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TECHNOLOGY FOR SUSTAINABLE GROWTH

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- 1st Asian-Australasian Conference on Precision Pastures and Livestock Farming
- Digital Farmer and Grower 2017

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Preparing the digital future of livestock farming

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16 – 18 October 2017, Hamilton, New Zealand

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Raj Khosla
DOI:

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Nicolas Tremblay*, Kosal Kuhn, Philippe Vigneault
http://doi.org/10.5281/zenodo.1002905

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ABSTRACTS

Presentation

Determining pasture evapotranspiration using active optical sensor derived normalized difference vegetation index

Muhammad Shahinur Alam*[1,2], David W. Lamb[1,2], Md Moshiur Rahman[1,2], Ron Bradbury[1,2], Cheryl McCarthy[1,3]
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Actual evapotranspiration (ETc) is one of the important parameters that determines the daily and seasonal water requirement by the crop community. It varies with numerous factors including weather, soil moisture availability and other crop related factors such as growing stage, fraction of field coverage and crop vigour. In this study we investigated the relationship between normalized difference vegetation index (NDVI) that is closely related to photosynthetically-active biomass (PAB) and the evapotranspiration of pasture at different soil moisture condition. A portable enclosed chamber was used to measure ETc of a target pasture canopy and consequently the NDVI with a hand held active optical sensor. The portable chamber was calibrated in the laboratory and produced a calibration factor of C=1.02. Field experiments were conducted on the UNE SMART Farm in Tall Fescue pastures (Festuca arundinacea var. Dovey). Under limiting soil moisture condition the relationship between NDVI and ETc showed a negative correlation (R2=0.73) whereas a strong and positive correlation (R2=0.82) were observed in a non-limiting soil moisture condition.

Presentation

Accessible farm animal welfare data: the role of interoperable standards in precision livestock farming

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http://doi.org/10.5281/zenodo.897205

Farm animal welfare information will be increasingly available through on-farm data collection using sensor networks and other Precision Livestock Farming (PLF) technologies. Such private data can be augmented by, and federated with publicly available data, if interoperability standards are used.

A review of the international literature identified the challenges related to PLF data, specifically in extensive livestock farming systems. The review showed the necessity of using open interoperability standards but found a lack of standards applicable to livestock data. The review also investigated farm animal welfare standards and technologies that enable the measurement of welfare indicators. It was shown that more research is needed to match on farm data capture methods with welfare indicators to measure welfare "performance". It was concluded that a cross-disciplinary approach using geographical information systems and open standards will allow federation with data from other domains and enable the creation of welfare decision support tools.

While recognising that more work is needed for developing data standards for animal welfare data, a novel approach to creating a welfare decision tool is introduced. This is based on using a web portal and interoperable data standards.

Keynote

Advancements in rangeland livestock management: new technologies meet the old frontier of extensive grazing systems

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Over the last 20 years, global positioning system (GPS) collars have revolutionized livestock grazing behavior research. Practices designed to improve livestock grazing distribution can now be accurately and cost effectively monitored with GPS tracking. For example, cattle use of feed supplement placed in areas far from water and on steep slopes can be measured with GPS tracking and corresponding impacts on distribution patterns estimated. Ongoing research has identified genetic markers that are associated with cattle spatial movement patterns. If the results can be validated, genetic selection for grazing distribution may become feasible. Tracking collars have become easier to develop and construct, making them significantly less expensive, which will likely increase their use in livestock grazing management research. Some research questions can be designed so that dependent variables are measured by spatial movements of livestock, and in such cases, GPS tracking is a practical tool for conducting studies on extensive and rugged rangeland pastures. Similarly, accelerometers are changing our ability to monitor livestock behaviour. Today, accelerometers are sensitive and can record movements at fine temporal scales for periods of weeks to months. The combination of GPS tracking and accelerometers appear to be useful tools for identifying changes in livestock behavior that are associated with livestock diseases and other welfare concerns. Recent technological advancements may make real time or near-real time tracking on rangelands feasible. This would allow development of applications that could remotely monitor livestock well-being on extensive rangeland and notify ranchers when animals require treatment or other management.

