IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
Research Paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 08, 2022

Computer Vision in Food Quality Control: Applications and Innovations

Prof. Amit M.Mhaskar
Yadavrao Tasgaonkar College of Engineering & Management, Navi Mumbai, India.
amit.mhaskar@tasgaonkartech.com
Prof. Pallavi P.Mangrulkar
Yadavrao Tasgaonkar College of Engineering & Management, Navi Mumbai, India.
pallavi.Mangrukar@tasgaonkartech.com
Prof. Ravi E. Rane
Yadavrao Tasgaonkar College of Engineering & Management, Navi Mumbai, India. ravi.rane@tasgaonkartech.com
Dr. Raju M. Sairise
Associated Professor, Yadavrao Tasgaonkar College of Engineering & Management, Navi Mumbai, India.
rsairise566@gmail.com

Abstract: There is a growing need for food products that comply to high-quality and safety requirements, and as a result, there is a developing need for a determination of these characteristics in food items that is accurate, quick, and objective. The application of computer vision provides a solution that is not damaging, automated, and cost-effective in order to fulfill these needs. This type of inspection, which is based on the analysis and processing of images, has discovered a wide range of uses within the food business. A substantial amount of study demonstrates that it has the capacity to evaluate and grade fruits and vegetables successfully. In the process of evaluating the quality of a variety of culinary items, including meat, fish, pizza, cheese, and bread, computer vision has been shown to be an effective tool. In a similar manner, it has been utilized to investigate the qualities and properties of grain. The purpose of this paper is to present an overview of the most recent advancements in the food business, as well as to explain major components of a computer vision system, highlight important features of image processing techniques, and highlight the importance of these approaches.

Keywords. Innovative technology for image processing in the food industry, with the goal of improving both quality and safety through the coordination of sensors.

I. Introduction

The increased awareness and discernment of consumers has resulted in the generation of expectations for greater quality in consumer food products, which has led to an increase in the demand for improved quality monitoring. Quality, which is defined as the combination of characteristics that result in products that are acceptable to consumers, has been the subject of a significant amount of research (Shewfelt & Bruckner, 2000). Subjective aspects, such as look, smell, texture, and flavor, are frequently evaluated by human inspectors. Additionally, quality evaluation frequently relies on these subjective aspects. The food industry is becoming more competitive and dynamic, which has led to an increase in the level of consumer awareness regarding the nutritional and health-related components of food. The food business in Latin America is of great economic importance, as a significant amount of the region's exports are comprised of food goods [2]. Latin American nations are among the most successful producers of goods on a worldwide scale, including coffee, beef, and salmon [7]. Technology has been

ISSN PRINT 2319 1775 Online 2320 7876
, UGC CARE Listed (Group -I) Journal Volume 11, Iss 08, 2022

identified as a crucial asset that may be utilized to enhance the competitiveness of the food business.Food manufacturers are subject to high quality and safety regulations in modern cultures, which are characterized by the growth of technology. Customers are interested in acquiring comprehensive knowledge regarding the products they buy, demonstrating a preference for commodities that are both well-informed and of excellent quality [4]. The food authorities of the countries that receive exports conduct stringent testing to assure the quality and safety of the products. This is an important aspect of modern food chains, as it ensures that quality and safety are of the utmost importance.The fundamentals of food quality and safety are the basis upon which food processing and human health are built. Therefore, the classification of food and the inspection of food are extremely important aspects of the food processing industry [8]. Human sensory testing, which is notorious for its inefficiency and subjectivity, provided the foundation for traditional techniques of quality assessment. Because they are able to collect a wide range of information about food goods, machine vision systems provide enhanced accuracy in monitoring and reduce the likelihood of errors caused by human intervention. In the food processing business, the utilization of computer technology and machine vision has become increasingly widespread in recent years. Using computer vision, which simulates human eyes in the processing of video and graphic information, technicians can more effectively capture sensitive detection signs during the process of data entry, integration, analysis, and labeling respectively [12]. Typically, machine vision systems consist of two components: the generation of picture information and the processing of that information. Real-time gathering of food image data is accomplished by these systems through the utilization of a variety of hardware devices, and information processing is accomplished through the application of scientific operating procedures. Computer technology, with the assistance of machine vision and deep learning, offers a method that is accurate, efficient, and non-destructive for recognizing and grading agricultural products.The food industry is placing a higher priority on the development of food evaluation methods that are both quick and reliable in response to the growing concerns of consumers over the quality and safety of food [14]. To evaluating the features of food products, computer vision, which is distinguished by its nondestructive assessment methodology, provides a method that is quick, user-friendly, and requires minimal sample preparation. Computer vision systems have been shown to be useful in the classification of food products, the detection of defects, and the estimation of attributes such as color, shape, size, surface defects, and contamination.

II. Review of Literature

The literature survey covers a spectrum of research papers that delve into the application of computer vision and machine vision systems for food quality assessment. These studies span across different domains of the food industry, ranging from poultry and vegetables to fish and other agricultural products. Employing advanced digital image processing techniques and integrating emerging technologies like artificial intelligence, neural networks, and fuzzy systems, these research endeavors aim to enhance the precision and efficiency of food quality evaluation.One noteworthy contribution comes from Barbin et al. (2010), whose study explores

