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Newsletter BioBusin€ss

WHEN BIOLOGY MEETS TECHNOLOGY

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FINAL ACHIEVEMENTS OF THE PRODUCT GROUPS

Monitoring cow behaviour and performance is a key factor in dairy health and welfare management. Due to increased farm size and limited time per animal, visual observation of cow health and welfare is evolving to automated monitoring systems. Computer vision is a promising technique for cow monitoring because it is relatively low cost and simple to install.

Locomotion scoring is an often used tool for lameness detection in practice, but Andres Schlageter-Tello and Kees Lokhorst from Wageningen UR (the Netherlands) have shown that it is however a subjective gold standard with a high inter-observer reliability. Therefore there is a need in the industry for an automated and objective measurement of lameness.

Within the BioBusiness Cow Group, we opted to use the back posture as a key indicator for lameness detection. In the first part of the project, a 2D-side view perspective was used to measure the back posture in an automated way in a commercial Israeli dairy farm. Stefano Viazzi, Eduardo Romanini and Claudia Bahr from KU Leuven (Belgium) developed the software for the automated back posture assessment. In order to make the back posture extraction more robust and allow the system to be implemented in real farm conditions, we moved from a 2D-side view to a 3D-top view solution. The 3D-top view solution was tested by Tom Van Hertem and Ilan Halachmi from the Agricultural Research Organization (Israel) in a commercial Israeli dairy farm.

With the aid of Daniel Rozen and Uzi Birk in DeLaval AB (Sweden), we built a fully automated 3D lameness detection system in a commercial Belgian dairy farm. The lameness detection system was built in the aisle when the cows return from the milking parlor to the barn. The electronic identification of a cow by a commercial RFID antenna triggered the recording of a new video. The timestamp of the recorded video-file and the electronic identification was used to identify the correct animal in the video. The videos were recorded during, and processed after each milking session when all cows have passed the system. A preprocessing of the videos filtered out the videos that contained (a) bad quality images; (b) multiple cows in the video; (c) not enough frames for analysis (d) an irregular cow gait (stop or run).

The system started in September 2013 and runs since then every day. Due to the promising results of the BioBusiness project it was possible to raise further fund for a follow up project allowing to validate the fully automated setup in 1-year IOF-leverage project (Industrial Research Fund in Flanders, Belgium).

The scientific output of the BioBusiness Cow Group resulted so far in four published journal articles and five more submitted articles. Six articles are still in preparation and will be submitted in the course of the following year. The work was presented in more than 10 different international conferences around the world.

The objective of the BioBusiness Pig group was to reduce the level of aggression using PLF technology. In order to achieve these results, the group tried to answer two main questions: Can we detect aggressive interactions automatically? Is it possible to stop the pigs while they are fighting?

To answer these questions, eight experiments were performed in Germany at TiHo's experimental farm in order to gather data to develop an automatic monitoring of pig aggression. After obtaining the images, KU Leuven focused on developing an algorithm to detect fights the same videos in an automatic way. The Veterinary university of Milan (UNIMI) developed a database in which all the fighting episodes, the intensity and period were defined. This database was used to develop and validate the algorithm. Different techniques were applied to the video analysis. We started by trying to detect fighting behaviour from simple features extracted from the image such as the activity of the animal and how they spread over the pen during the fights. This technique provided already some information to detect fights, but it was not reliable enough. In a second step, the spatial and temporal motions of the image were investigated to provide more insight on the interaction between pigs during fight. In the last part of the project, a 3D camera was added in order to extract other valuable features for reducing the number of false positive cases. This equipment captured the vertical movement that the pigs perform during a fight. However, the increased of accuracy has also negative aspects such as the necessity of having more complex hardware and more complex algorithm.

While the obtained results looked promising, we still needed to consider that even though the algorithm to detect aggression was tested in different repetitions, the algorithm should be validated in different farms, in different environmental conditions and in different production stages.

At the same time, TiHo investigated a way to reduce the levels of aggression among pigs by training the piglets to associate a sound stimulus with a food reward in form of chocolate raisins, and use this association to redirect the pigs' attention from aggressive interaction in early stage. In different trials we saw that the piglets were responding to the training and were able to associate the sound to the reward. The piglets also responded very well to the stimuli applied during aggressive interactions in confrontation tests, made with pairs of trained piglets, whereas the response was less effective at group level, when the piglets were grouped with other 12 piglets.

The results of the BioBusiness project offer a proof of concept that can be exploited by the company Fancom BV to develop in future a prototype. The idea of the company is to develop in a first stage a monitoring system. The level of aggression will be measured by an aggression index. When the number of fight events crosses a certain threshold, the alarm system is activated and the farmer is informed about the level of aggression as well as possible countermeasures to be taken in order to reduce the aggression level in the farm.

The scientific output of the BioBusiness Pig Group resulted so far in five published journal articles and five more submitted articles. Six articles are still in preparation and will be submitted in the course of the following year. The work of the Pig group has been presented in more than 10 different international conferences around the world.

