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Use of watering hole data as a decision support tool for the management of a grazing herd of cattle

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Abstract.

Establishing grazing practices would improve the welfare of the bovine, allowing them to express more natural behaviours. However, putting animals out to pasture reduces the ability to monitor them. To ease the adoption of grazing, farmer would benefit from indicators from pasture that identify abnormal behaviours possibly related to a health problem in a bovine. The path to the watering trough offers a proper location to collect data autonomously. We therefore investigate, in this paper, the possibility to use watering place as a place to acquire data to compute some welfare indicators at pasture level. This study allows us to establish a baseline of the drinking behaviour of cattle under the conditions of the experiment and whether interesting information for herd management can be derived.

For this purpose, we developed a monitoring gantry with sensors to perform animal-based measurements. This device is equipped with an RFID reader that allows the detection of the time of passage and identification of the ear-tag equipped animals. This gantry was placed at the single one-way access of the watering trough. The experimentation was performed during summer 2021 for a total of 103 days of data collection. An average of 11.6, a maximum of 13 and a minimum of 6 cattle were present on this pasture, with 15 different individuals during the measurements season. The experiment took place in the Belgian temperate oceanic climate.

This experiment allowed us to observe the diurnal behaviour of cattle, when most of the drinking events are taking place. On average each animal passed by 1.23 times per day. Since we have the temporal follow-up of the passages, we found a significant impact of the weather on the number of passages.

These observations therefore allowed us to determine the classical watering pattern of our cattle when placed on pasture. A significant change in the habits of an animal can therefore be used to suggest the intervention of the farmer.

Keywords:

Cattle welfare, Pasture, RFID, Watering behaviour

Introduction

Animal welfare can be defined as "the perceived quality of life of the animal". This is not only defined by the absence of physical suffering but also by the absence of psychological suffering and the possibility to express natural behaviours (Bracke and Hopster 2006). In order to allow the expression of these behaviours, it is possible for the dairy farmer to place animals that are not in production (heifers and dry cows) on pasture. However, this practice reduces the surveillance of the herd and increases the time required to intervene in the event of a problem with an individual.

In order to solve the problem, monitoring via stationary sensors placed on pasture can be implemented (Frost et al. 1997). These sensors can then be used to obtain an individualised indicator and to detect a change in the habitual behaviour of an individual and intervene if necessary.

The first step in setting up such monitoring on pasture is therefore to choose the location of the sensors for monitoring the animals. The watering trough is one of the most regularly used areas of the pasture, making it potential place to study animal behaviour.

Most observations related to cattle watering were conducted in Africa, North America, Australia and Asia and very few has been made in Europe (L. R. Williams et al. 2017). In addition, many experiments were conducted on intensive farms and not on pasture (Spigarelli et al. 2020). Furthermore, although drinking behaviour is well detailed for producing cows (Cardot, Le Roux, and Jurjanz 2008), that of heifers and dry cows is less detailed. Therefore, we decided to study drinking behaviour of heifers and dry cow on pasture using watering trough access data in North-West Europe.

From these data on drinking habits, our objective is to determine how frequently it is possible to monitor a herd by placing stationary sensors at this location and determine whether an individual event that changes the drinking behaviour of an animal could be observed.

Material and method

The experiment took place on a pasture of the Centre for Agricultural Technology (CTA) in Belgium (50°30'24.4"N 5°19'08.5"E). The climate is temperate oceanic. The pasture where the experiment took place has an area of 9300m². The water point is located 164m from the furthest point of the pasture, bearing in mind that the maximum recommended distance is 250m in welfare standards (“RSPCA Welfare Standards - RSPCA” n.d.). The animals have permanent access to the trough. This conformation avoids the effect of distance to the watering hole, the impact of which is still a subject for study (Lauren R. Williams et al. 2020). Since shading of the water point does not affect drinking behaviour (Coimbra, Machado Filho, and Hötzel 2012), the influence of the factors related to the positioning of the water tank are limited.

We have placed an in-house designed gantry in this pasture. The gate is placed as the single one-way entrance to the waterhole. The gantry is equipped with a RFID reader (agrident ASR 650) and its antenna (agrident APA160 100 x 60cm panel antenna) that allow the identification of the animals and the recording of the time they were identified. The gantry has been designed to accommodate various sensors, such as RGB-D cameras. Figure 1 shows a sketch of the arrangement of the gantry in the pasture and a picture of the gantry used for the measurement campaign.