This paper was given at the 1st Asian-Australasian Conference on Precision Pasture and Livestock Farming (Hamilton, New Zealand, 15-18 October 2017), which was sponsored by the OECD Co-operative Research Programme: Biological Resource Management for Sustainable Agricultural Systems whose financial support made it possible for the author to participate in the conference.

Presentation

Sound analysis and detection, and the potential for precision livestock farming - a sheep vocalization case study

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Livestock vocalizations contain a wealth of information pertaining to welfare state and behaviour. Acoustic monitoring is non-invasive and has potential for numerous Precision Livestock Farming (PLF) applications. A key step in the development of a PLF acoustic monitoring system is the development of stock vocalization detection and classification algorithms. To this end, an algorithm based on Mel-Frequency Cepstral Coefficients (MFCCs) and Support Vector Machines (SVMs) was created. Audio data was acquired from a sheep farming enterprise, reflecting realistic operating conditions. Algorithm performance was across three experiments: (i) sheep vocalization classification, (ii) adult vs. juvenile classification, (iii) multi-animal vocalization. Performance in experiments (i) and (ii) was very high (>98% accuracy, stratified 10-fold cross-validation). A novel probability-based approach is proposed to handle the difficult problem of experiment (iii). The use of a threshold allows application-specific customization of class classification distribution. By use of the MFCC-SVM algorithm it is entirely possible to detect and classify sheep vocalizations in noisy environments. These results, combined with examples from the literature, show that sound analysis and detection holds promise for PLF.

Keynote

Benefits, limitations and expectation to animal based farm information management systems

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The global demands of society to increase the amount of animal based food, to reduce the environmental impact and to improve animal welfare are developing parallel. In the digitalized world, livestock farming obtains new opportunities to become more efficient, transparent and animal friendly. Information and communication technologies (ICT) dominate innovation in many sectors, including food and agriculture. Farm management needs information and knowledge at different levels, from herd to individuals, to body organs or metabolism. Animals are the starting point and the aim of livestock management at these different levels. With examples from welfare management, emission control and milking technologies options will be shown how to improve the farm management in knowledge based circular bioeconomy.

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Poster

A monitoring system of swinery activity amount based on passive infrared detector

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Background: The daily activity of pigs can be used as an important data base for the analysis and evaluation of the health status of pigs. In order to solve the problem of high cost and complex systems by using the traditional method of monitoring the swinery activity amount under the farm environment, a monitoring system of pig group activities based on passive infrared detector was proposed.

Methods: By using SRN-2000 passive infrared detector, the information of pig group activities was collected. The circuit, which has high accuracy, multi−channel and strong real−time operational performance, and takes 24 bit ADS1256 chip as its A/D conversion and signal input channel, was designed for a seismic data acquisition system. Based on LabVIEW software platform, the real-time acquisition, display and storage of the data was finished, the model of daily activity amount and growth cycle activity amount were established.

Results: Test results of finishing pigs which just entered the circle showed that the correlation coefficient of daily activity amount model of swinery and measurement value was 0.88, moreover, the correlation coefficient of growth cycle activity amount model of swinery and measurement value was 0.85.

Discussion: Through the model comparison using the data of experimental station and the validation in the real farm, it is proved that the swinery activity amount can be fairly explained by the model.

Conclusion: The monitoring system of swinery activity amount based on passive infrared detector can detect the daily activity of pigs precisely. The model established can explain the routine of swinery activity amount.

Poster

GPS cows: improving digital literacy & engagement in rural students through an applied Agri-tech learning resource

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Background: A key issue facing rural communities is the low level of digital literacy amongst students. This is particularly pertinent for students involved in agricultural studies where it is commonly perceived that digital literacy is not relevant to their future occupation. However, this is far from the truth as the reality of farming today means that students must have an excellent grasp of technology. This project will develop and evaluate an innovative learning module “GPS Cows” for use in senior agricultural science classes.

Methods: A collaborative workshop and action research pedagogical evaluation processes to develop and deliver the GPS Cows learning module will be utilised to deliver this project. Surveys pre and post completion of the learning module, of both educators and students, will be developed to assess the knowledge gained and level of engagement achieved of the relevance of technology in agriculture.

