Monitoring Lameness in Cattle Using the Vitalimeter

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Abstract
The most serious medical illness in breeding dairy cattle include diseases of the limbs, especially the hooves, which is a cause of premature decommissioning of the breeding. This is a crucial economic factor, because it can also significantly reduce the production of milk, and weight. It is therefore very important early detection of lameness. The aim of this study was to monitor the correct movement of dairy cows and subsequent detection of lameness through the automatic scoring system (vitalimeter), which facilitates the search for sick animals.

Keywords: hooves, vitalimeter, lameness

1. Introduction

Lameness in dairy cattle is a significant problem in intensive dairy industries around the world [1]. It is one of the most important indicators of welfare and animal health. Furthermore, it causes pain [2], reduces longevity [3,4] milk production [5,6], reproductive performance [7,8], and consequently, has a large economic impact [9]. Lameness is a response to pain. Foot lesions causing lameness in cattle are multifactorial, causing trauma, metabolic disorders and infection [10]. To a lasting and to sustainable reduction of lameness requires a combination of three procedures: firstly familiarize farmers about the existence and extent of the problem and understand the consequences of lameness for the physical and financial performance of the herd, and secondly, the introduction of effective prevention strategies farms and reduce the rate at which new cases are developing [11] and thirdly early detection, rapid and effective treatment of clinical conditions, whereby will be reduced the length of time for which animals are lame [12]. Detection even of tiny pain conditions could be important for early and accurate intervention. Pain in the hooves is difficult to assess in the terrain. Usually is manifested the pain by changing their gait [13]. The erosion of hoof feet, cleft hoof, and inflammation of the corium of the hoof, laminitis, dermatitis, infectious necrobacillosis and interdigital tylom are the most common disease causing lameness.

With the advent of development in electronics, computer technology, and identification of different types of sensors it became possible to use these resources in primary agricultural production. In practice they gradually appeared devices that detect a step frequency or movement activity cattle. We can find them under various names - pedometer, redactor and vitalimeter. These establishments serving information on health status are being used also to detect oestrus.

Its own the detection element first pedometers were implemented to help the mercury sensor that

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panned motion only in the vertical direction. At each shake the sensor above the specified level they are generated pulses corresponding to the intensity of aftershocks. These pulses are processed by a microprocessor. Pedometer with this number is placed only on foot. Reading the number of pulses is carried out using the antennas located in the milking parlour. At each passage the animal milking parlours reads the number of pulses. From time prior to passage counts the number of pulses / steps over a period of time. Detection algorithm deviations of those pedometers compare the current value with the average for the last two days. If the deviation exceeds a specified limit (e.g. 100% - doubling their movement activity) is an animal with this pedometer shown in the signal the assembly for insemination. The disadvantage of these pedometers is that their own reading is realized only at the milking parlour.

The next generation of pedometers used a sensor that is used in first pacemaker. It was a completely passive 3D sensor, which consisted of a coil and the magnetic beads. Armature coils had a spherical shape in the middle, into which was placed a bead. Vibration the ball moves in the ball area and creates an electrical voltage to the coil, which was subsequently amplified and sensed by the microprocessor. The problem with this sensor is that the sensitivity is equal in all directions and you can not to recognize the direction of movement. With omni-directional scanning it can be used to detect movement of the neck and the leg [14].

Currently, most manufacturers use the accelerometers to detect motion. During the last 5 years they have undergone great development caused by their use in mobile phones. It is a component which senses acceleration in three axes.

2. Materials and methods

For the determination of lameness animals are many different variants tested, we concluded that the best use of the device for monitoring physical activity, in our case are vitalimeter. Testing the application in operating conditions in several different types of stables, we had gained a lot of valuable data that is used to confect an algorithm for assessing different types of movement including lameness. As a basic sensor for evaluation activities, eating and rumination and movement of cattle were used accelerometer. It is an electronic component with the frame rate of 10 Hz, and its consumption is about 6uA, which is suitable for the desired lifetime. Information about the acceleration in each axis is secured by processor. Processor based on the detection algorithm decides whether it is a movement of the animal or any other type of movement. Data from vitalimeter are then wirelessly transmitted every hour on the computer, where they are being treated. For the user reporting the programs are available, on which it can easily evaluate the problem.

The first operational testing was performed at ZD Krasna Hora nad Vltavou Ltd. The farm is not only the largest, but also the most successful economically and breeding farms in the Czech Republic. Farm an area of 4,892 hectares, of which 3,269 hectares of arable land, behaves 3,700 heads of cattle. Testing was conducted on a farm Petrovice where are 700 Holstein milking cows.

Monitoring procedure was as follows: selected cow had on the neck and on all four legs vitalimeter, perform a manual registration in ethogram, a handheld video camera while video from fixed cameras. Results of vitalimeter were then compared with those records. First were monitoring cows without clinical symptoms or rut. They were identified following behaviours: chewing, eating, drinking, walking, focusing on a single element-step, lying down, and getting up. In a similar manner were observed limping dairy cow.

3. Results and discussion

Even walking of dairy cows is shown in Figure 1.

