Session 7: Latest tools using MIR-spectra in the ICAR world.

S07.O-05

IN-LINE REAL-TIME MILK COMPOSITION ANALYSIS BY TUNABLE LASER SPECTROSCOPY FOR DAIRY FARMS

Tadas Bučiūnas, Benediktas Bilinskas, Ieva Šimonytė, Tomas Žukauskas, Arūnas Miasojedovas, Vladislavas Čerkasovas, Augustas Baltrėnas, Augustinas Vizbaras, Kristijonas Vizbaras, Dominykas Vizbaras.

Brolis Sensor technology, Vilnius, Lithuania.

In this work we discuss latest advancements of spectroscopic sensing based on tunable laser spectroscopy in the SWIR/MIR spectral region for individual animal-level milk composition monitoring in dairy farms. In-line milk composition monitoring in dairy farms is challenging for a number of reasons - aggressive environment, rapid milk composition dynamics during a single milking cycle, turbulent flow and challenges of associated with the fundamentals of liquid spectroscopy such as large spectral bandwidth requirements, etc. To address these challenges in our work, spectroscopic sensing was performed using BROLIS Herdline tunable laser-based sensor, operating in the 1.9-2.5 micron wavelength range, with a very fast spectral acquisition rate of ~1000 spectra/s and a capability of sensing milk fat, milk protein and lactose in-flow within the milking line. This spectral region is known for high specificity and sensitivity vs shorter wavelengths, and the choice of the laser allows access to maximum spectral power density possible. Rapid spectral acquisition allows tracking dynamic composition change throughout the individual milking cycle. We deployed 136 sensors across 4 different commercial dairy farms with a total cow number of over 2800 cows. Depending, on the milking infrastructure used in the farm, a single sensor serves from 12 to 60 cows. Cows under investigation were being milked 2-3 times per day. Data was continuously collected for a period of several months and yielded impressive results with regard to Root-Mean-Square-Error-of-Prediction (RMSEP) of 0.2% for milk fat, 0.15% for milk protein and 0.25% for lactose. Such high accuracy provides high confidence for the discussed technology to seek ICAR certification in the very near future. In addition, collected data consisted of all individual animal milkings throughout the monitoring period and was used to build a data model for individual animal and herd-level management not only from the point-of-view of farm economics but also in terms of animal health monitoring. Early insights into the Herdline health model demonstrate the potential ability to detect health deterioration earlier compared to the standard operating procedures currently in use.
We believe, our work demonstrates first larger scale deployment of laser-based MIR spectroscopic sensor technology for dairy farms, with a real ability of real-time high-accuracy individual animal level milk composition analysis.