Results and discussion: The pilot program will involve 8 high schools from Queensland and New South Wales. The GPS cows project will:

- Deliver educator and student resources enabling the use of GPS tracking in the senior high school agriculture curriculum;
- Increase student and teacher knowledge and appreciation of the role of technology in agriculture;
- Inform the development of a best practice in the creation of collaborative agri-tech learning modules.
- Provide researchers and industry with a better understanding of how technologies can be offered for development as student engagement activities.

Conclusion: The “GPS cows” project will develop and evaluate a unique learning resource targeted at increasing digital literacy and engagement amongst year 11 and 12 agriculture students. This project will work collaboratively with teachers, curriculum developers and researchers to identify best practice in linking current agricultural research technologies into high school teaching through the development of teacher and student resources.

Presentation

Estimating biophysical variables of pasture cover using sentinel-1 data

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Over the years, different optical remote sensing platforms and data have been used to estimate aboveground pasture biomass in a variety of landscapes, both heterogeneous and homogenous and at varying spatial scales. Optical methods are often confounded by target visibility, namely presence of cloud cover and haze, and are constrained to daylight conditions. In this study, we used the synthetic aperture radar data from the European Space Agency Sentinel-1 mission to estimate pasture biomass, sward height and leaf area index of a complex extensive grazing 'farmscape' comprising of a range of grass vegetation communities We observed that the quality of digital elevation model used in radar data pre-processing significantly influences the ability of eigenvector scattering decomposition in estimating biomass, sward height and leaf area index.

Presentation

Spatial distribution of beef cattle on a New Zealand hill country farm: monitoring the use of streams and wet areas

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Grazing livestock are an important source of contamination of freshwater, particularly when they have direct access to streams. Cattle in particular contribute to riparian habitat deterioration through stream bank destruction and direct defecation and urination in streams. Exclusion of stock or planting of riparian areas, are the most common catchment management methods used to protect waterways. Given the relatively low returns from beef and sheep farming, both of these strategies are very expensive and often logistically prohibitive in steep hill county landscapes. Despite this, policy trends indicate that fencing of streams in agricultural catchments may become mandatory in the future. It is important that we understand how much time cattle spend in and around hill country streams and wet areas (wetlands and hill side seeps), in order to quantify the likely environmental benefits from such policies.

The current study examined cattle movement data obtained using Global Positioning System (GPS) collars from experiments undertaken at Massey University's hill country research farm, Tuapaka, near Palmerston North, to investigate the amount of time cattle spent in and around streams and wet areas. Animal movement data were collected over seven grazing events, in three winter periods (2012, 2013 and 2015). Permanent streams and wet areas were identified using a digital elevation model derived from 1m LiDAR data, aerial RGB images and RTK measurements.

Cattle spent 3.3 – 6% (48 – 86 min/day) of their day in streams and wet areas consistently across the 7 data collections. Cattle spent more time in streams and wet areas during the afternoon. There are differences in the median amount of time individual animals spend in non-risk areas. Further research is necessary to evaluate how we can influence the amount of time cattle spend in riparian areas on hill country and how stream bank behaviour varies at different times of the year.

Presentation

Precision grazing management - understanding farmer uptake of grazing software

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Increased precision in grazing management decisions requires regular pasture measurement and effective use of the data for enhanced decision-making. Technology adoption theory can help to provide insights on the incentives and barriers to uptake and on-farm adaptation of precision farming tools. In this study, we used an inductive workshop process with experts in grazing management software design and marketing to explore software adoption by farmers. Important factors included alignment of data for monitoring key performance indicators, using data for benchmarking and reporting, enabling farm team communication. Discontinued use by farmers was seen to be influenced by; technology features being misaligned with farmer practice, users not having the skills required to interpret data, practice change inertia, and farmers lacking the time to invest in learning. Future research aimed at understanding those farmers who apply 'best practice' in respect to grazing management, either with or without the use of precision farming tools, would guide better product development.

Poster

Private & public good research and extension (R&E) roles in precision farming

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http://doi.org/10.5281/zenodo.1002327

Background: Precision dairy technologies are principally developed by private companies. Research has shown these companies can lack farm systems expertise to support on-farm use and adaptation, leading to uncertainty about how to best use technologies on-farm. Support structures are required to facilitate learning and reduce uncertainty for farmers, however this currently represents an area of market failure.

