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Technologies Used for Animal Welfare Monitoring

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Abstract. With the use of technology in the livestock sector, it has been allowed an increase in animal production and reduction of waste with more precision. The use of these technological resources in the sector gave rise to Precision Cattle Raising, which makes use of information and communication technology to extract the best from animal production with more precision. Studies show the use of telemetry to measure the state of animal welfare. However, during transportation from the farm to the slaughterhouse there is no specific way to check animal welfare, this can affect meat quality and the livestock economic sector and animal production. This study aims to identify the variables that can be read through sensors or biomarkers for monitoring animal welfare.

Keywords: Telemetry, Precision Livestock, Animal Welfare, Monitoring.

1 Introduction

Animal welfare is associated with the comfort that the individual feels in relation to his environment and his harmonious behavior with it [1]. It relates to stress, health, and the physiological and psychological needs of the animal [1, 2].

The environment in which the animal is inserted also contributes to welfare, and is related to the interaction of the animal with the environment and its fellows [3]. This presents variables that can be controlled and that influence positively or not in the production [1].

During the transport of animals to the slaughterhouse, there are several variables that bring discomfort to the animal, such as environment temperature, relative humidity, space, the balance of transport during the journey, thirst, and hunger.

Several studies discuss animal welfare in long-distance transport and how this affects meat production and quality due to a high level of stress on the animal during the long journey.

The objective of this study is to identify which variables can be read by sensors to bring thermal comfort to the animal and to monitor the animal's stress level.

1.1 Animal Welfare

According to the user's guide to animal welfare, it is described that animal welfare is related to the physical health and physiological conditions experienced by the animal [4].

Broom [2, 5] describes that inability and difficulty in dealing with problems cause feelings of fear and anger, generate stress levels that alter an individual's well-being [5].

According to the Terrestrial Animal Health Code (Terrestrial Code) of the World Organization for Animal Health (OIE) [4] defines animal welfare as the behavior and conditions in which the animal lives, that is, an animal that is well nourished, able to perform innate behavior, healthy, and is not in distress, pain, and fear, is considered to be in a good state of welfare [4].

For an animal to be in a good state of well-being, it is necessary for the animal to have veterinary treatment to treat and prevent disease, proper shelter, good food, and an environment that brings comfort [2–7].

In order for farms to be able to guarantee a good welfare state for the animal, they use tools that make it possible to measure variables about the animal and the internal environment.

1.2 Telemetry

With the advancement of information and communication technology (ICT), farms make use of telemetry to take measurements of the indoor environment and the animal [8–10].

Telemetry allows measurement of the environment through sensors that take real-time readings on relative humidity, ambient temperature, water temperature, and recognition of stress level through the sound emitted by the animal [11, 12].

This insertion of telemetry in the livestock sector is known as precision livestock, or Precision Animal Science [13, 14], which makes use of technological resources to more accurately assess and monitor the conditions of the areas of animal production activities, measuring and analyzing the data of each animal.

Precision livestock presents similar objectives to precision agriculture [15], to follow the technological advances to automate animal production, and can assist in increasing production [13], saving water and energy, reducing costs and waste, and detecting pests and caring for the animal's health.

According to Dawkins [3], measuring animal welfare is not an easy task, just as measuring the height of a five-story building is, and it is complex due to the many variables that can be presented during the measurement. However, highlighted some activities that can be observed to analyze and measure animal

welfare [3]: (1) Natural Animal Behavior; (2) Fitness and Longevity; (3) Stress and Physiological Symptoms.

In observing these activities it is possible to perform tests to generate behavioral indicators [3], for example, cutting off the water supply for a long period and analyzing the behavior and measuring body temperature and the sound emitted by the animal. In this way it allows a better analysis to measure the state of animal welfare.

2 Materials and Methods

In this study, a literature review was conducted [16,17], in order to identify related work on the use of technologies to measure animal welfare and stress levels.

It was established that to avoid duplicate work and because it is one of the largest databases, the Scopus database, the Scopus database was used to identify, evaluate, and interpret the results relevant to the scope of this research.

The expression used was 'animal transport for slaughter', papers were selected that contained the keywords 'animal transport', 'animal welfare', 'slaughter' and 'monitor animal' (Table 1).

