore, the proposed solution meets expectations of many users of this equipment in the sawmill industry, in that it presents low-cost solution improving already existing and expensive equipment.

Key words

Sawmill, log sorting lines, power fit speed, efficiency

Introduction

The paper [1] compares the mechanized and non-mechanized sawmill industry companies in Wisconsin. According to the paper, only 44% of all the companies that are engaged in log processing are described as mechanized. A similar situation is observed in other regions in the world, as well as in Europe. The exception for this rule is Scandinavia, where, for example, in Sweden almost 96% companies use automatic log sorting lines. This undoubtedly contributes to the country’s leading position in the world’s sawmill industry. Low automation in the USA and Europe result from the very high implementation cost of the automatic cutting and sorting systems. Nevertheless, this paper [1] shows very clearly how profitable using the automated sorting process, as it directly compares the profits of, and results of, these two kinds (mechanized and non-mechanized) approaches in Wisconsin. There are many examples of increasingly complex measuring methods used in the sorting lines. The author claims this to be a positive trend in the industry. Each solution gives a more exact measuring result, and new possibilities. For example the article [2, 3]. It does not change the fact that if we look at the efficiency from a holistic point of view, it continuous to be an open and attractive subject for researchers to explore. However, the low level of mechanization in many regions calls for the need of inexpensive and low-capital methods to improve efficiency. This paper will present a simple solution which can be implemented in an already existing device. Most of the sorting lines for roundwood, and all of the lines designed for large diameter wood are processed with chain saws. The length of chain saw exceeds 1m and even reaches 2m. Therefore, the time of the cutting process, is the longest during the fabrication period, this is the main factor in determining the final efficiency of the fabrication. In most solutions, cutting modules are equipped with chain saws. Power fit is accomplished with the contribution of hydraulic cylinders. Most cutting process appears as shown in Figure 1.

Fig. 1. Cutting process algorithm

The proposed time of sawing, and the low cost of upgrade of the cutting module have been learned from the offers long experience with implementation and monitoring of sawmills in Poland. The two top European firms producing such machinery are also focused on increasing the efficiency. Each of them is attempting to shorten the cutting time. The above mentioned firms attempted to reverse the saw to a point of non collision log transport. Prototypes were built and many experiments were conducted to prove that this is an efficient solution. The primary goal
was to find a safe saw location above the log so that the following segment of wood would not damaged the equipment. As a result, the time for full return of the blade would be saved. This solution required thorough information about the diameter of the log placed in front of the saw and secondly the exact information about the saw’s position. The first information requires the implementation of a 2-axis scanner in front the saw, which contributes to a cost increase. The second information requires following the saw’s position by the angle rotation of the saw’s down bolt monitoring or by following the saw’s blades cutting angle, using sensors on the runner. For the reasons presented above, the idea has never been implemented in series production. The implementation of the idea was too expensive to be accepted by the industry.

This paper presents an alternative solution, implemented and tested in the industry by the author. The final result was a reduction in the unproductive time the saw uses to moves back to the it’s starting point. This solution does not require any additional information about the log’s measurements and the saw’s position

Assumptions

The proposed solution occurs when small modifications in the hydraulic circuit are made. This circuit is responsible for power fit speed. By adding a simple device and equipping the saw with an optoelectronic sensor (receiver/ transmitter) with range 2-3m, the modification is complete. The solution presents a different approach to the problem of the saw’s time-consuming return move to initial cutting position. The solution presents a different approach to the problem of the saw’s time-consuming return to initial cutting position. The additional advantages of this solution are low cost and low downtime in the small changes made to existing machinery. The industry needs are easily met at low cost to the company, and will be met with wide approval and practical use. This concept assumes automatic 2-step control of the saw’s movement speed which depends on the temporary position of the saw blade in the entire cycle. In most cases the work cycle duration time of the saw is exactly as presented above (figure 1.). The machines construction looks as presented in figure 2. As one will notice the length of the saw is considerable. Therefore, traditional systems that use only one speed while work cycle duration time, determined by saw’s maximum speed, cutting process, lead to time loses. The suggested solution aims to introduce the automatic change of the saw’s power fit from an approachable one to a cutting one. As a result of the two different speeds, the implementation we achieve is a meaningful time saving process in the cutting cycle. As mentioned before, the concept assumes two actions. One of which is modification of the hydraulic circuit through the addition of simple parts. The second action is to provide the saw with an optoelectronic sensor that allows identification of the saw’s two positions we are interested in. These positions are: the saw while cutting material, and the saw on its return it initial cutting position.