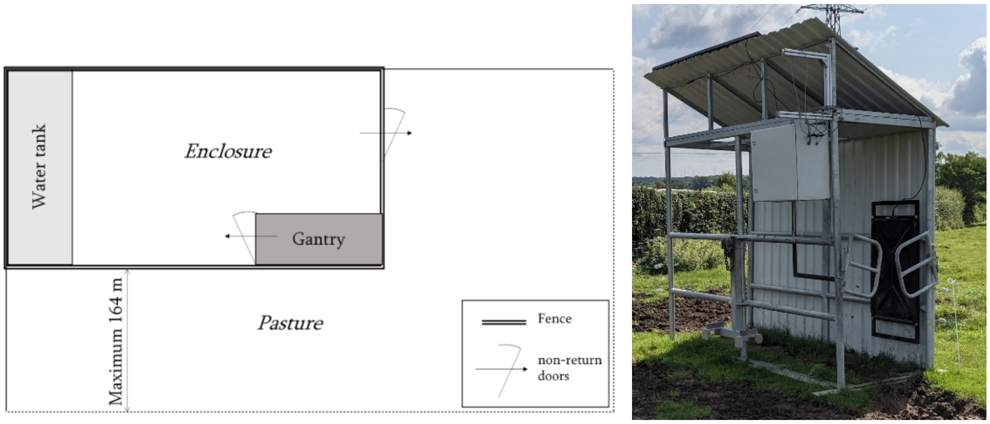

Figure 1 : Arrangement of the gantry in the pasture (left) and gantry used for the experiment (right).

The experimentation was performed during summer-autumn 2021 from June 16th to October 31th, two periods do not contain any recordings due to a hardware dysfunction, resulting in a total of 103 days of data collection. Sunrise was between 05:25 and 08:30 and sunset between 18:22 and 21:52. The maximum temperatures and minimum temperatures during the measurement period are presented in Figure 2. The recorded temperatures reflect a summer without any heat wave. All weather data were collected at the CTA site, where the experiment took place.

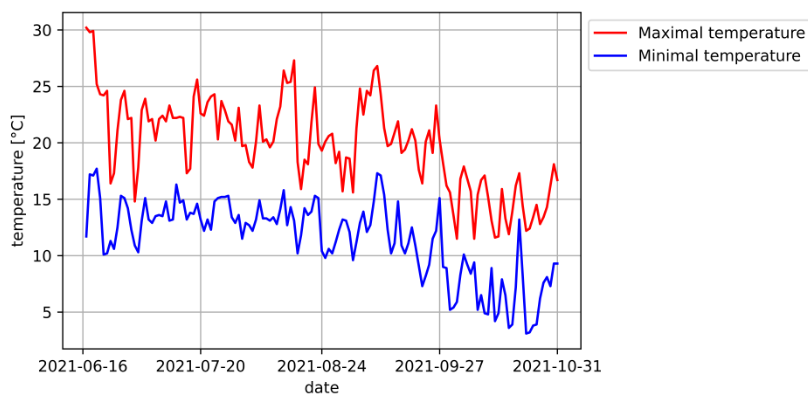

Figure 2 : Graph of the maximum temperature and minimum temperature for each days during the measurement campain.

The animals present in the herd are of Belgian Blue White and Holstein races. 15 different individuals were present on this pasture during the measurements season placed according to forage availability. As the animals are not all continuously present on the pasture, only actual presence time are taken into account in the statistics. For this reason, we divided our measurement periods into three parts, between the periods when no measurements were taken, and we considered the animal present between its first passage to the watering trough and its last on each period.

When an animal is identified by the RFID reader, the time of passage is recorded and stored in a file containing all the times of passage of each animal for the day. An animal can be identified more than once on a pass. Indeed, when an animal stops at the reading antenna during its passage, the reader continues to read the number and thus records several passages. To filter this data, we looked at the minimum time between two identifications of the same animal separated by the identification of another animal. Since these two identifications are separated by the identification of another animal, we are certain that they represent two distinct passages. We therefore used this time as the minimum time between two measurements for them to be considered as distinct passages.

