AN EFFICIENT AIOT FRAMEWORK FOR IMAGE-BASED BEHAVIOR MONITORING IN DAIRY CALVES

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Abstract: Monitoring behaviors in dairy cattle is crucial for efficient livestock management and welfare enhancement, as variations in behavioral patterns often signal health issues. Image-based behavior monitoring systems are non-invasive and suitable for automated dairy farming practices, while these intelligent systems require substantial computational resources to process consecutive video frames, which makes it challenging to deploy behavioral recognition models on edge devices in dairy farms. Therefore, our objective is to develop an efficient AIoT framework for image-based behavior monitoring system for dairy calves, which balances computational demands with reliable recognition performance. In this study, several MoViNet models for dairy calf behavior recognition were compared and evaluated based on their predictive performance and hardware efficiency on Raspberry Pi 4. The analysis revealed that MoViNet-A0 with Float16 Quantization achieved the best performance in behavior recognition, with a 47ms latency and a 0.916 F1-score. Additionally, long-term behavior monitoring at the National Taiwan University's experimental dairy farm was conducted to assess the effectiveness of our AIoT dairy calf behavior monitoring system in real-world settings. The experiment demonstrated that our threshold-based calibration approach effectively enhanced model predictions, with a decrease in MAPE from 60.1% to 10.4% and RMSE from 82.4 to 13.1 in behavior monitoring in dairy calves.

Key Words: Behavior Monitoring, Image Recognition, Deep Learning, Edge Computing