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Challenges in accurately detecting chicken eggs in production lines through image processing techniques

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ABSTRACT
Egg production represents a crucial element in both the agricultural industry and food security on a global scale. In addition to being an indispensable source of protein and nutrients for human consumption, it plays an essential role in sustaining poultry production, ranging from the supply of commercial eggs to the vital process of incubating new chicks (NUNES et al., 2005).

Keywords: Egg detection, Poultry, Image processing.

1 INTRODUCTION

Egg production represents a crucial element in both the agricultural industry and food security on a global scale. In addition to being an indispensable source of protein and nutrients for human consumption, it plays an essential role in sustaining poultry production, ranging from the supply of commercial eggs to the vital process of incubating new chicks (NUNES *et al*., 2005).

Egg counting in the industry is often performed manually, often requiring labor to count eggs as they are transported on a conveyor. This method is recognized for its slowness, demanding high precision and facing several operational challenges (KANJANASURAT *et al*., 2021). In addition, manual counting is susceptible to human error that can adversely impact production efficiency and quality, as well as process costs and profitability. A promising approach to overcome such challenges is the automation of this procedure, through the installation of cameras that capture images and perform real-time processing for egg detection and counting.

Many image processing techniques are widely applied in this context, but the most commonly used is object detection. Image processing, an interdisciplinary field, applies computational techniques to manipulate and analyze digital images in order to extract useful information and reveal relevant features.

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This includes a variety of operations, such as filtering, segmentation, feature extraction, and pattern recognition, applied to 2D or 3D digital images (GONZALES; WOODS; EDDINS, 2020).

However, it is imperative to recognize the limitations of this approach. The development of image processing algorithms can be a challenging task and their applicability can vary according to context, often requiring adjustments for different scenarios. When used in real-time egg detection and counting systems, these limitations become more evident and complex.

The integration of technology in poultry farming is an undeniable trend, as highlighted by Fronza (2020), driven by the search for competitive advantages in the industry. Previously, the prevailing perception associated low production costs with cheap labor and limited technology on farms. However, it is now widely recognized that major poultry genetics companies are adopting advanced technologies. The direction of the market points to a trend of expansion of poultry complexes, with less dependence on labor, prioritizing product quality and continuous cost reduction.

Although facing challenges inherent in its implementation, egg counting automation has considerable advantages for both small producers and large poultry industries. These advantages include reduced labor costs, simplified inventory management, decreased need for skilled labor, and access to more detailed information about the production process, giving a stronger position in sales negotiations.

The aim of this study is to investigate the main challenges in the accurate detection of chicken eggs by means of image processing, in farm environments. The study seeks to provide *insights* This article aims to analyze the possible problems encountered in the accurate detection of eggs in a production environment, which can directly impact the result in the counting and monitoring of production belts. Thus, this work aims to present the possible problems faced when using an automated system for egg counting, using image processing techniques.

2 MATERIALS AND METHODS

As a source of data, we used a study previously conducted by Luz *et al*. (2024), where the images were captured by an *IP camera* positioned on a production conveyor belt on a poultry farm, with a resolution of *1280x720 pixels* and a frame rate of 20 *FPS*, over a period of one hour. More than 9,000 images were obtained, which presented several difficulties for detection, such as variations in color, lighting, presence of dirt and irregular sizes of eggs. The *IP* camera used was the *DS-2CD1323G0E-I model*, manufactured by *Hikvision*.

The recording period covered a full hour of operation on the farm, faithfully reproducing part of the operational routine to ensure the representativeness of the data collected for the training of the system. This approach eliminates the need for simulations with fake eggs or the use of online images, which may not accurately reflect the reality of the work environment.

In order to address the accurate detection of eggs on production lines through image processing, a number of challenges inherent in the production environment were considered. First, the variations in color and lighting along the production belt were investigated, which can affect the contrast between the eggs and the bottom, making it difficult to segment and accurately identify the eggs. In addition, the presence of dirt and residues on the surface of the eggs was analyzed, which can compromise the appearance and texture, negatively impacting the detection.

In addition, variability in egg sizes and shapes was considered as another significant challenge. While some eggs may have regular shapes and sizes, others may be more irregular, requiring adaptive detection algorithms to cope with this morphological diversity. The influence of the speed of the production belt and the image capture rate on the quality of the images obtained was also evaluated, observing that very high speeds can result in blurred or distorted images, impairing the accurate identification of the eggs.

3 FINDINGS

The results of the study by Luz *et al*. (2024) indicate a total accuracy rate of 96.01% in the detection and counting of chicken eggs in production lines through the image processing system, during the period of one hour of operation on the production conveyor belt of the farm, of the 1306 eggs analyzed, the system was able to correctly identify 1254 eggs.

The 3.99% of eggs not detected by the image processing system represent a significant portion of the challenges faced in accurately detecting chicken eggs in production environments. This unidentified percentage can be directly attributed to the difficulties inherent to the process, including variations in color and lighting along the production belt, the presence of dirt and residues in the eggs, as well as the variability in the sizes and shapes of the eggs.

Variations in color and lighting along the production belt affect the contrast between the eggs and the bottom, making it difficult for the system to segment and accurately identify the eggs. Despite advances in image processing algorithms, the system's adaptability to handle these variations still poses a challenge, especially in environments where lighting conditions can be inconsistent.

The presence of dirt and residue on the surface of the eggs also compromises accurate detection. The uneven texture caused by these elements can confuse the system, leading to false negatives in identifying the eggs. In addition, variability in egg sizes and shapes presents an additional challenge, requiring even more adaptable detection algorithms to handle this morphological diversity. Therefore, optimizing these operating parameters is essential to improve the effectiveness of the detection system.

4 FINAL CONSIDERATIONS

Considering the results obtained in the study of detection and counting of chicken eggs in production lines through the image processing system, it is evident that, despite the satisfactory hit rate of 96.01%, the 3.99% of undetected eggs highlight the persistent challenges faced in this automated process.

To overcome these challenges, it is crucial to invest in continuous improvements in detection algorithms, prioritizing adaptation to different environmental conditions and egg characteristics. In addition, the optimization of operational parameters can contribute significantly to improving the effectiveness of the system.

Importantly, this study provides *insights* valuable for the future development of automated monitoring systems in poultry environments. Using real data collected directly from the production environment has proven to be an effective approach, eliminating the need for artificial simulations that might not accurately reflect the complexity of the real environment.

In summary, despite the challenges faced, the use of image processing techniques for egg detection in production lines is promising and viable. With continuous research and development efforts, it is possible to further enhance the accuracy and efficiency of these systems, contributing to the automation and optimization of monitoring processes on poultry farms.

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