

Simulation in Alpine Skiing

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Abstract: At the Department of Sports Science of the University of Innsbruck three typical situations in Alpine Skiing have been investigated:

1. Jumping in downhill skiing during the Olympic Game in Lillehammer
2. Carving in Lech
3. Downhill racing during the World Cup event in Kitzbühel

For data collection, the skier was recorded by video cameras and control points were surveyed geodetically. For certain points at the body and at the equipment of a skier, the so-called body points, the time history was determined with help of the Direct Linear Transformation (DLT). In each video frame body points as well as typically 10 control points were manually digitized. The body points were reconstructed by the data of at least two synchronized cameras. To demonstrate the accuracy of this procedure a movie is presented which shows a skier and a stick figure obtained by smoothing the DLT-data.

To simulate the jumping in Lillehammer we used a 2D musculo-skeletal model for the skier consisting of 4 segments (boot-ski, shanks, thighs, trunk) and 8 muscle groups. The force produced by the muscles was computed by a Hill modell. The muscle activation was determined by minimizing the differences between measured and computed data using a least squares fit.

The data of Lech was mainly used by the group of P. Lugner, Technical University of Vienna, to optimize binding plates. We have performed an inverse dynamic analysis to determine the loading at the joints. The equation of motion was written as a differential/algebraic equation. A major difficulty was caused by constraints depending not only on the position but also on the velocity. The joint loading was determined by the reaction forces.

The data collection of Kitzbühel was mainly performed for the visualization of a downhill slope. Here, also the snow surface was geodetically surveyed. Then, the trajectory of points on the snow surface could be reconstructed by the data of just one camera. We have determined the friction between ski and snow and the drag simultaneously. These values can be used to determine an optimal trajectory for the ski racers.

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