통합 이미지 처리기법 기반의 PLF를 위한 Swine 관리 시스템

A Swine Management System for PLF baed on Integrated Image Processing Technique

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요 약

세계 인구의 증가로 인하여 식량에 대한 요구 또한 이에 비례하여 증가하고 있는 가운데 지속적으로 안정적인 가축 공급을 위해서는 농장에 대한 효율적인 관리가 중요하다. 최근 여러 가지 기술적 진보와 혁신에 목축업이나 농업 분야의 생산성이 향상되고 있으며, 각종 스마트 센서와 여러 가지 자동화 디바이스를 이용하여 가축의 생육 상태를 지속적으로 모니터링하고 생산을 관리하는 PLF(Precision Livestock Farming)의 활용이 확산되고 있다. 본 논문은 이미지 프로세싱 기법을 이용하여 가축의 체중을 모니터링하는 swine 관리 시스템에 관한 것으로서 Pig Module, Breeding Module, Health and Medication Module, Weighr Module, Data Analysis Module 및 Report Module을 구현하여 카메라를 통해 획득한 이미지를 이용하여 체중을 자동으로 계산하고 먹이량을 조절하며 건강상태도 모니터링 할 수 있도록 하였다.

■ 중심어 : Swine 관리시스템, 정밀목축농장, 이미지프로세싱

Abstract

The demand for food rises proportionally as population grows. To be able to achieve sustainable supply of livestock products, efficient farm management is a necessity. With the advancement in technology it also brought innovations that could be harness in order to achieve better productivity in animal production and agriculture. Precision Livestock Farming (PLF) is a budding concept of making use of smart sensors or available devices to automatically and continuously monitor and manage livestock production. With this concept, this paper introduces a swine management system that integrates image processing technique for weight monitoring. This system captures pig images using camera, evaluate and estimate the weight base on the captured image. It is comprised of Pig Module, Breeding Module, Health and Medication Module, Weighr Module, Data Analysis Module and Report Module to help swine farm administrators better understand the performance and situation of the swine farm. This paper aims to improve the management in both small and big livestock raisers.

■ keywords : swine management system, precision livestock farming, image processing

Ⅰ. Introduction

Several researches estimate that there will be almost 9 billion people to feed by 2050 [1, 2]. For the next 40 years the demand for livestock products will continue to grow [3] and in order to meet this demand, there is a need of more livestock production through expansion of farms. As the demand on livestock such as pig and the number of animal production increases, this makes heavier demands on farmers' management skills in order to maintain profits and guarantee the continuity of farms [4]. Thus, this poses challenges in effective swine monitoring and management.

Precision Livestock Farming (PLF) is an infant technology [5] that combines automatic monitoring and data analysis of animal variables that help increase farmers productivity. Authors in [6] states that the main intention of PLF research and development efforts is to introduce process control principles in agriculture/animal production and management. It is usually a set of interlinked processes that acts together and utilizes measurements, predictions and data-analyses of animal variables (e.g. weight, activity, behavior, drinking and

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feeding behavior, feed intake, sound production and physiological variables) in a continuous and fully automatic way [7].

One of the areas of PLF that needs improvement is monitoring the weight of pigs where traditional backyard farmers either use weighing scales or length and girth measurements to estimate. These methods usually require human intervention which results to waste of time, increase in labor and stress to animals and people involved [8]. Authors in [9] proposed a method on estimation of live weight of broiler using digital image analysis. Several researches had also utilized image processing in improving management of swine farms [10, 11]. This idea leads us to propose a Swine Management System using Precision Livestock Farming with Image Processing that is comprise of several modules that ensures effective monitoring and management of swine in the farm. We incorporate Image processing as method of weight monitoring to effectively monitor and analyze pig data. We discussed the background and related works in section II and present the overview and components of the system in section III. Section IV shows the implementation and section V concludes the paper.

II. Background and Related Works

In this section we review several available Swine management systems that are used by large swine farms. Table 1 shows the comparison of some existing swine management systems and the proposed system.

A. PIGCOM

PigCom is an advanced database management system that allows extensive, detailed recording of every aspect in the life of every sow, boar and feeder in-herd. PigCom allows the user to have an accurate overview of the herd at any time [12]. The performance of any animal can be instantly accessed by its ID. There are weekly reminders & checklists to take on farm. There are extensive filtering and sorting of information to tailor reports and highlight relevant issues. There is comprehensive selection of weekly, monthly and analytical reports. Farm data can be consolidated to give an overview for larger producers. Graphs and charts bring data to life, showing trends over time and forecasting for the future.

