IMU AND GNSS-BASED TURN SWITCH DETECTION IN ALPINE SKI RACING

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INTRODUCTION

In alpine ski racing, the beginning of a turn can be determined by the crossing point of the athlete's center of mass (CoM) line projected onto the snow surface with the average ski line (Supej et al., 2003). This method was originally dedicated to camera based 3D stereo-photogrammetric systems; however, when using wearable systems (e.g. inertial sensors or differential GNSS) it is not a priori clear how accurate and precise this method performs. Moreover, for wearable systems there might be other reasonable definitions for the beginning of a turn. To this end two inertial sensor based turn switch detection methods were compared to the aforementioned camera system based standard method by Supej et al. (2003).

METHODS

Six European-Cup level athletes skied a giant slalom course twice whereas the beginning of one left and one right turn per run were analyzed, resulting in a total of 24 turn switches. For method A the athlete's CoM and ski lines were obtained by fusing inertial sensors (500Hz) fixed to the shanks, thighs, sacrum, sternum, head with a differential GNSS (50Hz), as proposed by (Fasel et al., 2016). The snow surface was estimated by fitting a polynomial surface to the left and right ankle positions. Subsequently, turn switches were detected in accordance to the method of Supej et al. (2003). For method B the turn switches were defined as the crossing points between the lengths of right ankle–CoM and left ankle–CoM vectors computed as in Fasel et al. (2016). Both methods were validated against the camera based reference system (50Hz) and a reference terrain model, as described in an earlier study (Gilgien et al., 2015).

RESULTS

Mean error (accuracy) and its standard deviation (precision) for method A were 18ms and 21ms, respectively. Method B had an accuracy of 7ms and precision of 38ms.

DISCUSSION

Both methods could accurately and reliably detect all turn switches. Accuracy for both methods was within time resolution of the reference system (20ms). The decreased precision for method B can be explained by the differences in

turn switch definition.

CONCLUSION

When using inertial sensors the assessed methods provide a valid and simple way for detecting turn switches. For maximum precision a GNSS system should be used in addition.

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