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Machine learning and RFID-based large wood tracking in rivers

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Large wood (10cm diameter & 1m long) gets recruited into a mountain river system from surrounding forested areas. Instream large wood positively influences the diversity of the river system, creating habitats for terrestrial and aquatic species. However, the corresponding risk to the presence of instream large wood is a more controversial topic in river management. On the one hand, large wood increases the riverbed roughness, partly dissipating energy during a flood. On the other hand, its transport during floods might cause damage to infrastructure. Direct observations or monitoring stations are scarce and knowledge on how and when wood is transported remains far from complete.

In order to quantify a river's instream wood transport regime, we are developing a video-based wood tracking system that counts the number of pieces that pass a certain point and estimates their sizes. We use a DeepSORT algorithm that uses machine learning to identify individual pieces of instream wood and draws a bounding box around every piece. Subsequently, it uses a Kalman filter to estimate the piece's trajectory. To prevent counting the same pieces multiple times, the projected trajectory is compared to the detections in the subsequent frame. The system is designed so that it can be applied to different datasets and will be available to the increasing wood monitoring efforts around the world. For a more detailed look into the large wood regime at one of our main study sites (Vallon de Nant, Switzerland), and to calibrate our video-based wood tracking system, we have installed RFID tags into all pieces of large wood (approximately 1000 pieces) over a stretch of 3 km. A stationary RFID antenna registers the tagged pieces that pass by, of which the size and origin are known.

First results show that the custom trained DeepSORT algorithm can not only identify pieces of instream wood, but also largely follow the pieces in subsequent frames. The approach seems to outperform current computer vision solutions. In our ongoing research, we aim to make the system more robust and expand the observation network to other rivers. With an expanding dataset, containing (manually) labelled training samples from different locations, and the low-cost measurement set-up, the system promises to aid successfully to an intercomparison of river systems in the context of the wood management debate.

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