Methods: A timeline analysis methodology was used to explore roles of public and private organisations in the development of precision dairy farming in New Zealand. This timeline method facilitates documentation and understanding of the important stages of an innovation processes. We used a meta-analysis and expert knowledge to identify and describe these important stages. These were then analysed using the seven-stage Hekkert framework for innovation systems functions.

Results: There were several key events in the development of PD in New Zealand. These included the Greenfields Robotic Milking project, instigation of the livestock traceability scheme (NAIT), evolution of dairy technology start-ups, and the influence of multi-national dairy technology companies.

Discussion: PD technologies are complex in nature and require a collaborative approach for successful innovation and adoption. Commercial organisations vary in their ability to support the technologies on farm. Historically, physical technologies (such as sensors) were the main focus, however in recent years there has been significant activity in development on online platforms for collating and analysing data for farm management decision support. Successful uptake of these products by farmers will require enhanced data integration and transfer to minimise 'computer time' for farmers and maximise useability.

Conclusion: The PD innovation system in New Zealand remains relatively immature and requires greater industry-level leadership to improve performance across the various innovation system functions. In the rapidly evolving agri-tech sector, a focus is required on more open innovation structures and building farmer skills and knowledge about technology options.

Presentation

Exclusion zones for variable rate nitrogen fertilisation in grazed dairy pasture systems in New Zealand

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To assess the variability of total soil nitrogen (TN) on grazed and irrigated pastures, TN was quantified from spatially distinct “areas” within the paddock (irrigated and non-irrigated areas, around the gates, and around the troughs) on two dairy farms located in Canterbury, New Zealand. During soil sampling, each area was sub-divided and multiple soil samples were taken to ensure adequate spatial representation of each area. The results showed there were no differences in TN between the farms, but differences were detected between the paddocks ($P < 0.001$), largely due to the significant interaction between the areas (gates and troughs) in different paddocks ($P < 0.001$). The greatest variability in TN was around the gates, due to either much higher or lower TN near the entrance of the gates. The TN levels returned to concentrations that were similar to those in the surrounding pasture after 4 m distance from the gates. This study shows while TN concentrations are relatively consistent spatially within pastures, there is high variability in TN in proximity to some farm infrastructure, such as gates and troughs.

Presentation

On-animal sensor technologies and their application in sheep production: a systematic review

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In this age of digital revolution, technological innovations are reaching across a variety of farming industries. Digital applications have been identified as a key method to improve farming efficiency; this is particularly attractive considering the increased pressure being placed on farmers to provide food to an ever-growing population. One farming industry, extensive sheep production, is yet to experience the full effects of the digital revolution but the potential is enormous. A systematic review was conducted to examine how existing on-animal sensor technology has been applied in sheep production systems. The review highlighted an increase in the number of studies being published in this subject area, with studies being conducted across a variety of countries, climates and seasons.

Presentation

System design and economic benefits of controlled traffic farming in grass silage production

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This paper reports on the range of commercially available equipment to configure grassland CTF systems with operating widths from 1.5m to 12m giving trafficked areas ranging from 40% to 13% respectively. The results of an economics analysis for four different guidance systems provides data on the additional cost per ha of the operation and compares this to the grass yield benefits from CTF systems, from which the breakeven areas are calculated. For areas larger than break-even, controlled traffic for a multi-cut grass silage system, is cost-effective in increasing yields due to a reduction in the extent of soil compaction and sward damage. UK£:US$ rate £1.00 = $1.25.

Keynote

Sensors and ICT to assess wellbeing to manage livestock and to inform the value chain

Daan Goense
http://doi.org/10.5281/zenodo.1001825

For centuries there has been a process of human observation of animals and crops by producers that results in a plan (schedule) to take action by the use of equipment. There has always been an incentive to reduce required labour with most recent the use of milking robots and autonomous tractors and roughage feeding machines.

Human observation was not possible for some important characteristics like soil chemical properties and the composition, eventual contamination of milk. Taking samples and sending them to a laboratory became practise and resulted in milk and soil property values determined following well described protocols. Appropriate measures could be taken by relatively simple decision rules.

