

STEALTH™—A GNSS-BASED ADVANCED DEVICE TO TRAIN CANADIAN OLYMPIC SKIERS

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Starting in 2006, the Schulich School of Engineering, through its PLAN Group has developed and tested, in collaboration with Own The Podium/  Nous le Podium 2010 and Alpine Canada Alpin, an ultra-precise, ultra-light and autonomous sensor, namely STEALTH™, the Sensor for the Training of Elite Athletes, to support the Canadian Alpine Ski Team during training. The GPS/GLONASS based sensor has proven to operate very well under a variety of conditions and is now used routinely by the ski team. This paper will describe the requirements and trials that resulted in the current system. A description of the sensor components, assembly, mode of operation, technical specifications and performance is presented. The positioning and motion components displayed to athletes and coaches for performance evaluation are described using data collected on ski slopes in the Canadian Rockies and elsewhere. The use of combined GPS/GLONASS resulted in 100% fixed ambiguity resolution when the elevation mask angle did not exceed 20  and 86% with a circular mask angle of 30 . Fixed ambiguity positions, available 20 times per second, were found to be accurate to better than 10 cm in such a case.

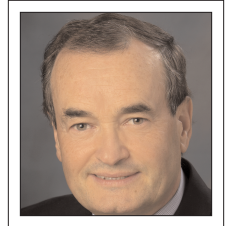
  compter de 2006, la Schulich School of Engineering, par le truchement de son groupe PLAN, a d velopp  et v rifi , en collaboration avec Own The Podium/  Nous le Podium 2010 et Alpine Canada Alpin, un capteur autonome ultra pr cis et ultra l ger,   savoir le STEALTH™, le capteur utilis  pour l'entra nement des athl tes de haut niveau, dans le but d'appuyer l' quipe de ski alpin canadienne durant l'entra nement. Le fonctionnement du capteur GPS/GLONASS s'est av r  excellent dans une vari t  de conditions et est maintenant utilis  de fa on r guli re par l' quipe de ski. Le pr sent article d crira les exigences et les essais qui ont men  au syst me actuel. Une description des composantes du capteur, de l'assemblage, du mode de fonctionnement, des caract ristiques techniques et de la performance y est pr sent e. Les composantes de mouvement et de positionnement affich es pour les athl tes et les entra neurs en vue de l' valuation de la performance sont d crites en utilisant les donn es collect es dans les pentes de ski alpin des Rocheuses canadiennes et d'ailleurs. L'utilisation combin e du GPS/GLONASS a r sult  en une r solution de 100 p. cent de l'ambigu t  fixe lorsque l'angle de masquage n'exc dait pas 20  et de 86 p. cent avec un angle de masquage circulaire de 30 . Les positions d'ambigu t  fixes, disponibles 20 fois par seconde, se sont av r es plus pr cises que 10 cm dans un tel cas.

Introduction

The use of technological advances to measure and enhance sport performance is increasingly common. Competitive athletes win or lose races by fractions of a second or a single decimetre. Numerous sport activities involve speed, distance, and timing. A prime example is skiing, in which case precise knowledge of the above parameters, plus rate of descent, lateral accelerations, and gate crossing times are important during training to assess skier strengths and weaknesses and remedy the latter.

GNSS has the potential to provide the above information to athletes and coaches. However equipment size, weight, power autonomy, signal tracking, accuracy, and availability performance pose major obstacles for skiing and most other sports. In this paper, the development and use of a GNSS-based system aimed at skiers is described. The *Sensor for the Training of Elite Athletes* (STEALTH™), whose

development started in 2006, overcomes the above limitations and is now used operationally by the Canadian Alpine ski team during training. At less than 300 g, the robust 10-cm accuracy belt-mounted STEALTH™ is the best performing system currently available anywhere for this type of application. The project was launched by the PLAN Group of the Schulich School of Engineering, University of Calgary, in collaboration with *Own The Podium 2010/  Nous le Podium 2010* (OTP) and Alpine Canada Alpin (ACA). OTP is a national sport technical initiative designed to help Canada's winter athletes win the most number of medals at the 2010 Olympic Winter Games in Vancouver, and to place in the top three nations (gold medal count) at the 2010 Paralympic Winter Games. The project was deemed Top Secret until September 2009. ACA is



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