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Roundwood Tracking using Log End Biometrics

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Abstract: Log end biometrics is a physically marking free approach to establish log traceability from forest-site to further-processing companies. Within an Austrian research project questions regarding the applicability of log end biometrics were investigated. This work introduces to biometric log end recognition, summarizes our research and provides an outlook on future work.

1 Introduction

Biometric tracking of wood logs is a potential approach to establish log traceability without the necessity for physical markers like plastic badges or RFID transponders. A biometric log recognition system based on log end images could be used to track the ownership from the forest based industries to further processing companies. Furthermore, the ongoing process optimization in the forest-based and the sawmill industry demands for technologies which efficiently identify wood logs and pass log specific information along the log processing chain.

By analogy to human biometrics, it is assumed that wood logs are unique entities which can be recognized using log characteristics. The approaches presented in [CG03, CG04, FOG08] utilized 2D and 3D scanners to extract geometric wood properties for tracking logs within the sawmill environment. The utilized capturing devices are however, not applicable at forest site.

On account of the fact that timber offers characteristics on log end faces in terms of annual rings, pith position, shape and dimension it is assumed that cross-section (CS) images of log ends can be used as biometric characteristic for log identification. In this work the concept of log end biometrics is introduced and the results of our research are summarized (Sect. 2). We conclude with an outlook on future research needs (Sect. 3).

2 Log End Biometrics

In the FWF joint project TRP254 entitled with "*Traceability of logs by means of digital images (TreeBio)*" we mainly contributed to the research on this field. For biometric log tracking, each log needs to be enrolled by the biometric system (Figure 1). A digital

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camera mounted on a harvester could be utilized to capture one log end of each fresh cut log. Subsequently, the log end image is processed by the system and a log template is computed which is stored, with additional meta data, to the database. Identification of each log can be performed at each stage of the log processing chain. Images for identification in the sawmill could be captured at the sorting station, at the sawmill yard or at any conveyor belt equipped with a capturing device. Subsequently, the image is processed by the biometric system and a log template is computed which is matched to all log templates in the database. The best match specifies the identity of the log.

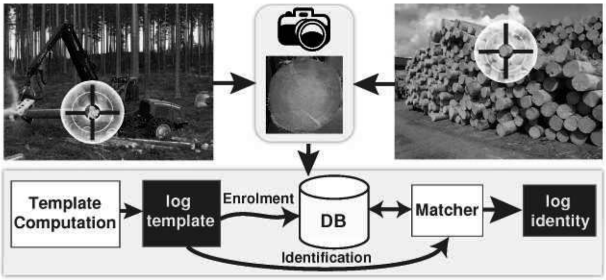

Figure.1: Exemplary enrolment and identification schemes

In our first work [SCPU14] longitudinal and temporal variances of CSs (annual ring patterns) are investigated based on 35 time-delay captured slices from a single log. For human biometrics, robustness of the utilized biometric characteristic is a basic requirement. In case of CSs robustness is related to the temporal changes caused by environmental conditions and the longitudinal variations of the CS pattern within a tree log. Temporal changes are caused by light and humidity and result in deformations like cracks and discolorations. Longitudinal variations result from log end cutting. Results show that, with an increasing time span between two images of the same CS the matching score gets worse. Longitudinal adjacent CS slices (~2.5cm) show good matching scores. An increasing longitudinal slice distance between two CS slices deteriorates the matching score.

In our second work [Sc15b] we shed light on the question if log end biometrics are suited to discriminate between a large set of tree logs. For that purpose we explored the applicability of fingerprint and iris-recognition based methods to identify 150 different tree logs. Additionally, for both methods the impact pact of enhancement is assessed. Results show that fingerprint and iris recognition based approaches can be transferred to the field of wood log tracking and that both are suited for log identification. In the experiments the fingerprint based approach and all iris configurations which use Log-Gabor features achieve 100% recognition rate. Furthermore, all results indicate that shape information of the CS area is required to achieve an acceptable recognition rate and that enhancement significantly improves the performance.

Based on these observations, in [SPU15] we assessed the discriminative power of geometric log end features for the same testset. Geometric features were extracted based on groundtruth data for the CS boundaries and pith positions. Results showed that radial distances from the pith and centroid center to the CS boundary and Zernike moments (Z) show a high discriminative power. The validation of these features for automated CS boundary detection [SU14] and pith estimation [SU13] showed that Zernike moments achieve the highest reliability.

Finally, in [Sc15a] additionally to the single log used in [SCPU14] further two logs are used in the experiments. This enabled to consider CS surface variations which arise if different cutting tools are utilized for the first cut in the forest and the clearance cut in the further processing company (e.g. chain-saw and circular saw). Three different matching procedures enable to present results for annual ring pattern features, shape features and the fusion of both. Results show that feature fusion increases the robustness and that CS surface variations are not crucial for the performance. We conclude that biometric log recognition is qualified to overcome the issue of cutting log ends in the sawmill up to 7.5 centimeters in thickness, even if the second cut in the sawmill is performed with another cutting tool. Furthermore, it is shown that knots are disturbing factors but knots do not introduce any propagative effects to the annual ring pattern and the CS shape.

3 Outlook and Discussion

Our results are very promising and indicate that digital CS images are well suited for log identification in the described setting. However, sawmills usually do not have such cameras installed and the accuracy of the approach is strongly influenced by acquisition conditions (sensor type, dirt, illumination etc.). The future vision is that a biometric log recognition system works in a more sensor independent manner and further processes the available sensor data to determine log quality properties (see Figure 2).

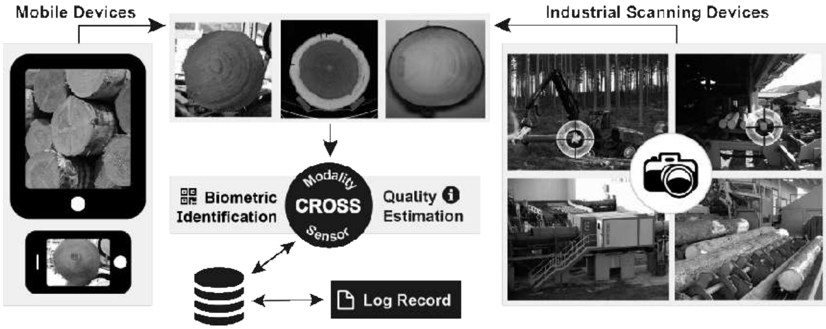

Figure.2: Cross-Sensor and Cross-Modality Log Tracking and Quality Estimation

Collecting and storing data for each single log at different stages of the log processing chain improves the correct allocation of logs, changes and leads to new processes and is thus beneficial to increase the yield.

Furthermore, it can be assumed that CT scanning will become state-of-the-art in the sawmill industry, resulting in corresponding data available at sawmills that can be potentially used for log tracking and wood quality assessment. The question if it is possible to identify tree logs based on a digital RGB log-end image captured in the forest and a second image captured by a CT scanner in the sawmill. Furthermore, the question arises how to link measurement and grading information between the forest and the further-processing companies. Consequently, future research has to deal with cross-modality and cross-sensor log tracking and quality estimation (Figure 2).

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