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Keynote

Putting precision livestock research to work in extensive livestock production systems

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http://doi.org/10.5281/zenodo.1006666

Since the relatively recent appearance in precision agriculture circles (as opposed to the domain of livestock R&D) of precision livestock management (PLM), this new form of PA has come a long way. In extensive farming systems, where the geographical conditions are challenging (large spatial scale and often considerable environmental heterogeneity), there are fewer precision livestock technologies at work than compared to, say, intensive livestock production systems. However the time lapse between R&D and operational use appears to be significantly shorter. R&D first reported only a few years ago is appearing in operational form owing largely to the proliferation of existing OEM devices or systems that can be easily repurposed by producers to put the R&D outcomes to work. In the context of extensive operations, to date, precision livestock R&D has tended to focus on two areas, independent of one another; namely feed base monitoring/management tools, and animal monitoring/management tools. Only recently are we seeing practical attempts to bring the two together.

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Presentation

The nutritive value of forage and weed species grazed by beef cattle in Australia and the effect on livestock selectivity

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The majority of Australian paddocks are heterogeneous (non-uniform) and hence vary in pasture biomass and quality widely at a variety of scales. Cattle are selective graziers, spending time in some areas whilst avoiding others. However, despite this, many grazing studies fail to examine the underlying pasture quality and potential influence these pasture variables have on livestock selection. Therefore, the aim of this study was to investigate beef cattle selectivity (time spent at a site) due to the underlying quality of pasture that had recently been sown, and non-sown pasture species along with a number of weeds.

Prior to cattle grazing, a range of pasture attributes were measured including pasture biomass and Normalised Difference Vegetation Index (NDVI) along with individual plant species to determine forage quality. These were later analysed for protein, minerals, organic acids, alcohols, fibre and non-fibre carbohydrates. Paddock variables (elevation and distance to shelter, boundary fence and water) were also determined. Eleven Angus heifers were fitted with a Global Navigation Satellite System (GNSS) collar and tracked for 58 days. Statistical analysis included pasture quality differences between species and random forest modelling to determine the main variables driving where livestock spend time.

There were significant differences across species for all pasture biomass and quality variables, except for Cu, Se and Starch. Preliminary results suggest that pasture quality variables are the major drivers of livestock selection emphasising the importance of the underlying role that pasture quality has on livestock behaviour. A repository of data for a range of pasture species including non-sown and weed species which are rarely sampled, for numerous pasture quality variables (protein, non-fibre carbohydrates, minerals etc.) is needed for improvements to be made for livestock production. By understanding the pasture quality drivers of livestock selection, producers are able to improve management practices including paddock utilisation, manipulation of pasture species and strategic rotation of paddocks.

Presentation

Incorporating hyperspectral data into variable rate fertiliser plans for NZ hill country

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Background

Precision aerial fertiliser application using GIS guidance and automated fertiliser hopper control allows application rates to better match the requirements of individual hill country landscape units which vary in productivity and soil fertility. Remote sensing using hyperspectral imaging technology is showing promise as a tool to determine soil fertility attributes and to classify vegetation across hill country landscapes. This data is being used in combination with models of pastoral productivity and fertiliser responsiveness to create precision fertiliser application maps.

Presentation

Defining the value proposition for using technology to improve pasture management and harvest more pasture

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There is large variability in pasture grown and harvested on New Zealand dairy farms. Some of these differences are due to fixed factors such as rainfall, soil type, and temperature, while other factors could be remedied, for example improving pasture management, soil fertility and drainage. Of the aspects that could be remedied, it is expected that a substantial proportion would not be profitable to fix with current costs, knowledge, or technologies available in the near future. Of the proportion where it may be possible to fix cost-effectively, it was estimated that the net gain (after costs) is approximately $200 million per year to the dairy industry.

Presentation

Applying proximity sensors to monitor beef cattle social behaviour as an indicator of animal welfare

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There are currently no approved monitoring programs in the beef industry that use paddock based behaviour as an indicator of animal welfare. Current animal welfare assessments are conducted at a single point in time, such as supplying food and water and treating illnesses as these needs arise. These aspects comply with the five freedoms that animals should have when addressing animal welfare, however, the assessments are infrequent. Of the five freedoms, the freedom to express normal behaviour can be a subjective measure, due to differences in the way individual animals express certain behaviours. There is a need for continual monitoring of welfare indicators in modern animal assessment methods to objectively measure behaviour and address public concerns about the welfare state of animals.

