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MADE TO MEASURE

Vibration measurement technologies are helping to provide new levels of accuracy for hailstorm observations

According to the German Met Office (DWD), April 2018 was the country's warmest since records began in 1881. That same month, parts of the country experienced several major thunderstorms, with reports of large hailstones causing damage to windows, shutters, cars and crops. According to hail insurers, the total area of farmland reported as damaged during the last week of April amounted to more than 6,500ha (16,000 acres) with an insured sum of €17m (US$19.7m).

Hailstorms are a common meteorological phenomenon across Europe and regularly cause major economic and insured losses. Although the need to better understand hail events is evident, current measurement techniques often fall short.

HAIL MONITORING TECHNIQUES

Standard hail observation methods are based on passive technology, specifically hail pads that are exposed to the hail and analyzed manually after an event. The process is cumbersome and has limitations, as imprints can be difficult to see and evaluate. Passive systems also fail to generate alarms to warn of oncoming hailstorms.

In other cases, weather sensors and disdrometers measure hail size optically or by means of radar using a relatively small optical beam or radar conus. The larger the hailstones, the greater the distance between them and the higher the probability that they go undetected.

To combat these problems, HyQuest Solutions (Kisters Group) partnered with the University of Applied Sciences in Saarbrücken (htw saar) and Swiss-based inNET Monitoring to develop a sensor that relies on vibration measurements and a much larger sensing surface to collect data, thereby increasing the probability of detecting a statistically representative sample of hail pellets. After several years of research and field-testing, the

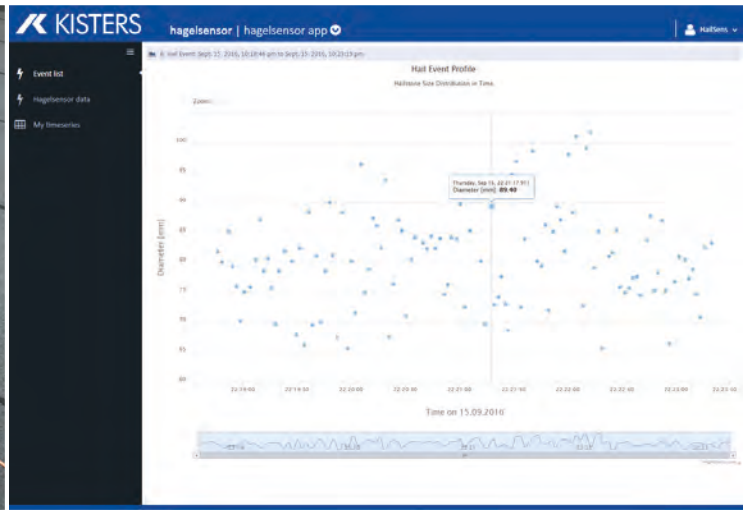

Figure 2: HailSens Model R&D/INS: Swiss HailSensor Network – typical flat roof installation. Image: inNET Monitoring

Figure 3: hailsens.online's cloud application visualization of a hail event. Image: Kisters

Figure 1: HailSens Model R&D/INS – industrial grade model. Image: HyQuest Solutions

HailSens is now able to provide automatic *in situ* hail measurements on the ground.

The solution's piezo microphones capture the energy of the hailstones at the moment of impact on the large measurement surface. An integrated micro-controller calculates the events in real time and provides data on the size of the hailstones and the intensity of the hailstorm. This data can be immediately transmitted to either a local data acquisition system or to a cloud-based server for further analysis and early warning alerts.

PURPOSE-BUILT MODELS

WMO SYNOP weather stations only record hail impacts when the diameter is greater than 5mm. However, weather model researchers and prognostic meteorologists require more detailed data to help improve their models and correlate detected events, including the magnitude in terms of number of impacts, pellet sizes and related kinetic energy. HailSens has been developed to serve both applications, with different models tailored for WMO SYNOP weather station use and for acquiring detailed data for research purposes.

The first model, HailSens SYNOP, is factory calibrated to report only impacts of pellets with a diameter greater than 5mm. Datagrams are sent over a serial cable to the data acquisition system of an automatic weather station, where the data is aggregated for reporting purposes.

For more detailed measurements, the HailSens R&D/INS model measures the energy of individual hailstones in real time and provides evidence on hailstone size, event duration and impact energy. All recorded data is transmitted to cloud-based servers using wireless communication, ensuring fast forwarding of data whenever an event is recorded. Thus, the damage potential of hail events can be assessed in real time. Event-driven data transmission and alarm functionality ensure that early warning systems can be put in place, providing more time to react before excessive damage occurs.

HailSens sensor networks can also provide a means to optimize both the prediction models of insurance firms and the hail claims process. With this in mind, Swiss insurance company Mobiliar partnered with MeteoSwiss in June 2018 to begin installing a network of 80 sensors (Figure 2). The collected data is expected to improve the MeteoSwiss hailstorm weather models with better radar algorithms leading to more notification time for citizens.

DATA IN THE CLOUD

The HailSens Model R&D/INS is the first online monitoring system dedicated to the meteorological phenomenon of hail. To simplify the storage and management of the data collected, a cloud application, hailsens.online, has been developed using advanced NoSQL-type storage.

Data processing can be adapted to various purposes depending on the needs of the user. For example, raw data can be made available for researchers, while other users may prefer hail damage classification (using a variety of classification schemes), and others may want to see statistical evaluations of each single event. With a cloud-based solution (Figure 3), users do not need to download and install software and can benefit from a web-based user interface that enable users to access, view, assess and download the data on any tablet, laptop or desktop computer.

By leveraging detailed measurements provided by hail sensor networks over a longer period, conclusions can be drawn as to when, where and why hailstorms occur. Those potentially affected can be warned early of heavy hailstorms, and millions of euros worth of damage prevented. ▮