Submitted Abstract

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Abstract

The Nordkette laboratory has been home to various aspects of avalanche research due to its proximity and accessibility.
Lately performed inflow avalanche measurements at the Nordkette laboratory were evaluated to investigate the internal dynamics of avalanches and provide data to test corresponding simulation models.
The used measuring system, called AvaNode, and improved algorithms showed promising results regarding motion reconstruction.
The AvaNode measures translational acceleration, angular velocity, magnetic flux density by means of an IMU (Inertial Measurement Unit), as well as GNSS (Global Navigation Satellite System) position and translational velocity.
In avalanche experiments with the AvaNode, the start- and end-point as well as the velocities of this particle can be extracted from the GNSS data.
Additionally, the particle trajectory is approximated by means of the IMU data.
As measured IMU accelerations are subject to errors, numerically integrated velocities and positions are as well.
This brings up the idea of a sensor fusion of computed velocities from measured accelerations and measured GNSS velocities. Thus, the purpose of this work is to evaluate the individual sources of translational velocities for the suitability to sensor fusion in the context of snow avalanche dynamics.
For latter evaluation we compare the Euclidean norm of translational velocities from three different sources.
The velocities from the IMU are derived by time integration of global acceleration data. Whereas the global acceleration data is obtained by transformation of measured local accceleration by means of computed rotation matrices.
GNSS translational velocities are either obtained by the time derivative of the GNSS positioning data or directly via the Doppler shift in the signal, whereby the Doppler method is more accurate and delivers a smoother velocity distribution.
To evaluate this method a data set from a real size snow avalanche is used. It was obtained on the 23th of January, 2022 on Nordkette in Innsbruck, Austria. The AvaNode was carried by a size D-2 avalanche from the release area all the way to the deposition area. Here, the AvaNode traveled a distance of 430m and reached a maximum velocity of 16m/s.
When comparing the Euclidean norm of GNSS velocities and IMU velocity we can observe a mean difference of 1.1 m/s. Additionally, a difference of 0.9 m/s in peak velocities was noticed, as well as similar acceleration and deceleration phases. Hence, the various velocities show high potential for future sensor fusion. Especially errors due to IMU sensor drifts could be reduced significantly.