The experiment commenced in June 2017 to assess changes in cattle social interaction patterns in response to social stress created by regrouping four groups of eight heifers. Previous research with cattle has provided evidence that social contact and spatial behaviour differ when novel individuals are introduced (Patison et al., 2010b), and re-grouped animals continue to experience stress until the social hierarchy is re-established after regrouping (Kondo and Hurnik, 1990). Proximity sensors that record the frequency and duration of close proximity contacts (<4 m) will be used to remotely collect animal association data, while blood cortisol concentrations will be used as an independent measure of stress. Responses to stress will be compared with a group of heifers where re-grouping does not occur.

This paper outlines the background and methodology to explore the potential for proximity sensors as a continual welfare monitoring device, related to an animal's freedom to express normal behaviour. Preliminary results of the project will be presented at The International Tri-Conference for Precision Agriculture held in New Zealand in October, 2017.

Presentation

Ear tag deployed accelerometer successfully infers sheep behaviour

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A study was conducted to determine the viability of ear tag deployed accelerometers to infer behaviours related to grazing and pasture height in sheep. Nine ryegrass/white clover pasture plots were mown to three different heights: “Low” (2.5 cm), “Medium” (5 cm) and “High” (10 cm). Sheep were allocated to one of three groups with each group grazing each height treatment for 36 hours over one week. Accelerometer signals were annotated against video recordings. Behaviours isolated from video analysis included: standing, walking, ruminating and grazing. Head up and head down posture was successfully inferred from the accelerometer signals by monitoring the raw *Y*- and *Z*-axes. Sheep grazing the “High” treatment tended to graze more consistently than sheep grazing the “Low” treatment which grazed sporadically as they had to search for food. Based on movement intensity (signal vector magnitude), differences ($P<0.05$) between grazing “Low” and “High” treatments were found in the number of counts above a threshold of 1.4. It was concluded that an ear attached tri-axial accelerometer could identify behaviours that were relevant to grazing and also determine when sheep were grazing either low or high pasture.

Presentation

Preliminary research shows potential for using proximal infrared technology for livestock monitoring and phenotyping.

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Two scoping studies have been undertaken recently investigating the potential application of infrared technology for phenotyping several different traits of beef cattle. These studies include the potential for non-invasive analysis of hair to discriminate classes of cattle (O'Neill et al. 2017) and analysis of beef through skin (Roberts et al. 2017). Infrared technology was used to collect spectra information in two different studies from hair and meat in a laboratory setting. Data was analysed using principal component analysis (PCA) and partial least squares discriminant analysis (PLS-DA) for classification. In each example, leave-one-out cross validation was applied once classification models were developed. Results from both studies were positive, with successful classification rates of muscle type and cattle class. This preliminary research supports continued investigation of if and how NIR may be developed as a versatile in-field beef cattle phenotyping sensor.

Poster

Urine patch detection using LiDAR and RPAS/UAV produced photogrammetry

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In grazed dairy pastures, the largest N source for both nitrate (NO_3^-) leaching and nitrous oxide (N_2O) emissions is urine-N excreted by the animals. Additional application of N on urine patches as fertilizer may increase these losses so adapting N-fertilisation in these areas is necessary. The objective of this study was to examine the use of a tractor mounted LiDAR (Light Detection and Ranging) system to accurately identify and quantify areas affect by excess N, such as urine and dung. To do so, a controlled experiment was designed in a paddock with no recent exposure to animals or N fertilisation. Synthetic urine was randomly applied within two 20m x 20m blocks and weekly LiDAR scans were taken for 5 weeks. LiDAR based contour maps of the pasture canopy were shown to accurately detect the asymmetric urine patches as well as calculate a percent area of urine based high N as early as one week after a simulated grazing event. Further, weekly flights were taken with a remotely piloted aircraft system (RPAS/UAV) to have aerial footage of the trial. Resulting mosaic of RGB and NIR images were used to create photogrammetric based contour maps. Both approaches (LiDAR and photogrammetry) show no significant difference in the identification and sizing of urine patch cluster.