Results

In this section, we will discuss the data filter that was used to establish the watering trough access information from the identification data. We will then discuss the results of the algorithm that allows us to determine whether an animal is present on the pasture. After that, we will discuss the observations made from the watering hole access data .

Data filtering

The above arrangement gives us a total number of 1935 identifications. From this data we were able to deduce the minimum time between two identifications representing two distinct passages. This delay was measured at 50s. It may vary depending on the layout of the delimited area of the waterhole and the distance to be travelled between the entrance and the exit of this area. After this data removal filter, we obtain a total of 1530 cow accesses recorded over the 103 days of measurements.

Presence of animals

As we do not have access to the record of the presence of animals on pasture, we have developed an algorithm to compensate for this lack. We therefore assumed that an animal was present on the pasture between its first and last passage for each of the measurement periods. These calculations allow us to determine that on average, 11.6 animals with a minimum of 6 and a maximum of 13 animals were present on the pasture throughout the measurement campaign. Figure 3 represents the temporal monitoring of the number of passages recorded as well as the number of animals present on the pasture. This result is probably biased at the beginning and end of each period, especially end of periods 2 and 3 when frequency of watering trough access were declining at the herd level.

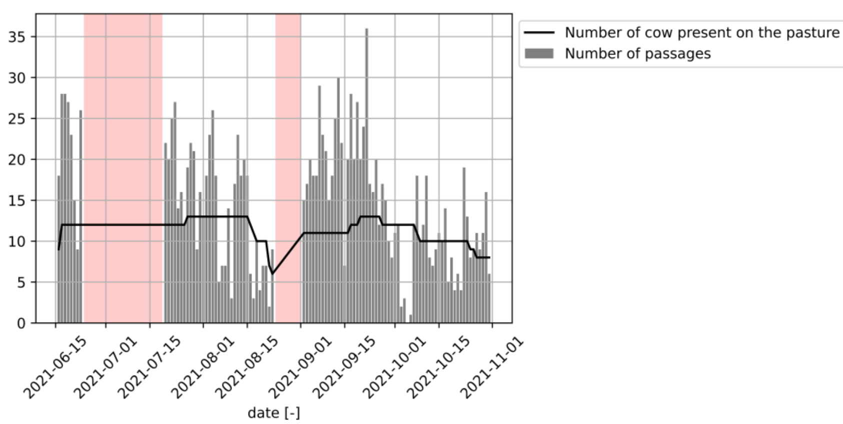

Figure 3 : Time tracking of the passages for all animals and the amount of animals on the pasture with inactive period of the gantry (red)

Monitoring of watering

The Figure 4 represents all the passages that were made for the 15 animals observed on the pasture during the entire measurement campaign. The precipitation (blue dots) according to some thresholds and the periods of malfunction of the gantry (red areas) are also represented.

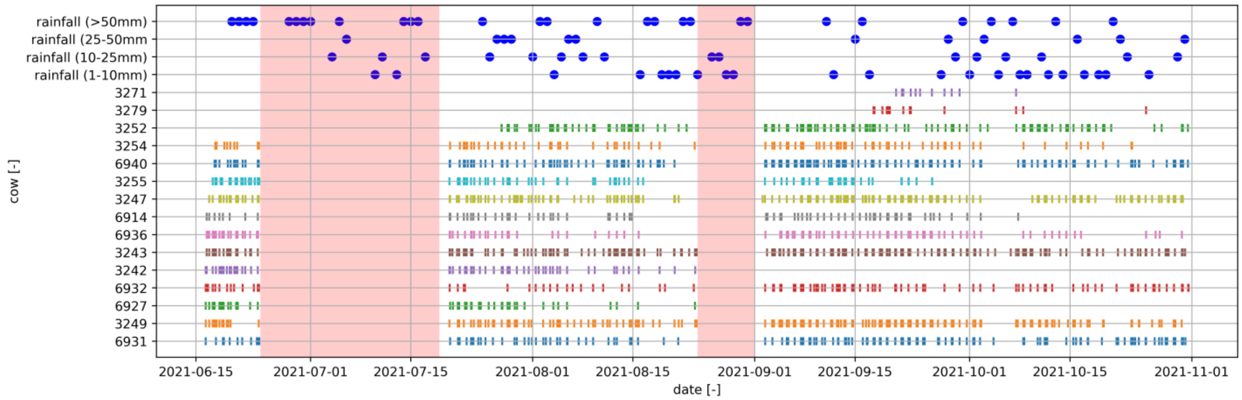

Figure 4 : Time tracking of the passages for each animal, inactive period of the gantry (red) and amount of precipitation (blue)

The main observation we can make on this graph is that the frequency of passages is very variable over time.

