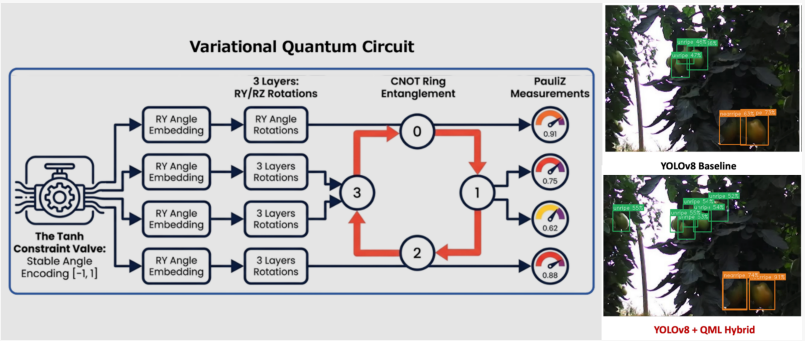
Chloros Publishes Quantum–Classical Hybrid AI Preprint on Fine-Grained Tomato Ripeness Classification

Simulation-based study combining YOLOv8 with a four-qubit variational quantum circuit achieved 93.80% accuracy and improved recall for near-ripe tomatoes.



Four-qubit variational quantum circuit and example inference results comparing the YOLOv8 baseline with the quantum–classical hybrid model.

TOKYO, JAPAN, August 4, 2026 /EINPresswire.com/ -- Chloros Inc., a developer of crop imaging and AI-based analysis technologies, has published a preprint on SSRN presenting a quantum-classical hybrid approach to fine-grained tomato ripeness classification.

The study was co-authored by Yuichi Ito, Co-Founder and CTO of Chloros, and Geetha K S of Yokohama National University, who conducted the research during an internship at Chloros. The proposed model combines the YOLOv8 object detection architecture with a four-qubit variational quantum circuit to classify tomatoes into four ripeness stages.

> The improvement in near-ripe recall is particularly encouraging. While this study is simulation-based, it highlights the potential of quantum-classical AI for agricultural imaging.”
>
> *Yuichi Ito, Co-Founder & CTO, Chloros Inc.*

Accurately distinguishing adjacent stages of tomato ripeness is challenging because color and surface texture can overlap, particularly between half-ripe and near-ripe fruit. Variations in illumination, occlusion, and background conditions can make the task even more difficult in agricultural imagery.

In the simulation-based evaluation, the proposed quantum-classical hybrid model achieved 93.80% classification accuracy, compared with 87.44% for the classical hybrid model evaluated under the same conditions. The result also exceeded the 90% accuracy target identified by Chloros through customer interviews as a practical benchmark

for considering field deployment.

Macro F1, which reflects classification performance across all four ripeness classes, increased from 58.92% to 73.63%.

The most substantial improvement was observed in the near-ripe class. Despite the use of data augmentation, the classical hybrid model achieved only 21.33% recall for near-ripe tomatoes. The proposed model, which combined the variational quantum circuit with data augmentation, increased near-ripe recall to 70.51%, an improvement of 49.18 percentage points.

The variational quantum circuit used in the study consists of four qubits with parameterized rotations and CNOT-based entanglement. Features extracted after YOLOv8 detects the tomatoes are encoded into the quantum circuit, and the circuit outputs are used for final classification.

The study represents an initial evaluation using a public dataset and a simulated quantum circuit. It does not assess performance on quantum hardware or under operational field conditions.

Future work will focus on evaluating the reproducibility of the approach on quantum hardware and testing its applicability to field imagery. Chloros plans to explore potential applications in ripeness assessment, harvesting support, yield estimation, and other agricultural image-analysis tasks.

The preprint, titled “Quantum-Classical Hybrid for Fine-Grained Tomato Ripeness Classification via YOLO and Variational Quantum Circuits,” is available on SSRN.

A more detailed overview of the study is available on the Chloros website:
Chloros press release

About Chloros Inc.

Chloros Inc. develops crop imaging, mapping, and AI-based analysis systems for agricultural research and production. Its technologies combine drone and smartphone imaging, computer vision, GIS, and cloud-based software to support crop observation, quantitative evaluation, and decision-making.

Founded in 2025 and headquartered in Tokyo, Japan, Chloros works with agricultural research institutions and businesses to advance the practical use of imaging and AI in crop development and production. The company operates under the mission “Visual Intelligence for Crop Evolution.”

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