Keynote

Can we improve the efficiency of livestock production by using technology to facilitate natural behaviour?

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There is strong evidence that the behavioural repertoire of modern domestic farm animals includes behaviours inherited from their wild ancestors, especially in terms of dietary choice. Many livestock production systems limit or deny the animals the opportunity to express these natural behaviours, and this can negatively impact on both animal welfare and production efficiency. Precision livestock farming technologies could help facilitate the expression of these instinctive behaviours in commercial farming systems, helping to improve animal welfare and production efficiency.

This paper was given at the 1st Asian-Australasian Conference on Precision Pasture and Livestock Farming (Hamilton, New Zealand, 15-18 October 2017), which was sponsored by the OECD Co-operative Research Programme: Biological Resource Management for Sustainable Agricultural Systems whose financial support made it possible for the author to participate in the conference.

Presentation

Fast object detection in pastoral landscapes using a multiple expert colour feature extreme learning machine.

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Fast and accurate object detection is a desire of many vision-guided robotics based systems. Agriculture is an area where detection accuracy is often sacrificed for speed, especially in the pursuit of real time results. Pastoral landscapes are especially challenging with varying levels of complexity, as competing objects are rarely textually smooth or visibly different from surroundings. This study presents a machine learning algorithm designed for object detection called the Multiple Expert Colour Extreme Learning Machine (MEC-ELM). The MEC-ELM is a multiple expert implementation of a Colour Feature Extreme Learning Machine (CF-ELM). The CF-ELM is itself a modification of the Extreme Learning Machine (ELM) with a partially connected hidden layer and a fully connected output layer, taking 3 inputs. The inputs can be utilised by multiple colour systems, including, RGB, Y'UV and HSV. Colour inputs were chosen, as colour is not sensitive to adjustments in scale, size and location and provides information not available in the standard grey-scale ELM. In the MEC-ELM algorithm, feature extraction and classification techniques were implemented simultaneously making a fully functional object detection algorithm. The algorithm was tested on weed detection and cattle detection from a video feed, delivering 0.89 (cattle) to 0.98 (weeds) accuracy in tuning and a precision of 0.61 to 0.95 in testing, with classification times between 0.5s to 1s per frame. The algorithm has been designed with complex and unpredictable terrain in mind, making it an ideal application for agricultural or pastoral landscapeFogarty

Presentation

Examining the potential of augmented reality to improve health and welfare of animals herded using virtual fencing

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Setting up fences and fetching animals is a highly time consuming and labour intensive process. The Virtual Fencing allows farmers to set up a controlled grazing environment. The technology requires animals to wear an Electronic Containment Device which receives the radio signals from the control centre. Whenever the animal approaches the virtual boundary, an audible alarm will be emitted by the device as a cue to avoid further progress towards the virtual fence which may result in a mild electric shock. Even though the technology is promising, there is limited information on how Virtual Fencing affects the behaviour and welfare of the animal. Augmented Reality devices helps to get feel of an imaginary environment augmented to the real one. Combining the Augmented Reality with Virtual Fencing may help to control and herd the animals with a proactive approach. The aim of this trial was to study the responses of an animal to Augmented Reality stimuli and evaluate the potential of Augmented Reality to improve the welfare of animals herded using Virtual Fencing. The Electronic Containment Device fitted to cattle was modified to incorporate some features of Augmented Reality.

Presentation

The combination of wetted prilled urea and VRA nitrogen application technology on dairy farms: is it worth it? The first 7 months results from 6 irrigated Australian dairy farms.

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Background: This study looks at six irrigated dairy farms in Victoria, Australia that have entered into a commercial agreement to use VRA plus wetted prills technology for two years to try to reduce nitrogen inputs and costs. The author has attempted to quantify the impact of changing from an "ad-hoc" granular nitrogen application to a "wetted prills/VRA application" on a commercial scale.

Methods: Weekly paddock based pasture measurements were taken using a sonar Automatic Pasture Reader (APR) for the past year and will continue for the next two years of the trial. Yield maps were created using the APR data for each of the 300 odd paddocks, and nitrogen inputs are weighed onto each farm using a Kuhn spreader fitted with scales. This data is aggregated over all the farms versus the previous year's data.

