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Computer Vision Technology on Food Science

How cameras and smart algorithms are changing food quality control

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SUMMARY

What Is This Paper About?

1 What is computer vision?

A field of science that automatically pulls useful information from an image, using theory and algorithms.

2 Why use it in the food industry?

It detects surface defects, spoilage, and quality problems — replacing human inspectors with fast, consistent, low-cost systems.

3 What this review covers

Computer vision applications in meat, poultry, seafood, fruit, vegetables, grain, and bakery products.

4 A look at the future

Real-time, robot-controlled, fully automated production — and mobile tools that let consumers check food quality themselves.

Why Food Quality Control Is Changing

Why aren't old methods good enough anymore?

- Controlling food safety and quality is critical. Producers must follow strict rules and also meet customer expectations.
- Visual checks done by people are slow, expensive, and subjective — different inspectors may reach different conclusions.
- Computer vision gives objective, fast, and low-cost results. It can even outperform human eyesight in tricky lighting conditions.

3
Main processing stages:
image capture, analysis, recognition

7
Food categories reviewed:
from meat to bakery products

50+
Research studies and
applications discussed

Source: Sun (2007)

How a Computer Vision System Works

1

Image Capture

A camera records an image — visible light, UV, infrared, or hyperspectral.

2

Pre-processing

Noise and unwanted signals are removed to make the image cleaner, at no extra cost.

3

Segmentation

The object is separated from the background so it can be studied on its own.

4

Feature Extraction

Size, colour, shape, and texture are measured from the image.

5

Classification

Algorithms such as neural networks or SVM make the final decision.

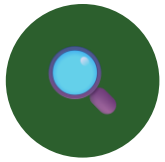
Source: Mery et al. (2013); Jackman & Sun (2013)

2.1 · CHALLENGES

Main Challenges That Affect Performance

Lighting

Poor lighting is one of the biggest causes of unexpected or wrong results (Vithu & Moses 2016).



Resolution

Higher image resolution is needed to reach better accuracy (Zhang et al. 2014).

Round Objects

A normal camera only sees part of a curved surface, not the whole object (Misimi et al. 2016).

System Robustness

Good data alone isn't enough — strong algorithms and clear standards are also needed (Cubero et al. 2011).

3 · APPLICATIONS

7 Application Areas in Food Science

Meat

Colour, pH, and PSE detection

Poultry

Weight, colour, defects

Seafood

Freshness, microbial contamination

Fruit

Ripeness, bruise detection

Vegetables

Classification, defect detection

Grain

Shape, moisture, classification

Bakery Products

Size and foreign-body checks

Studies outside this classification were not included (Sun 2007)

Key Studies in Meat and Poultry

Product	Application	Method	Accuracy (%)
Pork	PSE* detection	Image analysis	—
Beef, lamb, pork	Colour prediction	Hyperspectral	97 · 84 · 82
Lamb	Tenderness prediction	Hyperspectral	84
Broiler chicken	Weight prediction	3D camera	92.2
Chicken	Colour prediction	Image analysis	99 · 74 · 88

*PSE = pale, soft, exudative meat. Source: Tables 1–2, p.405 (e.g. Kamruzzaman et al. 2016; Mortensen et al. 2016; Barbin et al. 2016)

Quality Detection in Seafood and Fruit

Product	Application	Method	Accuracy (%)
Salmon	Classification	Hyperspectral	98.2
Shrimp	Freshness evaluation	Image analysis	90
Sea bream	Freshness evaluation	Image analysis	99
Apple	Bruise detection	Hyperspectral	98
Strawberry	Ripeness evaluation	Hyperspectral	95 · 83.3

Source: Tables 3–4, p.405–406 (e.g. Xu et al. 2017; Dowlati et al. 2013; Keresztes et al. 2016; Zhang et al. 2016)

Classification in Vegetables and Grain

Product	Application	Method	Accuracy (%)
Tomato	Quality evaluation	Image analysis	96.47
Potato	Blackspot detection	Hyperspectral	94
Soybean	Colour & moisture prediction	Hyperspectral	86.2 · 97.1
Rice	Classification	Image analysis	98
Wheat, cassava, corn flour	Flour adulteration analysis	Hyperspectral	97

Source: Tables 5–6, p.406 (e.g. Arakeri et al. 2016; López-Maestresalas et al. 2016; Pazoki et al. 2014; Su & Sun 2017)

Checking Shape and Size in Baked Goods

What matters for quality?

Products like cake, bread, crackers, and muffins are judged mainly by their shape and size.

Producers track the standard deviation of thickness, diameter, and weight — these are the key parameters to watch.

Product	Application	Method	Accuracy (%)
Corn tortilla	Classification	Image analysis	95
Biscuit	Foreign-body detection	IR thermography	—
Potato chips	Acrylamide detection	Image analysis	94

Source: Table 7, p.406; Domingo et al. 2010; Senni et al. 2014; Dutta et al. 2015

4 · LOOKING AHEAD

Future Research Directions

1 Hyperspectral Imaging

Use is growing, but the technology is costly and complex — cheaper, more efficient algorithms are still needed (Amigo et al. 2015).

2 From 2D to 3D Systems

Thermal, X-ray, and MRI imaging are needed to detect internal defects and measure height or depth (Wang et al. 2015).

3 Robot-Based Automation

Flexible, reprogrammable robots for evaluation, handling, and processing tasks.

4 Cloud Robotics & Big Data

Access to large datasets can improve a system's ability to learn and get more accurate over time (Sun 2016).

CONCLUSION

A Proven Technology That Keeps Improving

- Combined with good image-processing techniques, computer vision is a proven technology that provides reliable, useful information about food quality and safety.
- Over the past two decades, colour, multispectral, hyperspectral, thermal, X-ray, and MRI imaging have been studied for fast, objective, and non-destructive quality checks.
- Machines now show great potential for locating and characterising raw materials before they are handled or processed.
- Non-destructive systems already work well, but more research is needed to get even more information from contactless methods.

REFERENCE

Source

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Thank You