A Concept for Animal Monitoring and Identification

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Summary: A concept for animal identification and monitoring has been developed based on the fact that both features are necessary to incorporate the device within integral control systems of the whole production process. The following aspects are under investigation: the relevant physiological parameters to be monitored (sampling spot and frequency), the electronics for measuring and transmission of data (taking into account the weakness of the biosignals), the battery, the packaging.

1 State-of-the-Art

The essence for having an effective overall control of the production system is to have a reliable method for monitoring and identifying individuals. In such an automatic system, a transmission link must be established between the object and the interrogating system. This link can be provided by light, sound or electromagnetic waves. Of these, radiowaves have received the most attention, largely because of the ability to easily create omnidirectional linkage. An integral part of the radiosystem is a device known as a transponder, which is attached to the object.

Transponders can be classified as either active or passive depending on their power source. Active ones require a power source which needs replacement, adds volume and is relatively expensive. The cost is important for active as well as passive systems since each animal has to have one. The passive technique uses a pulsed radarlike principle, where a power antenna transmits radio frequency bursts and the passive transponder returns a coded signal ("echo") to a separate time division multiplexed antenna (SIGRIMIS et al., 1985).

Prior devices and systems for monitoring animal data have been concentrated primarily in the area of wildlife biosystems, utilized to obtain movement data and animal identification data.

Such wildlife tags, being implantable transmitters and receivers for low level signals from animals by telemetry are well developed now (SKUTT et al., 1973; MOHUS, 1983; PUERS et al., 1988).

The problem with farm animals is, that such implants have a too high investment cost and that they require surgery under general anaesthesia not applicable by the farmer himself, introducing additional costs, while external devices may be lost. Therefore injectable electronic identification systems have been developed, but which transmit only coded information per animal indicating e.g. the herd number, animal number, etc. This information is very useful to be integrated in computer-aided management systems applied in order to optimize selection programmes, reproduction and feed efficiency. Within these applications the systems cover already a broad market, especially for large production units under loose-housing and self-feeding conditions (MCINTOSH, 1986). However, in order to make the system cost-effective within integrated production chain control, also biosensors have to be integrated allowing a much broader application field (GEERS and GOEDSEELS, 1988; POSTMA, 1990).

2 Objectives

Examples of integration in different farming and agro-industrial applications are: automatic early detection and alarming in case of oestrus, pregnancy, farrowing in wich case the farmer can focus his attention on problematic animals, and thus achieve a more efficient herd management; during loading and transport of pigs, animals could be monitored in order to detect early unacceptable stress levels which can influence welfare, mortality rate during transport and meat quality after slaughtering; slaughterhouse processing could trace back animals to their farm of origin, organizing appropriate payments according to meat and carcass quality, alerting producers to any health problems and taking into account preceding stress levels meat quality may be preserved by an adaptable slaughter procedure; but the disease status of an animal can already be detected on the farm, allowing individual care and treatment of animals, preventing an outspread within and between herds; optimizing of breeding schemes and sire evaluation, especially for individual selection on heat and cold tolerance, malignant hyperthermia; with the identification interrogation feature the farmer can go into the herd and collect animals by any particular criteria stored during the past and the present.
Implants measure quickly the physiological response to heat stress, feeding and exercise (HETZEL et al., 1988). However, there has been a lack of, and there remains a substantial need for a commercially acceptable long-life-long-range telemetry system for accurate monitoring and identification of individuals on a group or herd basis. E.g. passive systems are up to 50% cheaper than active ones, but also identification errors up to 30% can occur depending on the applied encoding principle for error free detection (SIGRIMIS et al., 1985).
Within the concept as presented here and focused on pig farming, we aim to develop an intelligent biosensor based on an injectable long-life telemetry system having the appropriate sensors for animal physiological monitoring and identification as applicable in methods related to intensive animal husbandry, improving animal health and welfare. The innovative characteristic will be a combination of positive features with respect to biosensor monitoring: injectable, active but power saving, precision, cheapness, read and write features from and to individual animals kept within a group.

3 Expected technical and economic benefits

Individual animal identification is becoming more and more important (e.g. disease control, payments, quality control, breeding records, etc.). Most pressure is from the pig industry, who are in the forefront of quality improvement, disease eradication and feed back of information to the producer. The development of an active transponder combined with different sensors will provide possibilities to improve pig handling, housing and transport, and will provide the key for integral chain care. These steps will lead to an improvement of animal welfare as well as of meat quality. Another aspect of the integral chain control is the prevention or embankment of a disease break-out. According to the suppositions made, i.e. two farms less infected and 12 days less exportation blockade in case of a break-out of swine fever, savings on a Belgian scale would be about 20 million ECU per year.

4 Work Programme

Since the system will gain its added value from the monitoring aspect, first of all representative biochemical and physiological parameters (sampling frequency and measuring spot taking into account the recuperation of the transponder during slaughtering) have to be identified. In a first step only sensors will be implanted, while the transponder remains outside the body.
Biosensors transform physical quantities like pressure, temperature, etc. into a basic electrical quantity, e.g. current, voltage or frequencies. Biosignals are often weak signals in terms of physical effects. So the first difficulty is the problem of the accuracy of measurement in spite of disturbances. Normally physiological reactions are not clear and cannot be related to one physical effect. So the second difficulty lies in the problem of interpretation. The problem of weak signals is prevailing when monitoring analog signals. Special problems arise in respect to accuracy, masking, noise, calibration and exchangeability. Moreover, also interpretation of data according to time series has to be taken into account (PAUL, 1983). This means that the measuring device has to be miniaturized, and that sufficient long measuring periods (long-life telemetry) are necessary in order to have the possibility to make a distinction between noise and real data.
Parallelly the electronics for measuring and transmitting data have to be worked out, taking into account the technical aspects of the signals as mentioned above. With respect to the dimensions in order to make the device injectable, the bottle-neck will be the size of the battery, which has to give sufficient power for measuring, capturing, internal management and transmission of data. Another aspect is the packaging of the transponder. Taking into account the integration of sensors we will have to investigate whether or not the sensors may be integrated in the package, depending on the materials used in order to prevent leakages of body fluids in the transponder.

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