The Chicken Group strived to enhance and improve commercial incubation in three areas: to monitor the hatch of individual eggs; to synchronize the hatching process by adding natural components currently absent from modern machines; and to assess how incubation inputs affect the health, welfare, and productivity of broilers during rearing. The chickens group's approach was animal-driven, technology-driven and market-driven under the umbrella of Precision Livestock Farming.

During this project, the Chicken Group was successful in developing an algorithm to detect precisely when individual chicks hatch inside a commercial machine using non-invasive recordings of eggshell temperature. This work provides a novel way to determine individual hatch time not previously possible without bulky expensive equipment or disturbing the eggs or incubation environment. The methodology of this work is currently being applied to determine the time of embryonic death in unhatched fertile eggs.

In separate trials, our group added brief regular periods of light (to account for the time broody hens leave their nest) and played pre-recorded nest sounds (to account for the communication between the hen and her clutch). Light exposure did not successfully shorten the hatch window but it did show promise in establishing embryos' diurnal rhythms. Adding natural nest sounds successfully delayed and shortened the hatch window; however, hatchability was reduced in our lab trials. For this reason, further research is needed on the effect of sound on hatchability before applying to large-scale trials.

The optimal temperature and humidity levels for incubation are well established in literature and practice. Optimal gas concentrations are less understood. Our group tested the effect of a commercially-used high CO_2 profile on embryonic development. We found that a heightened CO_2 level during the final stages of incubation shortened the hatch window without any negative impact on embryo development or chick quality.

Lastly, we researched the long-term effect of different individual hatching times and flock hatch windows on health, welfare and productivity during grow-out. Late hatching chicks (those who spend a shorter holding time in the machine than their early hatching peers) were 4 grams heavier at farm placement. Chicks from shorter hatch windows had more remaining yolk sac (used less of their energy reserves) than chicks from longer hatch windows. The duration that newly hatched chicks must wait for food and water was isolated through a series of transport experiments. At 21 days old, chicks that were placed immediately (0 h transport) weighed more than chicks transported for 10 hours. While the birds did not significantly differ in weight by market age (day 35), the differing growth curves indicate that early food and water deprivation influence the bird's experience. Potential positive outcomes from a lighter weight, such as reduced lameness and foot lesions would need to be considered against possible negative outcomes, such as early hunger and thirst.

Though the BioBusiness Project officially draws to an end this year, the chicken group will continue into 2014 with automating embryo and bird assessment tools using temperature and image algorithms, respectively. We carry our contribution forward by communicating our research results to our industrial partner Petersime and to the wider scientific and engineering communities. We are deeply grateful to the European Union and Marie Curie Training Network for funding our project; to our academic, research and industrial partners: RVC, Anses, KU Leuven and Petersime NV for their support and guidance; and to Daniel Berckmans and the organizing committee of the M3-BioRes lab (KU Leuven) for initiating this incredible opportunity.



BioBusiness YearBook – "Pig Group"

Maciej Oczak was born in Krakow, the historical capital of Poland, in 1984. He started his studies in animal husbandry at Krakow Agricultural University in 2003. During his studies he spent 1.5 years working at a farm in Ireland where he obtained practical experience in pig production. In 2009, he finished his studies and decided to emigrate, first to UK then to Ireland. In both countries he was broadening his practical experience on modern pig farming. In 2011, Maciej decided to move to the Netherlands to start the work at Fancom in the exciting BioBusiness project. In the project he was employed as an industrial fellow and the focus of his work was research and product development. In 2013 he was admitted to the Arenberg doctoral school at the Katholieke Universiteit Leuven in Belgium. Maciej appreciated the 3-year experience within the BioBusiness project and believes that joining the knowledge gained in the commercial company and university conditions together with his practical experience on animal production is the key to success.

Gunel Ismayilova was born in 1981 in Baku, Azerbaijan, the ancient city of fires and winds situated on the Caspian Sea shore. She is a veterinarian graduated from Moscow State Academy of Veterinary Medicine and Biotechnology in 2003. After graduation, Gunel worked in the development projects of such international organisations as FAO and World Bank. Additionally, in 2009 she obtained Agris Mundus Master in Animal production during which she studied in Italy, France and Spain and as a consequence learned local languages in addition to Russian, Azerbaijani and English. In 2010, Gunel was admitted to BioBusiness project and moved to Milan, Italy. At Milano State University she is responsible for labelling and analysing the behavioural data coming from pig group experiments. She says: "BioBusiness was a great opportunity for me to get valuable scientific and personal experience. I have enjoyed a lot the international and interdisciplinary collaboration of this project. It has also permitted me to meet great people, who became my friends."

Stefano Viazzi joined the BioBusiness team in 2011, moving from Italy to Belgium to obtain his Ph.D. in BioScience Engineering. Even though Stefano had never been to a farm or handled animals in a professional context before, he joined the team with his playful enthusiasm for animals and his strong passion for computer vision and modelling, and he soon proved to be a very committed team member with a strong focus on delivering the multiple projects of the BioBusiness group that he is involved in. His major task within the research of the pig group was to develop an algorithm to detect aggressive interactions among pigs by using computer vision techniques to monitor the animals in real time.
After his first Master studies in Computer Engineering in Italy, he obtained a double degree in Intelligence Systems at the university NTNU in Trondheim, Norway, spending more than two years in the cold, but beautiful Scandinavian landscape. With an incredible cultural adaptability, considering his Italian roots, Stefano comments on his life and career in Belgium: "My work in the BioBusiness team is the Ph.D. opportunity that I have been long looking for. However, living in Belgium is just yet another life experience for me that had a great impact on how I can evolve as a person as well."

