

Can Artificial Intelligence Monitor the Growth of Individual Pig Through Non-Invasive Technique?

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ABSTRACT

In pig production system accurate estimation of growth performance is essential as it contributes directly to the animal welfare and farm productivity. However, manual weighing of pigs is labor intensive and often cause stress to the animals, thereby increasing the risk of disease transmission. In modern pig production, group housing systems has made the accurate measurement of individual-level growth performance a challenging task. To address this challenge, the article will explore the used of artificial intelligence (AI) to estimate individual pig growth in group-level housing systems. There are two complementary approaches to estimate individual pig growth. The first approach is to analyse temporal weight data to understand the hidden growth variations among pigs and predict the performance of the animals in a non-invasive manner providing high performance. The second approach is to extract morphological features from images or videos data to analyse the growth patterns. These approaches can be used for early detection of abnormal pigs, reduce labor costs, improve efficiency and long-term sustainability in pig production.

INTRODUCTION

Growth rate is a phenotypic characteristic in pig production that directly linked to feed conversion efficiency and productivity. In commercial pig farming, animals are required to meet a defined market weight in which a small deviation in growth performance can significantly affect the overall productivity. As feed accounts for nearly 60–70% of direct cost of pig production, optimizing growth in relation to feed supply can improve economic returns. Routine measurement of body weight of pig helps farmers identify the slow-growing animals, detect early signs of abnormalities, adjust feeding strategies and make informed decisions on pig management.

Traditionally, the growth of pigs is measured through manual weighing technique using electronic scales by moving the animal through weighing crates to record the body weight. Though this method provides accurate body weight measurements, it encounters several challenging stages. It involves significant manpower effort, time-intensive and often induces stress to animals. Manual handling of pigs can increase stress levels, potentially affecting the growth performance and welfare. In large commercial farms where pigs are housed in groups, individually weighing each animal becomes logistically difficult. As a result, some producers rely on pen-level or group-level weight estimation which may mask individual growth differences. Consequently, underperforming or unhealthy pigs may go unnoticed until visible symptoms appear by which productivity losses may have already occurred.

In recent years, advances in digital technologies have opened new possibilities for non-invasive monitoring of pig growth. Artificial intelligence (AI), machine learning, computer vision and sensor-based systems are increasingly being explored to estimate body

weight without physical handling of animals. Camera-based imaging systems can capture body dimensions such as length, width and surface area which are then analysed using predictive algorithms to estimate weight (Taylor, C. *et al.*, 2023). Similarly, time-series analysis of group-level weight data can be used to model and infer individual growth trajectories. By learning patterns from repeated measurements over time hidden variations in growth can be determined and generate accurate predictions at the individual level (Taylor, C., *et al.*, 2022).

These emerging technologies offer significant benefits for farmers and stakeholders. Initially, manpower involvement will be reduced and minimize stress causing to animal, thereby improving welfare outcomes. This also provide continuous monitoring enabling early detection of growth abnormalities, nutritional imbalances etc. This advance technique can lead to the reduction of mortality, enhance feed conversion efficiency and overall productivity. Analysis of farm data can also support precision livestock farming by allowing farmers to optimize feeding plans, adjust housing conditions and align market trends effectively. Such advance technique can provide a reliable growth data for accurate decision-making and production forecasting for other stakeholders like veterinarians, farm managers and policymakers. (He, Y., *et al.*, 2021).

Lastly, non-invasive technique for monitoring individual animal presents a practical and scalable solution that bridges the gap of traditional and modern data analytics pig husbandry practices. By integrating artificial intelligence technique into routine farm management, farmers can move from routine manual measurements to continuous, intelligent growth estimation of pigs making a

more efficient, sustainable and profitable pig production system.

How Does It Work?

The working function of growth rate estimation of pigs using Artificial Intelligence (AI) involves data collection, feature extraction and developing predictive models to automatically estimate body weight and analyse the growth patterns without relying entirely on manual weighing (Kaewtapee, C., *et al.*, 2019). The steps involve are as follows (Figure 1):

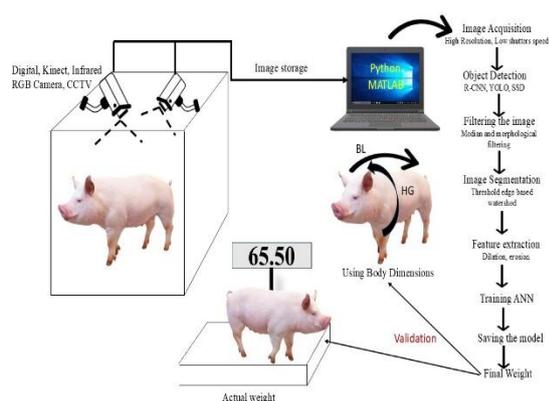


Figure 1: Illustrating the workflow of an AI-based pig weight estimation system with multi-camera image acquisition (such as RGB, infrared, Kinect, CCTV), model development using Python/MATLAB and predict final weight.

