Monitoring and Classification of Cow Activities using Three-dimensional Accelerometers

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I. Abstract

Monitoring cattle motion is essential, it helps farmers has a comprehensive view of the cattle's healthy. However, the issue is not able to supervise the cattle in the long time, especially raise many cattle. This paper research the method to prognosticate the cattle's healthy by using a cattle monitoring device that can record the 3-axis acceleration to analysis. This sensor is used to measure three axes accelerometer from Viet Nam Yellow cows. The data of the accelerometer output signal is used to modify a simple behavioral classification as: lying, standing and feeding. Hence, we can identify some of cattle health events such as: lameness, estrus cycle. The classification results were tested with the model of the cow. In conclusion, accelerometers are an excellent tool to easily recognize different types of behavior patterns in cows.

II. Introduction

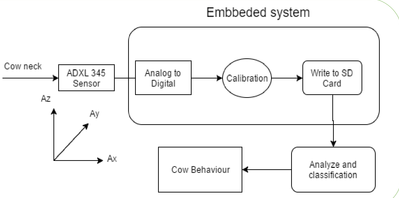
Vietnam is located in the region of tropical monsoon climate, where is endowed with cow farming. Dairy farming requires high technique and investment. In fact, 95% dairy cows in the country has been scattered raised by small, unskillful households and using traditional breeding methods. The system will provides farmers with all of the information that they need and therefore they could be define health problems or a risk of animals for disease, moreover predicting estrus status.

III. System design

ADXL345 Sensor

SD Card Module

Kit Arduino Uno



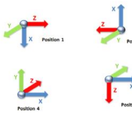
IV. Proposed method

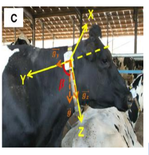
Convert to *g* values:

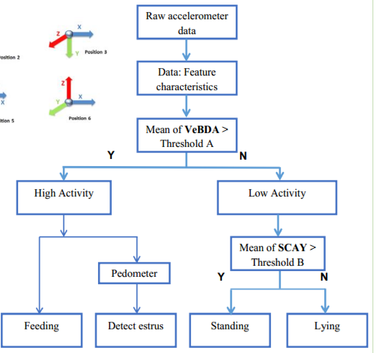
Gs = Measurement Value × Scale

in which, **Scale** $= \frac{G - range}{2^{10}}$, **Gs: g values(9.81 m/s^2)**

Rotate the device from +1g through -1g to calibration.







Flow chart of the proposed algorithm

Feature characteristics

- ❑ Dynamic body acceleration (DBA)

  $\mathbf{DBA_i = A_{i_t} = |A^*_{i_t} - \mu_{i_t}|}$ (2) where $\mu_{i_t} = \sum_{t-S/2}^{t+S/2} \mathbf{A^*_{i_t}/S}$ **and i = x, y, z**

- ❑ Overall dynamic body acceleration (ODBA) $\mathbf{ODBA} = |A_X + A_Y + A_Z|$
- ❑ Vectorial dynamic body acceleration (VeDBA) $\mathbf{VeDBA} = \sqrt{A_x^2 + A_y^2 + A_z^2}$.
- ❑ Static component of the acceleration in the *y*-axis (SCAY)

$$\vec{g}_y = \mathbf{g} * \cos(180 - \beta)$$

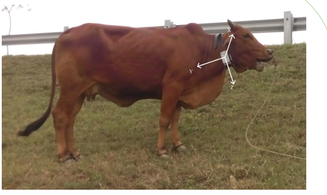
Pedometer

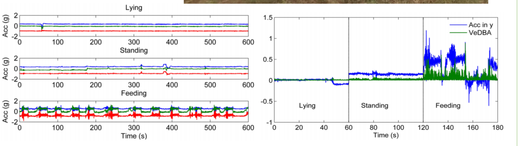
❑ Pedometer: counts the number of steps.
❑ Reason: increased restlessness, and the increased activity.

A real cow behavior's monitoring system

V. Results

Cow is wearing a neck collar with attached sensor with the position and orientation as figure.



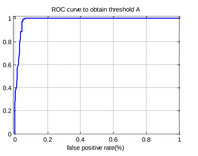


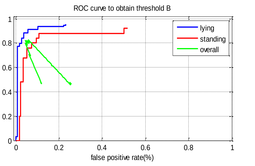
Raw tri-axial accelerometer for lying, standing, feeding (x-, y- and z-axis correspond to the blue, green and red line respectively).

The running mean of the acceleration in the y-axis (SCAY) and vector dynamic body acceleration (VeDBA) value under the three behaviors.

Define threshold

Approach 1: Use ROC

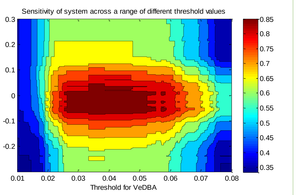




The best threshold value is the one that generates the pair of TPR and FPR values closet to the top left corner which represents the value that separates perfectly the positives from the negatives.

Approach 2:

Running a comparison of the performance of the algorithm over a 2-dimentional space range.



Sensitivity	Lying	77.42
	Standing	88.00
	Feeding	98.78
	Overall	**88.06**
Precision	Lying	98.63
	Standing	55.00
	Feeding	93.10
	Overall	**82.24**

Best performance is obtained at the window size of 600s

VI. Conclusion and future work

Accelerometers can be used to recognize some important behavior patterns in cows as: lying, standing and feeding. Simple decision-tree classification algorithm was useful in classification of these patterns. This is a part of a real-time behavioral monitoring system in order to automatically detect the heal problem in cow even in other similar cattle.
In the future work, a wireless sensor network will be researched and developed to collect and transmit data on larger scales.

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[5] Bidder, Owen R., et al. "Love thy neighbour: automatic animal behavioural classification of acceleration data using the k-nearest neighbour algorithm." PloS one 9.2 (2014): e88609.