B. SIGAPIG

SigaPig is a software tool for complete swine herd management [13]. It includes easy management of all breeding events in one screen, customizable automated breeding calendar, complete management of treatment and interventions, management of animals by location, genealogy and progeny genetic modules available for purebred facilities. It also manages finishing, feed formulation, genetics and it can generate reports.

C. HERDSMAN

Herdsman is a software program that, in its simplest form, collects data from swine farms and summarizes that data on-farm, into standard reports and action lists to better manage the farm. It has the capacity to create individual animals at farrowing and link them to their parents. You can therefore track multigenerational lineage of inbreeding. In this pedigree analysis you can track 4 reproductive traits and 3 performance traits on each animals and its relationship to the mean of its contemporaries [14].

III. System Overview and Components

The system is comprised of different modules namely, Pig, Breeding, Health and Medication, Weight and Data Analysis. It determines the weight of the pigs using camera and reports can be generated and analyzed for decision making. Figure 1 shows the system architecture of the Swine Management System.

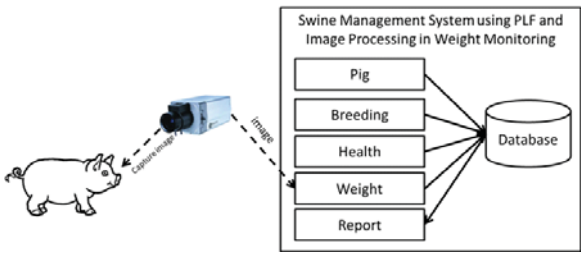

Figure 1. System Architecture

Table 1. Comparison of Swine Management based on functions

System	Individual Record Keeping	Automatic Weight Monitoring	Breeding	Health & Medication	Report & data Analysis
PigCom	✓		✓	✓	✓
SigaPig	✓		✓	✓	✓
Herdsman	✓		✓		✓
Proposed System	✓	✓	✓	✓	✓

1. Pig Module

This module includes functionalities like adding, editing, deleting and searching of pig records.

2. Breeding Module

This module records the breeding data of sows and boars used. Just like the first module breeding module can insert, edit, delete and search for pig records.

3. Health and Medication Module

This module records the medication and supplements administered to the pigs.

4. Weight Module

This module monitors the weight of the pigs using camera. We implemented parallel processing using time interval of two timers for weight calculation of pigs and the steps for the process are as follows:

(1) When the pig goes to drink the camera will capture an image. The captured image will be processed in the first timer by extracting and cropping the big object and store it in the database. Detected small objects (e.g. food molds, stones, etc.)on the other hand are discarded.

(2) Images are then processed by a second timer in a first in first out (FIFO) queue. The images are converted into grayscale followed by application of certain threshold to make it black and white.

(3) The system will then check the pig id of the animal using object character recognition (OCR). OCR is a method of converting text image into characters. The pig id are sprayed in the pigs body using a specific swine

farm numbers. Authors in [10] also used this method in swine identification. This spray does not cause harm to humans and animals and is a cheap method. The sprayed id number is not permanent but will last for 200 days which would be enough since pigs are mostly sold after 150 days at maximum.

(4) Pig ids that were not identified are discarded and those that are identified will be verified in the database if it has already been monitored within an hour. If not, the

image will be processed for weight monitoring. Since threshold was applied (in step 2) only the black and white

pixels will remain in the captured image. The white pixel between the heap and the shoulder of the pig will be counted and converted to centimeter in order to determine the surface area and as basis of the weight of the pig. Then using this information the estimation of weights pig will be handled by the system.

(5) After the pig's weight is determined it will be stored in the database along with the corresponding pig id.

5. Data Analysis Module

This module and analyzes pig data using a decision support rules and provide reports by consolidating several pig data like total number of sow, total number of piglets produce, mortality, males and etc.

IV. System Implementation

The system was developed using Microsoft Visual C# and MySQL as database. Figures 2 to 6 shows the main menu, pig, breeding, health and medication, weight monitoring and data analysis module screens where administrators manages pig records.

Figure 2. System Main Screen

Figure 3 shows the Pig Module Screen where users can add, edit, and delete a record of a pig. Data that can be added includes PigID, Name, Breed, Boar, Sow, Birth Date, Gender, Location and weight. A search capability is added to the module for easy access of pig record stored in the system.