3 Results and Discussion

After an analysis of the literature found in the scopus database, it was noted that the studies are related to the use of telemetry in farms where the environment can be controlled and automated. And they follow the guidelines established by Farm Animal Welfare Committee (FAWC) [6,7] for production on farms, known as the five animal freedoms (Fig. 1).

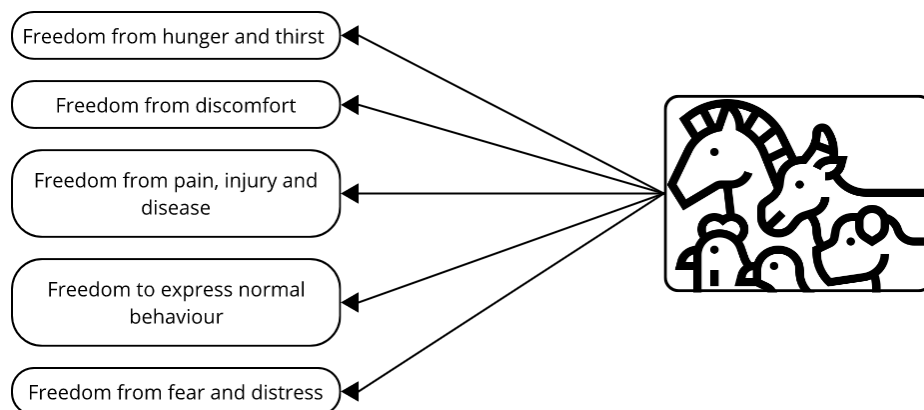


Fig. 1. Five Freedoms of Animals.

Table 1. Selected papers

Title	Objective	Method	Reference
Automatic prediction of stress in piglets (<i>Sus Scrofa</i>) using infrared skin temperature	Development of a model to predict stress in piglets using an infrared sensor	Thermal image analysis detects stressful conditions in piglets.	[8]
Classification of piglet (<i>Sus Scrofa</i>) stress conditions using vocalization pattern and applying paraconsistent logic $\text{E}\tau$	Analysis to automatically classify stressful conditions in piglets using vocalization	Animal sound analysis detects stressful conditions in piglets.	[9]
Use of Temperature, Humidity, and Slaughter Condemnation Data to Predict Increases in Transport Losses in Three Classes of Swine and Resulting Foregone Revenue	Analysis of the effects of temperature and humidity on pig deaths during transport	Analysis of meteorological data and temperature sensors	[10]
Transforming the Adaptation Physiology of Farm Animals through Sensors	Review of technologies for evaluating the adaptation of farm animals	Analysis of sensor technologies used on farms	[11]
Precision animal production: image analysis to study broiler's behavior under stress conditions	Evaluation of broiler behavior by analyzing images	Use of images to analyze behavior under heat stress	[14]
Welfare of lambs subjected to road transport and assessment of carcasses and meat	Evaluation of the welfare status of lambs in road transport and the impact of stress on meat	Evaluation of carcasses and meat	[18]
Temperature conditions during commercial transportation of cull sows to slaughter	Describing temperature changes and variations within trucks transporting sows to slaughter	Analysis of the temperature inside the trucks depending on the stop/movement	[19]

The five animal freedoms present guidelines for the animal to have access to water, nutritious food to maintain vigor and health, provide an appropriate and comfortable environment that allows the animal to express its natural behavior [6,7]. Veterinary care is also included presenting techniques and procedures for prevention, rapid diagnosis and treatment ensuring conditions that avoid suffering such as disease, injury and pain [6,7].

In order to achieve these guidelines, the farms make use of ICT to analyze and automate processes, and in this way can ensure a good state of animal welfare.

The study by da Fonseca et al. [8], used infrared imaging to measure temperature and identify thirst and stress conditions with high accuracy, thus presenting a non-invasive method to identify the level of stress.

With the use of a software that analyzes the vocal signals of piglets, obtained 93% (percent) accuracy for identification of pain condition [9], the vocal signals

of 40 readers were analyzed through a scenario with stressful conditions of thirst, pain, hunger, cold and heat [9].

