APPLICATION OF INFRARED THERMOGRAPHY FOR ASSESSING BEEF CATTLE COMFORT USING A FUZZY LOGIC CLASSIFIER

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ABSTRACT

This work aims to develop a fuzzy logic classifier that integrates both environmental and animal factors to determine the level of thermal comfort to allow the environmental assessment and control. An experiment was performed with Nellore steers during eight days where air temperature, relative humidity, skin temperature and rectal temperature were taken in different periods. Those data were used to construct a fuzzy classifier that has three inputs, air temperature, relative humidity, skin temperature, and a output that predict the rectal temperature. The fuzzy logic classifier is evaluated in comparison with a traditional temperature-humidity index and it shows some important benefits related the traditional indexes.

Keywords. Precision livestock production, thermal comfort, fuzzy logic.

INTRODUCTION

Timely works have shown the negative impact of the thermal stress on cattle performance and well-being. The first response of the animal to thermal stress involve maintaining thermoregulatory by increasing the activity of the mechanisms for heat loss, while simultaneously reduces its functions essential for growth and food intake (Padodara and Jacob, 2013). The thermal comfort index in animal housing is determined typically based on ambient variables such as temperature and humidity. Furthermore, the physiological measures of thermoregulation are important indicators of thermal comfort, but this measurement is usually laborious and the development and implementation of automation systems for environmental assessment and controlling require non-invasive sensors (Brown-Brandl et al., 2005). This work aims to develop a classifier based on fuzzy logic that integrates data from non-invasive sensors, but that consider animal response to determine the level of thermal comfort.

MATERIALS AND METHODS

The fuzzy logic classifier (FC) was constructed with the inputs the air temperature (DBT - dry bulb temperature), relative humidity (RH) and skin temperature obtained by using infrared thermography (IR - infrared thermography). The output of the FC is a variable associated with the rectal temperature (RT), thus the classifier uses two environmental variables and a physiological variable of the animal to estimate the level of comfort associated with the RT of the animals. An experiment was carried out to guide the development of the FC with eight Nellore steers during eight days. In each day variables were taken in different periods of the days and the IR was collected using an infrared camera (TI 20-9 Hz, Fluke Corporation, USA). The stored measurements were applied by the animal science specialist in other to guide the composition of the fuzzy knowledge base. Different sites of IR measurements and the RT measurement were evaluated by Pearson's correlation and the front area of the animal was selected as the IR measurement. The rules of stress levels were defined according to data supported by previous studies with cattle and the FC is evaluated in comparison with a traditional temperature-humidity index (THI) (Thom, 1959)

RESULTS AND CONCLUSIONS

The thermal environmental is classified in four levels (comfort, critical, danger and emergency) by THI, while FC classify the environment only in the first three levels (comfort, critical, danger). The classification by THI and FC are coincident for 28,5% of the days (71,5% are classified as divergent way), i.e., THI classify the days as emergency while the same days are classified as danger or critical by FC. In fact, the physiological responses RT show no value that could infer a state of emergency of thermal stress by bovines. Common value of RT 38,8 ^{o}C observed for the animals in the same day when the environment is classified as emergency by THI reinforces this result. On the other hand, the average of RT value for animals during the days classified as danger by FC is 38,9 ^{o}C showing greater consistency between this classifier and animal's response, since RT values above 39,0 ^{o}C could be indicative of initial stress for bovines. Thus, FC developed using IR as an input is a promising tool to allow the environmental assessment and control. Common value of rectal temperature observed in the same day reinforces this result. Besides, the average of rectal temperature value during the days shows greater consistency between the FC and animal's response.

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