Lília Thays Sonoda is the BioBusiness fellow living in Germany. Born in 1985 in the English colonized city of Londrina, located in the south of Brazil, Lilia spent most of her childhood taking care of abandoned animals her father used to bring home after his many trips around the Brazilian roads. Her interest in pigs started when she was 14 years old and on the age of 17 she started studying Animal Science. Five years later, in 2008, she received her Diploma from the State University of Londrina. In 2009, she moved to the state of Sao Paulo to continue her studies at the State University of Campinas, where she obtained her Master title in Agricultural Engineering in 2011.
Still in 2011, she joined BioBusiness to work on the project's "Pig Group" that focused on the reduction of aggressive behaviour of pigs raised indoor in intensive commercial farms. At the University of Veterinary Medicine Hannover, Foundation, where she is currently working on her PhD thesis, she was responsible for carrying out all the field experiments and making the on-farm observations. "In the BioBusiness project I had the chance of not only improve vastly my scientific skills but also gained more experience in team work and became more confident due to the many conferences I attended in different areas of knowledge. On the personal side, the opportunity of living in Germany taught me how to be more organized, assertive and dynamic."

BioBusiness Conclusion by Daniel Berckmans (project coordinator)

Four years ago (in December of 2009), we kicked off the EU-BioBusiness project. The project was a Marie Curie Action (ITN) funded by the European Commission allowing us to spend 2.5 Mio Euro. A group of ten partners from nine countries took the challenge to bring together and educate eleven young researchers (Fellows) originating from ten different nations in the field of Precision Livestock Farming. The main objective was to train young promising people with a biological background (e.g. veterinarians, biologists, animal scientists) in the potential of ICT technology to monitor and improve health, welfare and production of farm animals (Precision Livestock Farming - PLF). They were trained in Research, Product Development, Marketing and Sales of PLF technology for the livestock industry. The fellows had to invent, design and develop three “prototypes” (cows, pigs and chicken) to show proof of principle to the involved companies Fancom, DeLaval and Petersime so that these could do further product development.

The development of new products for monitoring bioprocesses in livestock husbandry requires the combination of biological knowledge with expertise in technology. This has to be realised by a real collaboration between people from totally different disciplines. It was very challenging to make people from totally different backgrounds and cultures work together but in terms of bringing PLF into the future of European farming, these fellows should have exciting new skills to bring new products into the market; benefiting the industry as well as the consumers and the animals.

So, ambitions were high, but what have we learnt and what have we achieved?

First of all, we are glad and happy to have experienced this challenge and to end the project in the same manner as we have started it: with enthusiasm and a positive drive. Honestly, not all milestones and deliverables have been achieved into all details and to complete satisfaction. However, we succeeded in the most important part of the project: The training of the fellows. We can say that, except one who was replaced, all fellows who have started on the project have also finalized the project. On top of that, there was an additional fellow joining the group during her Ph.D. We have seen the fellows growing together as a group, communicating and working closely with each other despite being spread all over Europe. It looks like the fellows have made a group of friends for the rest of their life. They shared their experiences, frustrations and successes. They developed their skills and adopted the BioBusiness as their project. The efforts of fellows and supervisors resulted in: 11 trained young people who now have a unique expertise in the field of PLF; 12 published scientific peer reviewed articles, 6 accepted scientific peer reviewed articles, in more than 30 oral presentations and posters on conferences, 1 patent, 1 prototype considered for commercial product development, 1 proof of principle and gained scientific knowledge and many experiences and inspiring moments of inestimable value. And last but not least, 1 fellow has finished the Ph.D, 8 fellows have the target and are finishing their Ph.Ds. within 2 years after the project has ended.

Another experience is that collaboration of young people and supervising researchers over the countries is Europe growing together. It is investing in a better Europe and a better world since people discover that they are not so different and that open collaboration is a win-win situation for everybody. Not only for the fellows, but also for all involved project partners, the collaboration between different disciplines was very interesting. As in all projects collaboration between partners has ups and downs, but partners experienced that those who are most collaborative also get most out of the project in terms of a return in networking, publications and satisfaction. Now, several partners are collaborating or negotiating a new collaboration in new projects.

As a coordinator I want to say “Thank you!”. Thanks to all the fellows for the hard work, thanks to all the partners for the collaboration and last but not least thanks to the European Commission who has funded this exciting project.

Consortium:

Marie Curie Actions

Animal Sciences Group Wageningen UR

KU Leuven

RVC Royal Veterinary College University of London

Fancom

Agricultural Research Organization (ARO) Israel

DeLaval

Petersime

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