Using magnetic gates to track slalom skiers' performance

February 27 2017, by Sandy Evangelista

Credit: Ecole Polytechnique Federale de Lausanne

EPFL researchers can now measure a slalom skier's exact time at each gate all the way down the slope. Their system also calculates the skiers' speed and trajectory more accurately than GPS.

Whether they're racing the slalom or giant slalom, skiers all face the same imperative: to round the gates as fast as possible. But when it comes to carefully analyzing their performance, existing technologies provide only limited information. This includes some split times along with video images – which have to be reviewed manually. Coaches have also tried GPS-based systems, which track the skiers' speed and trajectory, but they're not always that easy to use.

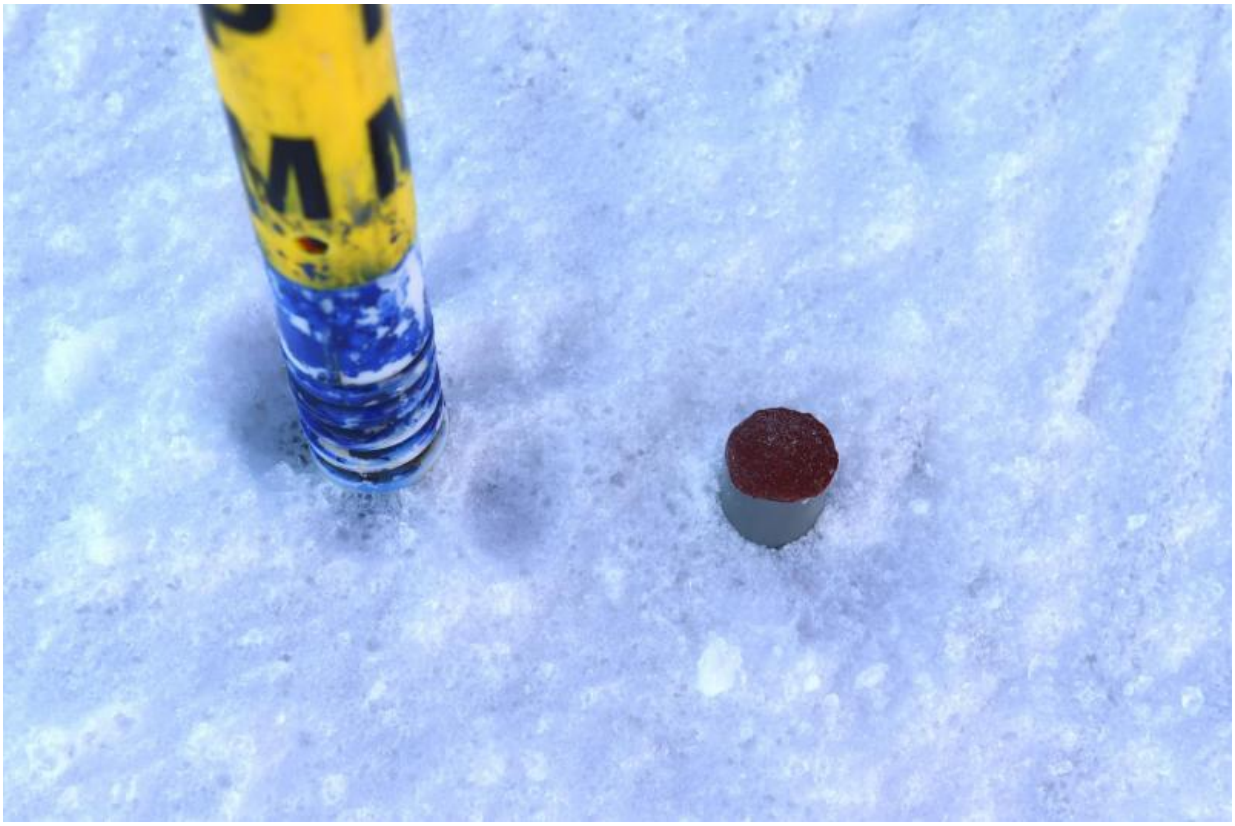
Benedikt Fasel and the team at the Laboratory of Movement Analysis and Measurement (LMAM) have now come up with a way to closely track performance on each section of the slalom course by drawing on several different technologies. "We found that by combining systems designed for different purposes, we could determine a skier's time, speed and trajectory both accurately and automatically."

They started with accelerometers and gyroscopes, which measure the skiers' acceleration and angular speed. This data is used to determine the orientation of different parts of the body, such as the hips, knees and torso. The researchers then added a magnetic system to measure the elapsed time at each gate.

The inertial sensors do not directly track the skiers' speed or position. These two pieces of information have to be calculated using measured accelerations. But these calculations are highly susceptible to errors, which can result, for example, from the vibration caused by either the skier's speed or movements. "An ordinary or low-end GPS, like the type used in mobile phones, can measure speed and position with a lower level of error. But these systems are not accurate enough. We'd like a resolution of 10 to 15 centimeters," said Fasel. That led to the idea of combining data from inertial sensors and magnets.

Magnetic gates

The researchers equipped every gate with a magnet and put a magnetometer on the skier. "The magnetic field is strongest when the skier rounds the gate. If we know the amplitude, we can also calculate the distance. Using this information, we can figure out how far the skier is from the gate and determine their speed." Since the exact position of the gates is known, errors in the acceleration-based speed and trajectory calculations can be corrected at every gate.



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The researchers' method was successfully tested on 17 runs down a giant slalom course. A high-speed camera was used to verify the

magnetometer readings. It showed that the skier rounded the gate at the exact moment that the magnetic field amplitude was greatest. The EPFL lab has filed a patent for this technology.

"Our ultimate goal is to help athletes and coaches identify room for improvement on the basis of scientific data rather than intuition. The magnets let us map the skier's trajectory with precision. So we can analyze the line the skier takes and their strengths and weaknesses," added the researcher.

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