Researchers Peterson et al. [10], conducted an observational study, where he used temperature and relative humidity data to predict increases in pig losses and the impacts on lost revenue [8, 20].

Peterson et al. [10], analyzed data from weather stations that are located near slaughterhouses in the United States from 2010 to 2015, to identify the high and low temperature periods. And during the study period, it was noted that a loss of USD \$18.6 million due to condemnations of pigs that were not fit for trade because of injuries to the meat caused by high and low temperatures [10].

Neethirajan [11], presented some Sensors and biomarkers that can be used for welfare monitoring used in farms (Fig. 2), thus bringing advantages and disadvantages in adopting sensor technologies in farms [11].

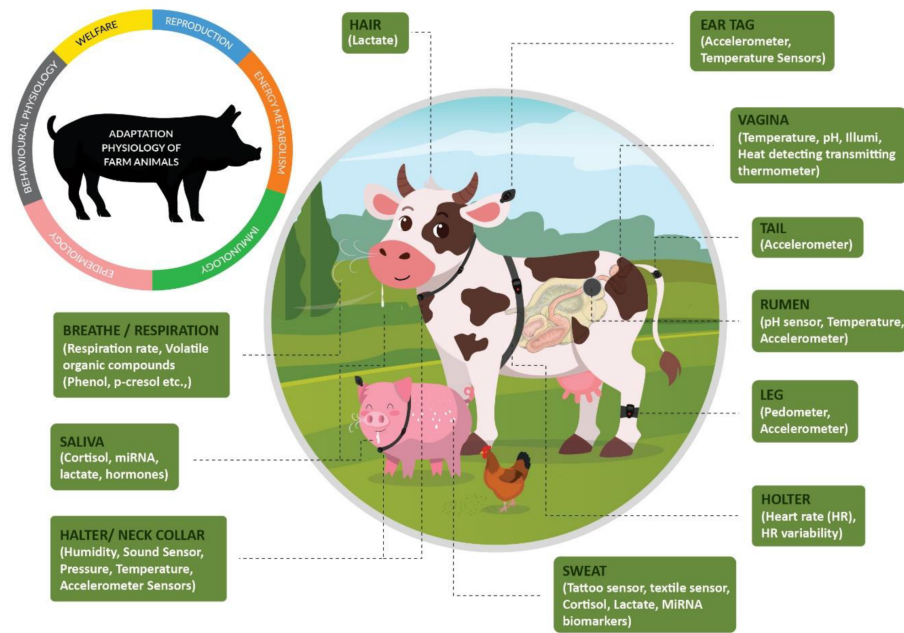


Fig. 2. Wearable sensors and biomarkers for animal welfare monitoring [11].

Sevegnani et al. [14], analyzed the behavior of chickens through images under heat stress conditions, the results indicated that the chickens ingested more water and less feed at high temperatures. This implies a decrease in live weight in longer transport.

The study by Silva et al. [18], analyzed images of lambs' behavior for slaughter, on trips between 7H30 to 10H30, the lambs ruminated more often than on

shorter trips due to the stress conditions of hunger and thirst on long trips and shows that there is a greater chance of tissue injury [18,21].

Thodberg et al. [19], analyzed the internal temperature of the truck to know in which period there is an increase in temperature during movement or when the truck is stopped. Data from 39 commercial trips were analyzed and it was noted that there was an increase in temperature when the vehicle is stopped thus leaving the thermal comfort zone of the nuts [19].

4 Conclusion

Through this study it was possible to identify the telemetry technologies that are used on farms to measure and achieve good animal welfare status.

Monitoring the animal makes it possible to perform operations that can improve the animal's welfare by decreasing discomfort due to stress conditions from hunger, thirst, and pain, thus reducing losses due to confusion or injuries to the meat.

Studies show concerns with animal welfare and how much this impacts the livestock economic sector. Through this study, the cattle breeder can identify which sensor technologies for monitoring can be used on the farm, thus reducing eventual risks and losses.

Another study is needed to analyze the factors that make the implementation of these technologies feasible. The prices and maintenance costs are factors that can make the use of monitoring technologies unviable.

As a complement to this study, research is being carried out that will make it possible to develop a low-cost prototype to monitor animal welfare in transports that travel long distances in Brazil.

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