ARTIFICIAL SNOW AVALANCHE RELEASE AND DETECTION USING ADVANCED RADAR TECHNOLOGY

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INTRODUCTION

Over the last decade artificial avalanche release has experienced a significant development in alpine regions. Avalanche towers are nowadays regularly used in ski resorts or for protection of traffic infrastructure, but also in exceptional cases for protection of settlement. Due to economic reasons, artificial avalanche release is expected to become more and more important in the future (Rudolf-Miklau and Sauermoser, 2011).

Remote controlled avalanche towers with over snow detonations using appropriate explosives have already been presented in Gubler and Wyssen (2002) and proven their reliability and effectiveness. From the theory of slab avalanche formation in a dry snow cover as well as from practical experience it is known that detonation above the snow cover leads to best results with respect to residual risk for unforeseen avalanches (Gubler, 1977).

Even though artificial avalanche release offers an efficient and reliable possibility of avalanche mitigation, for realistic risk assessment the verification of the actual avalanche release is of crucial importance. In addition, it is essential for people being in charge of avalanche control work to know about spontaneous avalanche activity, especially under bad weather conditions. The avalanche radar offers the possibility of constant monitoring of endangered areas and the verification of artificial released or spontaneous avalanche activity. The aim of the present case study is to test the reliability and the practical application of avalanche detection with radar technology in combination with avalanche towers.

AVALANCHE RADAR EQUIPMENT

Several radar devices have already been used regularly for scientific studies investigating snow avalanches speed and dynamics (e.g. Gauer et al. 2007, Rammer et al. 2007). Most radar devices available nowadays are rather big and have a relatively high-energy consumption, which is limiting practical application.

Latest radar technology offers the possibility to detect avalanche activity based on continuous scanning of the endangered area with pulse radar, encased in a compact and robust device, designed for the use in harsh alpine environment. Due to low power consumption, the radar device can be powered with solar panels and the data transmitted using the mobile telephone network. Hence the radar can be installed at any given place.

The so-called pulsed Doppler radar emits short pulses and samples the echo in distinct time intervals, which are corresponding to distance intervals (range gates). With a Frequency shift analysis of the echo signals (Doppler-effect) the velocity distribution within the width of a range gate can be calculated. The integral under the velocity distribution gives a hint to the moving masses. With this information (avalanche velocity, moving masses, distances), an avalanche can be detected and roughly characterized and therefore in combination with an artificial avalanche release unit the success of a blast can be verified. The radar can detect the velocity of an avalanche, even during bad weather and wind conditions. The obtained data contains information about run out distance and magnitude of the detected avalanches.

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CASE STUDY: SILVRETTA ROAD

In a pilot project five avalanche towers together with a radar unit were installed for the protection of the state road B188 Silvretta Straße in Tyrol, Austria. The radar is installed in the valley on the opposite site, facing the avalanche release area (distance 1.800 m). On the one hand an automatic alarm is triggered if an avalanche, is released, on the other hand the radar data can be visualized with computer software to verify the alarm.

Preliminary results showed that the radar device detects artificial and spontaneous avalanche activity and sets an alarm signal. But we realized that at the beginning it is necessary to monitor a few events to adapt the automatic detection parameters to the environmental noise of the observed area. After redefining the alarm parameters based on two false alarms (8.12.2011 and 31.12.2011, see Table 1) and several detections, the system runs stable since beginning of January 2012.

Tab. 1 Preliminary results of the radar detection project in Ischgl (Austria). After one month and two false alarms the automatic detections parameters were adapted to the background noise at the site and the avalanche radar monitors reliable.

Date	Time	Alarm
07.12.2011	---	Yes
08.12.2011	---	False alarm
17.12.2011	---	Yes
17.12.2011	---	Yes
22.12.2011	15:34:26	No
22.12.2011	17:18	No
30.12.2011	10:17:30	No
31.12.2011	17:18	False alarm
31.12.2011	23:25:04	Yes
05.01.2012	13:41:38	Yes
06.01.2012	06:51:49	Yes
06.01.2012	17:43:41	Yes
08.01.2012	14:15:37	Yes
11.01.2012	15:21:15	Yes
20.01.2012	17:01:05	Yes
22.01.2012	03:35:43	Yes

With the experiences made during the first test winter it can be summarized that the radar device showed great potential for detection of artificial released and spontaneous avalanche activity. Especially when used in combination with avalanche towers, the residual risk of avalanche control work can be significantly minimized. Using the knowledge gathered after the first test winter we are conscious that further development is needed to perfectly adapt the hard- and software for the high demands of avalanche control work.

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