The first scale of observation, the global observation of the herd, allows us to see a higher overall frequency at the beginning of the season than at the end of the season.

On the second observation scale, at the individual level, we can see a disparity between individuals with, for example, animal number 6932 which drinks frequently at the beginning of the season and then decreases its frequency of drinking strongly during the second half of July, whereas this phenomenon is not observed in the other animals.

Variability at the individual level

In order to focus on each individual animal it is interesting to look at the distribution of the time interval between watering access for each of the animals studied. As shown in Figure 5, we can see that the trend is similar for all animals with a probability of showing up within 24 hours between 70 and 90%. We see a disparity between the animals. For half of them the time between accesses is less than 24 hours in 70% of cases and for the other half it is less than 24 hours in 90% of cases. We also see a similar trend to have access after 24 hours, showing a lower occurrence of cow watering more than 24 hours apart.

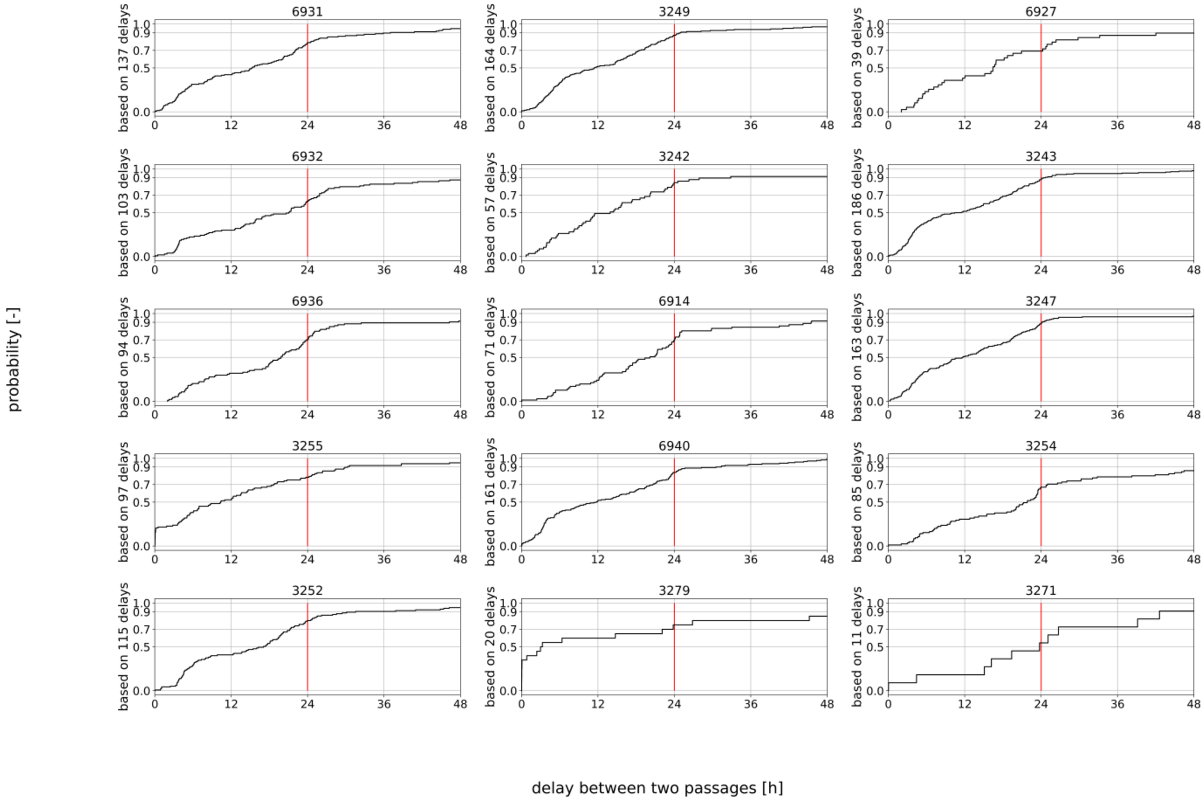

Figure 5 : Cumulative distribution of time interval between watering trough access for each animal.