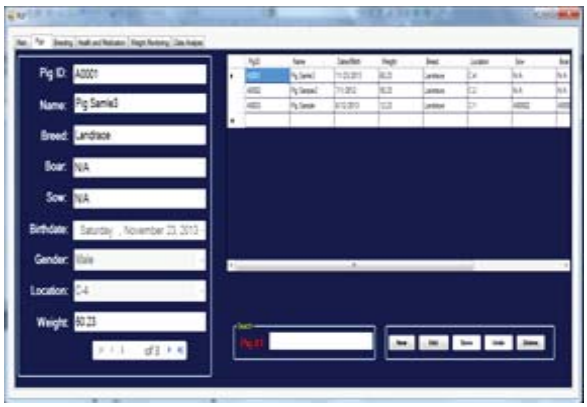

Figure 3. Pig Module Screen

The breeding data of the sow and boar (divided by tabs) can be seen on the Breeding Module Tab shown in Figure 4. Just like the Pig Module Screen, this component lets you also add, edit, delete and search pig records based on breeding parameters such as breeding number, mortality, number of piglets.

The health and medication module shown in Figure 5 is used to record the medication and supplements administered to the pigs. Figure 6 depicts the Weight monitoring screen where user does not need to input anything since weight identification is automatically done by the system using parallel image processing technique described in the weight module under section III.

Figure 4 Breeding Module Screen

Figure 6 depicts the Weight monitoring screen where user does not need to input anything since weight identification is automatically done by the system using parallel image processing technique described in the weight module under section III.

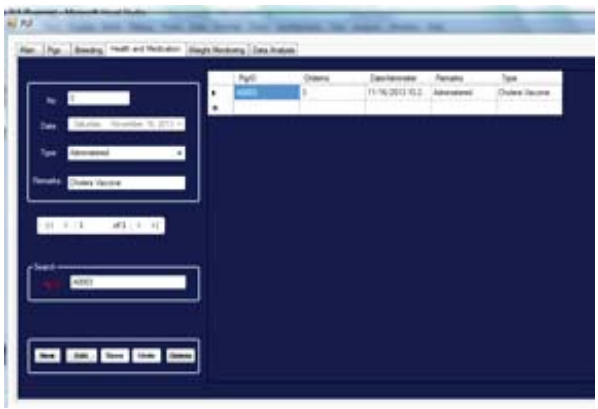

Figure 5. Health and Medication Screen

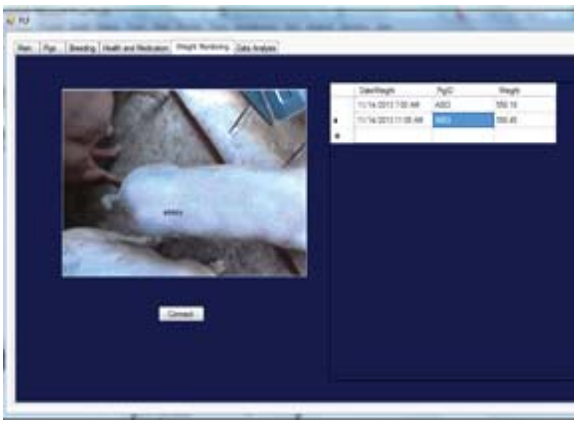

Figure 6. Weight Monitoring Screen

Several reports are generated by the system to help aid administrators in decision making these include pig summary report, pedigree analysis, and weight trends.

These reports can be access through the Report Module Screen shown also in Figure 7.

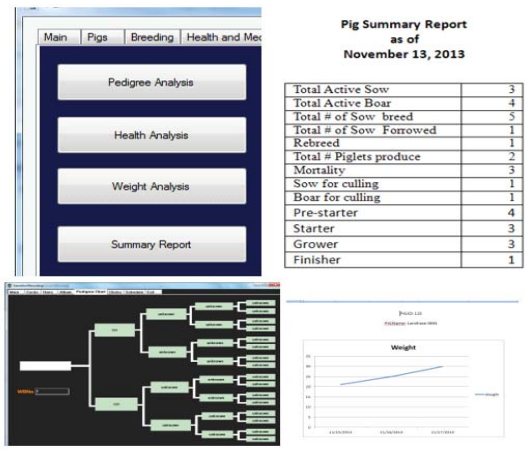

Figure 7. Report Module Screen with various reports

V. Conclusion

The demand for food supply increases rapidly as population grows. To be able to cope with demand, expansion of livestock farms are necessary. However, this expansion usually poses problems in terms of efficient and effective monitoring and management. In this paper we introduced a swine management system using precision livestock farming with image processing to improve weight monitoring of pigs. The system is composed of several modules that are used in monitoring and managing the pigs' data. It is also capable of generating reports by consolidating data from the database using decision support rules that help administrators know the status of individual pig and the whole swine farm as well. As of this writing of paper, the testing for the implementation is being conducted in the Philippines. In the future, we will improve the data visualization capabilities of system to better aid administrators in analyzing data provided by the system.

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