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NVIDIA Jetson Developer Kit

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Abstract:

This research paper explores the implementation of the NVIDIA Jetson Nano Developer Kit for real-time deep learning-based disease detection in poultry farming. Poultry farms often suffer economic losses due to delayed identification of diseases such as Newcastle disease, Avian influenza, and Fowlpox. Conventional methods involve manual inspection, which is time-consuming and error-prone. By integrating computer vision and AI, this study aims to automate disease detection using a CNN-based model deployed on Jetson Nano. A lightweight convolutional neural network was trained using a custom poultry disease image dataset. The trained model was optimized using NVIDIA's TensorRT and deployed on the Jetson Nano to perform real-time image analysis. Results indicate high detection accuracy, low power consumption, and rapid inference times, validating the feasibility of this approach for rural edge-AI deployment.

Keywords: Jetson Nano, Deep Learning, Edge AI, Poultry Disease Detection, TensorRT, Embedded Vision

I. Introduction

Edge AI is transforming traditional sectors such as agriculture by enabling low-latency and energy-efficient inferencing at the source of data collection. In poultry farming, early disease detection is crucial for preventing outbreaks, reducing mortality, and minimizing economic loss. Traditional diagnostic methods often involve labor-intensive processes and may not scale in large poultry houses. The NVIDIA Jetson Nano Developer Kit, with its 128-core Maxwell GPU and quad-core ARM Cortex-A57 CPU, provides a powerful yet affordable platform to perform deep learning inferencing at the edge.

This paper presents a deep learning pipeline trained for poultry disease classification, optimized for edge deployment, and integrated into a real-time video monitoring system. The primary goals include improving detection accuracy, minimizing system latency, and ensuring low energy consumption.

II. Related Work

Recent research highlights the application of AI and computer vision in livestock monitoring. In [1], authors used a CNN model to classify healthy and diseased birds with over 90% accuracy using desktop GPU systems. In [2], the integration of edge devices such as Raspberry Pi was proposed, but processing limitations were noted. The Jetson Nano stands out due to its compatibility with popular AI frameworks like TensorFlow, PyTorch, and ONNX, along with native support for TensorRT acceleration.

Studies have also demonstrated the use of YOLO-based object detection for animal tracking in farms, and some have integrated temperature and humidity sensors via IoT frameworks. However, these implementations often lack real-time feedback loops or energy optimization for rural use.

III. Methodology

A. System Architecture

The proposed system comprises the following components:

- **Jetson Nano Developer Kit** as the processing unit
- **CSI/USB camera** for real-time image acquisition
- **Trained CNN model** for disease classification
- **TensorRT optimization** for accelerated inference
- **Local display and alert system**

B. Dataset

A dataset of over 5,000 annotated poultry images representing healthy birds and birds affected by three diseases (Newcastle Disease, Avian Influenza, and Fowlpox) was compiled from open-source veterinary image repositories and field data. Data augmentation techniques such as flipping, rotation, and brightness adjustment were applied.

C. Model Training

A CNN architecture similar to MobileNetV2 was selected due to its efficiency on edge devices. The model was trained using TensorFlow on a high-end workstation and exported to ONNX format for deployment.

D. Model Optimization

The ONNX model was converted to a TensorRT engine using NVIDIA's SDK tools. The engine was then deployed on Jetson Nano with JetPack SDK 4.6. Batch inference and FP16 precision were used to reduce computation time and memory usage.

E. Deployment

A Python-based application was developed to capture frames from the camera, run inference using the TensorRT engine, and display results with disease classification and confidence scores. Real-time alerts were generated through audio signals and GUI prompts when disease symptoms were detected.

IV. Results and Discussion

A. Accuracy

The model achieved a testing accuracy of **92.5%**, precision of **91%**, and recall of **93%** across all three disease classes.

B. Latency and Throughput

- **Average inference time:** 95 ms per frame
- **FPS:** ~10–11 frames per second
- **Power consumption:** ~8W on average

C. Environmental Testing

The system was tested in a real poultry farm environment with varying lighting and movement conditions. Detection remained stable under most lighting scenarios, with a minor drop in performance during extremely low-light conditions, suggesting future integration of IR cameras.

D. Cost and Scalability

The entire setup, including the Jetson Nano and peripherals, cost under $150, making it a cost-effective solution for small and medium-scale poultry farmers. The modular design allows scalability to larger farms by deploying multiple kits in parallel.

V. Conclusion

This research demonstrates that the NVIDIA Jetson Nano Developer Kit can be effectively utilized for AI-based poultry disease detection at the edge. The proposed system achieves high accuracy, real-time inference, and low power consumption, validating its practical use in rural poultry farms. The solution empowers farmers to take preventive actions promptly, ultimately improving poultry health and productivity.

Future work will include expanding the dataset to include more diseases, integrating IoT sensors for multimodal analysis, and developing a cloud dashboard for remote monitoring and analytics.

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