Differences at the individual level would be due to factors specific to the animal such as the time of the cycle, disease, injury, etc. Determining a threshold for the time between watering at the animal level could be an indicator of the health status of the animal.

Variability at the global scale

When we want to set up a herd monitoring tool it is important to consider how often we can obtain data for each animal. Figure 6 shows the percentage of the herd that accessed to the watering hole within 1, 2, 3 and 7 days. On average, 75% of the herd will be visible every day, while 87%, 91% and 97% of the herd will be visible within 2, 3 and 7 days respectively. But as observed this percentage is highly variable during the season, probably because of climatic and pasture parameters variability.

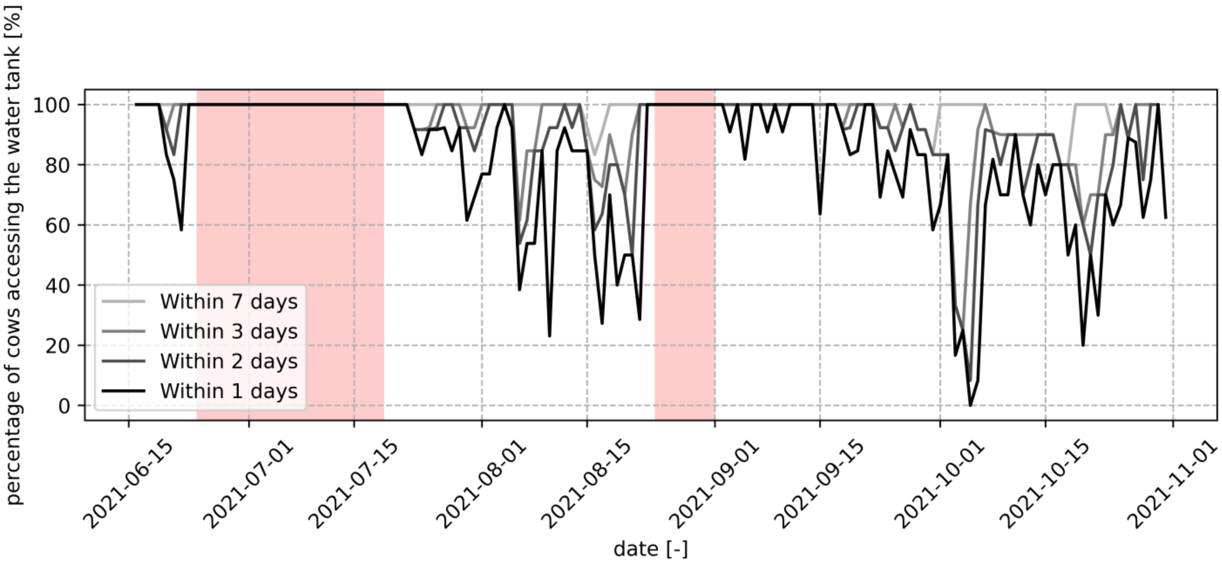

Figure 6 : Percentage of the herd that came to the watering place within 1, 2, 3 and 7 days.

We can therefore see that it is not realistic in this climate to carry out daily monitoring of each animal using the watering hole as the only point of attraction. On the other hand we can expect one data per week per animal for a longer term follow-up.

It is therefore appropriate to look at conditions that would reduce the frequency of data collection. The factors influencing the time between watering for the whole herd can be diverse. As distance to the watering place is not an issue, we have focused on climatic parameters. We therefore investigated the influence of rainfall and temperature on watering.

We do see a decrease in the use of the water point at the end of the measurement campaign, while the temperatures also decrease. We therefore studied the correlation between minimum and maximum temperatures and the frequency of watering. Figure 7 illustrates the relationship between the maximum and minimum temperatures of the day with the average number of watering of the day. This is illustrated by a linear relationship. The correlation coefficient is also presented. We can see that the highest correlation is observed with the maximum temperature of the day with a correlation coefficient of 0.451. The influence of daily maximum temperature on drinking behaviour is therefore not negligible as expected.

