DEVELOPMENT, DESIGN, AND INTEGRATION OF AN EGG TRAY SYSTEM WITH UNMANNED GROUND VEHICLE FOR ROBOTIC POULTRY AUTOMATION

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ABSTRACT

Eggs are among the most extensively consumed foods, valued for their nutritional and health benefits. While generally studied, the exact fine representation of a raspberry's egg shape remains complex. Egg forms are usually classified as globular, ellipsoidal, elliptical, and pyriform- the last of which still lacks a definitive equation.

This study presents a new system for modeling egg figures and calculating volume, based on crucial parameters, including the major axis, the minor axis, and the center-to-outside-breadth distance (xm). The model was validated through volume regression testing using 47 eggs, showing a minimum error of 0.1 and an outside of only 2. These computations are useful in flesh and natural exploration, particularly for prognosticating hatchability, juvenile weight, eggshell quality, and internal egg parameters. The integration of accurate geometric modeling supports developments in robotic automation.

Keywords: Egg Geometry, Volume Estimation, Robotic Poultry Automation

INTRODUCTION

Eggs play a big role in how people around the world get their nutrition and how the agriculture industry works economically. In poultry farming, using automation helps make the process more efficient, reduces the need for human workers, and improves the well-being of the birds. Although shapes like round, oval, and egg-shaped models can describe most eggs, many real eggs have a more irregular, pear-like shape that these models can't fully capture. This lack of accuracy can cause problems when using robots to handle eggs, because the robots need exact shape information to pick up eggs safely and fit them into the right trays.

In recent years, there have been new advancements in robotic farming, such as mobile platforms that collect eggs, systems that use cameras to detect eggs, and tools that help manage chicken flocks. However, not many of these solutions combine shape modeling, detection, and egg collection into one system. This study fills that gap by creating a new model

that specifically describes the pear-shaped eggs to estimate their volume, building an egg detection system using MATLAB, and putting these together in a small robot that can collect eggs automatically with a special tray.

MATERIALS AND METHODS

Geometric Modeling

47 eggs were measured with a digital caliper to obtain:

a= half the major axis   b=minor axis radius xm=distance from blunt end to maximum breadth

A modified elliptical model with a symmetry factor k was formulated. Volumes were validated using a water displacement method.

Egg Detection

The detection system, implemented in MATLAB, processed images through grayscale conversion, edge detection, and shape analysis to identify egg contours and dimensions.

Unmanned Ground Vehicle (UGV) Integration and Tray Design

A Unmanned Ground Vehicle (UGV) was fitted with:

-Front camera for detection feedback

-Microcontroller-based control system

--Egg tray designed according to the pyriform model, ensuring stable positioning and minimal impact during motion.

RESULTS & DISCUSSION

The model designed specially for pyriform shapes had an average volume error of 0.62% (ranging from 0.01% to 2%). Meanwhile, the MATLAB detection system achieved 96.3% accuracy. When combined with a tray that was optimized for geometry, the unmanned ground vehicle was able to collect eggs with a 91.5% retrieval rate, 8% damage to the shells, and each cycle took 43seconds. This shows that it has a strong potential for use in real farm automation.

Comparative Perspective

These results are competitive with other robotic egg collection systems, with the added advantage of a mathematically optimized tray for pyriform eggs. Limitations include sensitivity to lighting in detection and limited testing in real poultry houses.

CONCLUSION

This research demonstrates a successful integration of geometric modeling, machine vision, and mobile robotics for automated egg handling. The pyriform-specific model improved volume estimation and tray design, while the MATLAB detection system ensured high accuracy. The UGV-based collection achieved strong retrieval performance with minimal damage. Future work will focus on real-farm deployment, adaptive navigation, and integration with broader poultry house automation systems.

REFFERENCES

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