Data Collection

For development of AI model, first data collection is required from the farm using non-contact technologies such as:

- Cameras (2D or 3D) installed above or side of pens
- Depth sensors are used to measure body dimensions
- RFID systems are used for animal identification

- Automatic feeder records feed intake
- Group-level weight scales

The installation of such systems in farm environment can continuously record information on body shape, length, width, surface area, movement and feeding behavior.

Feature Extraction

After collecting images or sensor data, AI models can be developed to extract meaningful features such as:

- Body length
- Back width
- Body area
- Volume estimation (from 3D images)
- Movement patterns
- Feed intake trends

AI algorithms can detect the pig as object present in the image and segment the pig. Advanced AI models such as deep learning-based object detection or segmentation networks ensure accurate detection of pigs even in group house environment.

Model Training

The extracted features are fit into the machine learning models to train the model with the suitable data.

Some of the common approaches include:

- **Regression models** to predict body weight
- **Time-series models** to analyse growth over time
- **Deep learning models** (CNNs, LSTMs) for pattern recognition

The system is trained using historical data where the true weights are known. While

training the model learns the correlation of the body measurements and actual weight.

Growth Rate Estimation

After training, the AI system can:

- Predict current body weight
- Estimate daily weight gain (ADG)
- Generate individual growth curves
- Detect deviations from expected growth

By analysing weight predictions on temporal data, the system predicts the growth rate automatically.

Early Detection & Decision Support

AI-based growth estimation model helps in:

- Identifying slow-growing pigs
- Detecting early health problems
- Optimizing feeding strategies
- Predicting market readiness
- Reducing labor and handling stress

This technique helps in receiving continuous growth insights in real time.

Why This Matters for Farmers

Accurate monitoring of pig growth rate directly influences farm profitability, efficiency and animal welfare. For farmers the growing pattern of pigs is not just performance metrics but it is a significant decision-making tool. Farmers can gain real-time insights into herd performance by continuously monitoring the growth rate of pigs using artificial intelligence, without human intervention for manual weighing. The most important benefits obtained through this technique is feed management. Feed contributes the largest cost in pig production, even small improvements in

feed conversion efficiency can significantly reduce expenses. AI-based growth estimation technique enables farmers to recognize slow growing pigs and managed the feeding pattern and welfare management accordingly. Thereby resulting in optimal nutrient utilization and minimizes the wastage of feed. Another significant advantage of this technology is early identification of health problems. Growth retardation often serves as an early sign of disease, stress or nutritional imbalance. AI based systems enables tracking of growth trends over time allowing timely detection of deviations from expected growth patterns. Timely intervention reduces treatment expenses, prevents transmission of disease within the herd and sustain production losses. In addition, the monitoring system optimizes operational efficiency. The non-invasive farm monitoring approach decreases manpower involvements and also induced less stress to the animals. Stress reduction not only improves welfare of animals but also impact growth performance. Accessing to a reliable growth data can help farm managers and other stakeholders to make better planning and forecasting. Accurate predictions analytics enable to determine market trends, optimize space allocation and cost-effective feed procurement planning. Analytics based decisions making enhance farm management practices and increase profitability. The AI-based growth monitoring system can play a vital role in precision livestock farming by continuous tracking of individual animals and effective management in group housed environment. This technology empowers farmers to move from reactive management to proactive by converting routine farm data into useful information. Hence, adoption of predictive decision-making system ultimately enhances the productivity and ensures long-term sustainability.

Welfare and Sustainability Benefits

The implementation of AI-based non-invasive growth monitoring system can reduce manual handling of animals thereby improving animal welfare. Continuous real time monitoring of farm also enables early disease detection, ensuring timely intervention and better welfare standards. Accurate growth estimation enhances feed efficiency and lowers production expenses, thereby strengthening the long-term sustainable pig farming systems.

Challenges and Limitations

Despite the technological advantages, the implementation of AI-based growth monitoring system faces several challenges. The investment costs associated with hardware such as cameras, sensors and data infrastructure are high which may restrict adoption, especially among small-holder farmers. Models' accuracy depends highly on the data quality and environmental factors such as housing and lighting intensity. The implementation of such systems requires skilled technical personnel for system setup, maintenance and data analytics.

CONCLUSION

This article concludes that transitions from traditional manual weighing to AI-based growth prediction signifies a major technological advancement in modern pig production system. The application of artificial

intelligence in pig farming system provides a smarter alternative approach for non-invasive continuous monitoring of individual pig growth. AI can empower farmers to make prompt decisions that impact animal welfare and overall profitability. Therefore, AI based intelligent growth monitoring system is set to become a backbone of precision livestock farming.

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