Results: The budget was that the farms would reduce their nitrogen inputs from an average 249 kg/N/Ha down to 152 kg/N/ha, a reduction of 39%..

Discussion: If the budgeted reductions to nitrogen inputs (39%) and costs (30%) can be achieved without any loss to pasture production, this will provide a real pathway for irrigated dairy farms to significantly improve the environmental impact of their nitrogen applications without impinging on-farm profits.

Conclusion: The early indications are very promising and a full set of results will be submitted at 12 months and again at two years.

Presentation

A preliminary evaluation of the use of on-animal sensor data to predict metabolizable energy intake of sheep using deep belief networks

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The use of digital technologies in livestock businesses can improve the efficiency of farmers managing welfare and productivity of their animals. One opportunity is to use high resolution livestock behaviour information to inform decision making. Livestock behaviour recorded by sensors such as GPS or accelerometers, can be analysed to capture activities that can inform farm management. In this paper, our focus was on livestock grazing behaviour in relation to the feed supply in extensive grazing systems. We investigated the use of a Deep Belief Network (DBN) to predict the Metabolizable Energy Intake (MEI) of sheep directly using sensors. With the complexity and the availability of more data forms especially in the sensor data, the use of DBN was evaluated as an analytical method that could be applied to improve farmer's understanding of livestock grazing behaviour and feedbase management by the prediction of MEI values daily. Based on a field experiment, results generated from the DBN achieved with the MSE result of 5.6 to the training dataset and the testing dataset of 11.6. This demonstrated that the DBN method can be undertaken to predict the MEI for sheep using sensor data. Furthermore, by finding out which factors influenced grazing behaviour this study can be used to better interpret biological interactions in grazing systems, and potentially be extended to develop sensor technologies and new analytical methods in other agricultural domains.

Keywords: deep belief networks, livestock behaviour, energy intake, machine learning, predictions, on-animal sensor data

Poster

Design and implementation of large-scale pig farm big data acquisition system based on IOT

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Background: Pig farm environmental factors, such as temperature, humidity, light, harmful gas content like ammonia and carbon dioxide, as well as pigs' daily behavioral data, such as sit and walk, feed intake, make up pig farm big data, which is important basis for accurate control of pigs' health. The precise acquisition of such data becomes an urgent. Currently data collection in pig farm is of poor real-time performance and persistence, especially for video data in collaborative collection applications.

Methods: Based on Internet of things technology, this paper builds up a pig farm big data acquisition system, designs a detailed IOT topology architecture, a network communication protocol and an intelligent processing gateway system, implements an integrated big data acquisition system for large-scale pig farms.

Results: As a result, pig farm environmental factors, pigs' feeding data and life monitoring video data, etc., can be comprehensively coordinated acquired. The experiment has been carried out in a pig farm in Guangdong province. One month consecutive experiment shows that our system can on-line monitor the farm environment information, pigs' feeding and living conditions. It can catch the changes of pig farm environment and pigs' growing status in time.

Discussion: The relationship between environment and pigs' activity can be explored through the experimental data.

Conclusion: Our system has a broad application prospect. Farmers can take corresponding measures to cope with different scenarios according to the result of real-time monitoring. It is of great significance to the pig production industry.

Presentation

Automated pupil image acquisition to estimate of serum Vitamin A levels in cattle using pupil color analysis

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Japanese black cattle farmers usually decrease cattle serum vitamin A levels during the fattening stage of production to improve beef marbling score. However, such conditioning can negatively impact cattle health and so it is desirable to able to non-intrusively monitor cattle serum vitamin A level (no blood samples) during this period. The objective of this study is to build an automated system to measure serum vitamin A level by capturing and analyzing the color of cattle pupil images.

The system involves automated image capture of a cattle's pupil, extraction and analysis of the pupil's color (pupil color becomes reddish as the serum vitamin A decreases), and then finally a model estimates vitamin A level based on red and saturation components. The results obtained indicate the system has the potential to rapidly and non-intrusively monitor cattle vitamin A levels in real time.