Hydraulic circuit modifications

As it was said above, in most cases, the hydraulic circuit is responsible for the power fit. To be more exact, the cylinder of the mechanism. See figure 3. To achieve two different power fit speeds, there may be installed a bypass valve and choking-coil between the pomp and cylinder. During the movement, when the saw is outside the material, the valve is open and hydraulic liquid can reach the cylinder’s chamber without any loses. During this cycle the blade speed reaches its maximum value. When the saw reaches an appropriate distance from the wood, the valve will automatically close, and the only remaining route between the pomp and the cylinder is through the choking-coil. This causes a steep decline in the speed of the blade to the one that was set. Although, this rapid switch of speed causes a disorder in the process period. Generally, this is not troublesome because the blade is not yet in the material. An analagical situation occurs in the backward movement after the cutting process. The speed of the system switches automatically to a higher rpm and causes an immediate reversal of movement of the blade to save time taken for the blade to move back to initial position.
Detection of saw position with optical sensor

To automatically control the saw’s speed value, the knowledge of the exact blade position is required. An understandable way to detect exact position of the saw blade, with regards to project specifications, is the use of an optoelectronic sensor. The beam will flow a small distance from the cutting edge and guide the blade on its curse. See figure 4. More precisely said when the saw blade closes on it target the beam will be interrupted, which signals the hydraulic circuit to switch to a lower speed that is appropriate for the process at hand. Similarly, on its way back, the sensor indicates the saw’s having finished it work, the speed will again increase until such time it meets its new target on its backward motion. Speed switch will not result in damage to the blade chain because this occurs outside of the wood.

At the time when the cutting is finished, the optoelectronic sensor is below the wood and the beam flows into the receiver without any obstruction. This causes the change of the saw’s speed while performing the cutting. There are ways to solve this problem. Below, the author presents the way the problem was solved in the installation on the project.

Fig. 4. Mounted sensors at the saw

Solutions of the problem with the sensor in the research circuit

Fig. 5. PCI card based control system

During testing, which confirmed the advantages of the 2-step speed control, existing machines were used. The machines belong to a company headquartered in north Poland.

The line was equipped with a Control System based on PCI cards and PC computer. See figure 5. Figure 6 illustrates a block diagram of the Control System.

Fig. 6. Block diagram of the control system

The control system controls the speed of the saw by switching the distributor shown on the hydraulic diagram. Additionally, to the control system during testing, were attached an optical sensor on the input and a separating solenoid valve. This allows monitoring of the sensor which is fixed parallel to the saw’s edge. In this case, additional information is provided, which is the monitoring of the saw’s movement from the joystick operator level. Having information about the work done by the system, we can avoid the erroneous reaction of the saw by use of a simple software implementation, which introduces the connection between the sensor and the work cycle. The software allows the change of the speed when the sensor is below the cut-line. Because the solution of this problem is simple, it is universal for any other control systems-- For example, one based on the PLC controllers. We can avoid an erroneous activity of the control system by adding another sensor, which detects the saw’s position. Although this solution requires an additional occupation of additional input access in the control system, it allows us to keep a speed control system as a separated unit.

Test results statistical comparison of one day with and one without proposed system

The record of cutting process on the large log sorting and cutting automatic line is compiled in the tables below. The record was taken from the large company that operates within the wood industry in Poland and its activity mainly concerns wood working. To show benefits of the implemented 2-step movement’s speed control, two records were compared. One of the measuring scanner during the activity of the system, without the speed control, and the other with implemented speed control system that was presented above.
Table 1.
Data from the sorting line work with traditional cutting modules

<table>
<thead>
<tr>
<th></th>
<th>D [cm]</th>
<th>L [cm]</th>
<th>V [m³]</th>
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<tbody>
<tr>
<td>Average</td>
<td>22.23</td>
<td>202.44</td>
<td>0.08105</td>
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<tr>
<td>Max</td>
<td>35.5</td>
<td>245</td>
<td>0.2419</td>
</tr>
<tr>
<td>Min</td>
<td>13.1</td>
<td>178</td>
<td>0.0303</td>
</tr>
<tr>
<td>Quantity</td>
<td>749</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>93.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per minute</td>
<td>1.5625</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.
Data from the sorting line work using proposed efficiency increase solution

<table>
<thead>
<tr>
<th></th>
<th>D [cm]</th>
<th>L [cm]</th>
<th>V [m³]</th>
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<tbody>
<tr>
<td>Average</td>
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<td>198.62</td>
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<td>Max</td>
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<tr>
<td>Min</td>
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<tr>
<td>Quantity</td>
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<tr>
<td>Time</td>
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<td></td>
<td></td>
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<tr>
<td>Average</td>
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</tr>
<tr>
<td>Per minute</td>
<td>1.919</td>
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</tr>
</tbody>
</table>

Fig. 7. Comparison of the number of cut logs before and after using the new system

Conclusion

On the basis of the presented results one should conclude that the solution described in this paper is an easy and inexpensive way to meaningfully increase the efficiency of automatic log sorting lines in sawmills. Furthermore, the solution is interesting because of the low financial cost of its implementation. Another benefit is that of its implementation without the necessity of any significant changes in the existing system. The suggested improvement can be implemented into any system, as it supports the system as an independent part and its implementation and does not require a long down-time during the processing.

References

[5] Liya Thomas, Lamine Mili, Clifford A. Shaffer, Ed Thomas, Defect detection on hardwood logs using high resolution three dimension laser scan data 2004 international conference on image processing (ICIP).