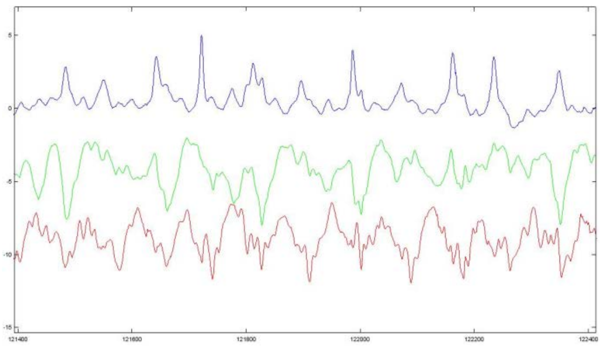

Figure 1. Acceleration in the individual axes when the animals are walking

Elimination of vitalimeter rotation on the collar is provided in the program. Of all the three current values of the acceleration is obtained by the acceleration vector and it always compares with the previous acceleration vector. The vector of acceleration is shown in Figure 2.

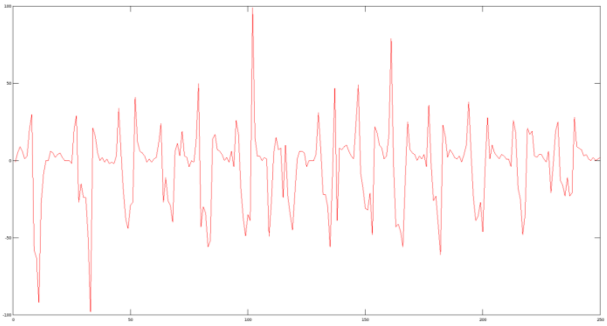

Figure 2. Vector of acceleration while the animal is walking

If the resulting deviation of acceleration exceeds a defined value, it declares that the animal was in motion in the defined period movement. The sum of the individual sub-movements for a certain period presents information about how the animal walked. This information is subsequently transmitted to a computer. During analyzing of the data from the accelerometers was found that when vitalimeter is placed below the neck, there are specific changes to individual activities of dairy cows: drinking, eating, and ruminating. E.g. during rumination, approximately every minute the animal calms down for 2-6 seconds which is associated with the swallowing and subsequent disgorging of feed. This calming is detected by the accelerometer as a zero motion, refer to Figure 3.

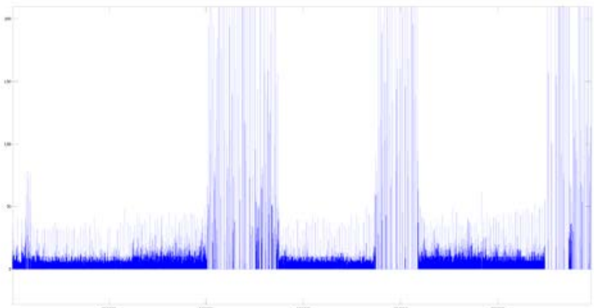

Figure. 3. The frequency of rest periods

In the case when the vitalimeter is on any of hind leg we detect:

- Lying time
- Standing time
- Walking time
- Number of steps
- Number of getting up

When we add vitalimeter from back to front leg detect any number of jumps cow to cow, but it does decrease the accuracy of detection times lie.

Vitalimeter on the neck detects the following information:

- the number of movements
- ruminating time
- eating time

Information from vitalimeter helps the farmer to determine the oestrus and health. Extension of functions to monitor the time of rumination and feed intake allows the opportunity to determine the health problems of dairy cows. A number of scientific papers deals with these issues which suggests that in addition to more accurate peak of oestrus, it is possible to detect the onset of diseases, metabolic disorders, stressors and other causes restriction of animal welfare [15, 16]. It was found that the period of rumination in dairy cows shortens to 48 hours before the manifestation of other signs as a consequence of stress factors. These may be in addition to diseases and inappropriate treatment (for example: when moving and milking), heat stress, overcrowding of pens, disturbed social stability in the group (due to frequent movements), limit time lying due to difficult "hit the sack" and getting up into cubicles. For cows with less time ruminating over 2 to 6 days after calving it was demonstrated incidence of postpartum complications and subsequent incidence of clinical diseases such as mastitis, displacement of abomasums, ketosis etc. Healthy cows after giving birth rapidly extended period of rumination and the third day they had an average value of herd while cows with the incidence of postpartum complications have reached this level up within 15 days. Reducing the duration of rumination was also observed for 10 days before diagnosis of hoof diseases.

There was detected lame cow during monitoring lame cows, but assuming that it had on each leg vitalimeter. This method is accurate but in practice cost inadmissible. It is clear from the behavioural observation that a cow with a bad leg falls on the health front or back leg and uses his head as a counterweight and thus relieves the diseased limb. Lameness might be recognized from the change of the move of the head. The precise mathematical function to detect lameness has not been compiled yet.

4. Conclusions

Vitalimeter became a great help for farmers, which helps them not only to ensure optimal fertility in the herd and timely solutions to problems in reproduction, but it can also monitor the animals' health. Information obtained by regular assessment of physical activity and time of eating and ruminating together with monitoring of production and reproductive performance give farmers a better overview of what is happening in the herd. It accelerates and renders more effective their work especially. Lameness is another important function of this device.

It's just we examined the ability to detect major health problem in modern factory farms. Currently, we can identify cows with lameness problem of combining these data from vitalimeter: reduced eating time, reduction in overall physical activity, reducing the number of standing up and lying down, a longer period of lying; the weight: weight reduction, a milkmeter: a reduction of milk yield.

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