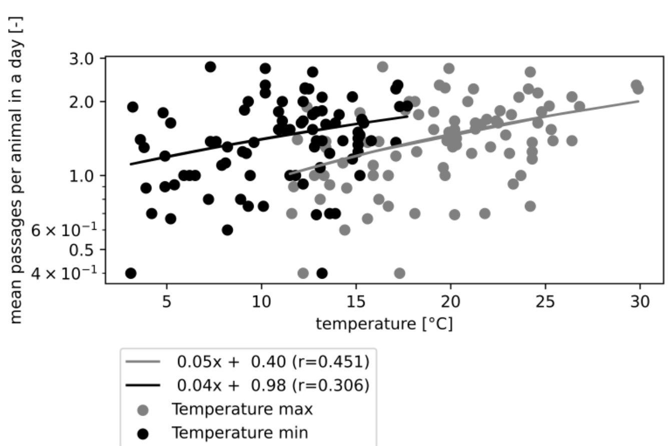

Figure 7: Relationship between average watering trough accesses for the day and maximum temperature for the day (grey) and minimum temperature for the day (black).

Another climatic variable that was studied was rainfall. Figure 8 shows the average number of watering according to the rainfall. The first situation is a day without rain and where it did not rain the day before either. The second situation is that it rained the day before. The last situation is that it rained the same day.

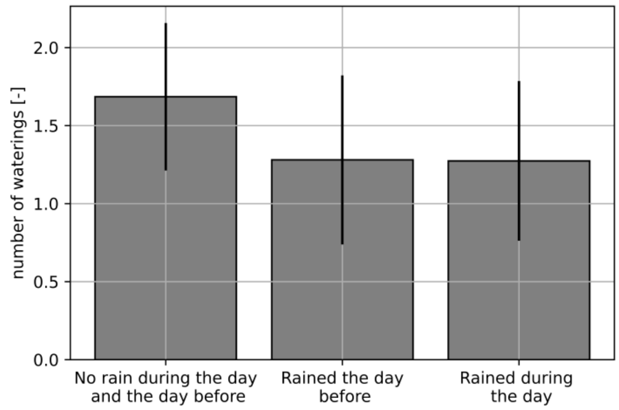

Figure 8: Average number (with standard deviation) of waterings for days with no rain, neither the day before nor the day, as well as days with rain the day of and days with rain the day before.

We observe a higher average for watering when no rain was recorded. The difference from the case of rain the day before was verified as highly significant with the student's t test resulting in a p value of 0.00113. We therefore observe that animals tend to use the water trough less when it is raining the day before or the day of access. This can be explained by the presence of water on the vegetation but also by the presence of puddles on the pasture which represent some other sources of water.

Monitoring will therefore be less frequent in cold or rainy weather and the opposite in hot and dry weather. Other parameters as fodder water content or animal development stage are probably important in the daily hydric balance to the animal.

Discussion

We studied the watering behaviour of a herd of grazing cattle in a temperate oceanic climate. From these data we were able to study the watering habits of these animals in Belgium during part of the pasture season.

We noticed that the frequency of watering varies a lot along time for the whole herd but also individually.

For the herd we confirmed two explanatory factors, the ambient temperature and the rainfall and some other as fodder water content are suspected.

At the individual level, we noticed that behavioural changes were present, suggesting that it is possible to detect anomalies at the individual level that may need further investigation.

The feasibility of placing a monitoring device at this location is questionable. For measurements to be carried out weekly, the water point may be sufficiently attractive, however, if measurements are to be carried out daily on each animal it is essential to provide an additional attractive element such as a licking bucket for example.

Conclusion

Our study consisted of recording the access to the waterhole using RFID ear tag of a herd of 15 animals located on pasture during part of the grazing season in Belgium. From this data we aimed to determine whether or not it was appropriate to install a stationary monitoring system at this location to observe the animal welfare along the pasture season. We also wanted to determine if the individual drinking behaviour of an animal change could be detected.

We therefore came to the conclusion that for daily monitoring, the attraction of the waterhole was not sufficient in Belgium climate, other forms of attraction must be considered as lick buckets to increase access frequency.

We also came to the conclusion that individual behavioural changes are detectable. It would therefore be interesting to carry out a new measurement campaign by manually monitoring each animal health in order to associate a health condition with an abnormal drinking behavior to develop decision support tools for the herd management.

Future works include the use of RGB-D cameras on the gantry as well as data collection of animal sensor data to collect more information for herd management during watering trough access.

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