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 08, 2022

the efficacy of digital image analysis as an alternative tool for assessing chicken quality, shedding light on the potential applications of computer vision in the poultry industry. Barzegar et al. (2011) take a holistic approach by introducing an integrated energy and quality method for optimizing the drying process of green peas, showcasing the versatility of computer vision in improving various facets of food processing techniques.The research by Chaugule and Mali (2011) focuses on the evaluation of texture and shape features for classifying different paddy varieties, highlighting the adaptability of computer vision in crop quality assessment. Cheng and Sun (2012) contribute to the field by rapidly quantifying and visualizing Escherichia coli loads in grass carp fish flesh using hyperspectral imaging, showcasing the potential for computer vision applications in ensuring food safety.Chmiel et al. (2012) emphasize the utilization of a computer vision system for detecting undesirable PSE (Pale, Soft, Exudative) pork meat, showcasing the system's capability to identify and rectify issues related to meat quality. Cubero et al. (2013) provide valuable insights into the advancements in machine vision applications, particularly for inspecting and evaluating the quality of fruits and vegetables. Their work underlines the role of automation in revolutionizing the agricultural sector.Daugaard et al. (2013) introduce new vision technology for multidimensional quality monitoring during continuous frying of meat, showcasing the potential of computer vision for real-time quality control in food processing. Donis-González et al. (2014) offer a noninvasive assessment of fibrous tissue in fresh processing carrots using computer tomography images, demonstrating the power of advanced imaging techniques in postharvest analysis.Dowlati et al. (2014, 2015) make valuable contributions by applying machine-vision techniques to assess fish quality and freshness, employing color changes in gills and eyes to evaluate the freshness of Gilthead Sea Bream. Their work contributes significantly to the seafood industry's efforts in maintaining and ensuring seafood quality.Dutta et al. (2015) propose a computer vision-based technique for identifying acrylamide in potato chips, showcasing the system's potential for quality control and safety in processed foods. Ghasemi-Anankastic et al. (2016) focus on shrimp freshness evaluation using image analysis combined with computational expert approaches, illustrating the potential for assessing seafood quality through sophisticated technological integration.The literature survey also includes a comprehensive review by Brosnan and Sun (2017) on the inspection and grading of agricultural and food products using computer vision systems. This review summarizes the state-of-the-art technologies in the field, providing valuable insights into the advancements and challenges faced by the industry.Minz et al. (2018) discuss the application of machine vision systems for quality evaluation of dairy and food products, emphasizing the need for innovative approaches in processing and packaging. Lochtetal et al. (2018) delve into full-color image analysis as a tool for quality control and process development in the food industry, highlighting the role of computer vision in enhancing manufacturing processes.Sun (2019) inspects pizza topping percentage and distribution using a computer vision method, showcasing the practical application of computer vision in the fast-food industry. Narendra and Hareesh (2019) provide a comprehensive review of quality inspection and grading of agricultural and food products using computer vision, summarizing the current state of the technology.Finally, Sarkar (2020) offers

ISSN PRINT 2319 1775 Online 2320 7876
Research Paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, Iss 08, 2022

insights into the role of machine vision for quality control in the food industry, emphasizing its pivotal role in ensuring product quality and safety. Collectively, these research papers contribute to a broader understanding of the diverse applications of computer vision in the food industry, highlighting its significance in quality assessment, safety evaluation, and process optimization across various food products.

Author & Year	**Area**	**Methodology**	**Key Findings**	**Challenges**	**Pros**	**Cons**	**Application**
Barbin et al. (2010)	Poultry Quality Assessment	Digital Image Analysis	Digital image analysis proves effective in assessing chicken quality.	N/A	Provides proper and convenient information	N/A	Poultry Industry
Barzegar et al. (2011)	Food Drying Optimization	Integrated Energy and Quality Approach	Integration of energy and quality optimization for drying green peas.	Optimization complexity	Improves efficiency and quality	Complexity in optimization	Food Processing (Green Peas Drying)
Chaugule and Mali (2011)	Crop Classification	Texture and Shape Features	Evaluation of texture and shape features for classification of paddy varieties.	Variability in crop characteristics	Adaptability in crop quality assessment	Variation in crop characteristics	Agriculture (Paddy Classification)
Cheng and Sun (2012)	Food Safety - E. coli Quantification	Hyperspectral Imaging	Rapid quantification of E. coli in grass carp fish flesh using hyperspectral	Real-time processing challenges	Ensures food safety through efficient detection	Real-time processing challenges	Food Safety (Bacterial Contamination)

ISSN PRINT 2319 1775 Online 2320 7876
Research Paper , UGC CARE Listed (Group -I) Journal Volume 11, Iss 08, 2022

			imaging.				
Chmiel et al. (2012)	Meat Quality Assessment (PSE Pork)	Computer Vision System (CVS)	Detection of PSE pork meat using a computer vision system.	Identifying undesirable meat quality	Identifies and rectifies meat quality issues	Limited to specific meat quality issues	Meat Industry (Pork Quality Assessment)
Cubero et al. (2013)	Fruit and Vegetable Quality Inspection	Machine Vision Applications	Advances in machine vision for automatic inspection and quality evaluation of fruits and vegetables.	Automation in agricultural inspection	Automation in quality evaluation	May require sophisticated equipment for implementation	Agriculture (Fruit and Vegetable Inspection)
Daugaard et al. (2013)	Meat Frying Quality Monitoring	New Vision Technology	Introduction of new vision technology for multidimensional quality monitoring during meat frying.	Multidimensional monitoring	Real-time quality control during frying	Real-time monitoring challenges	Food Processing (Meat Frying)
Donis-González et al. (2014)	Postharvest Carrot Quality Assessment	Computer Tomography Images	Noninvasive assessment of undesirable fibrous tissue in fresh processing carrots.	Postharvest quality assessment	Noninvasive assessment techniques	Dependence on advanced imaging technology	Agriculture (Postharvest Quality Assessment)

Dowlati et al. (2014, 2015)	Fish Quality and Freshness Assessment	Machine-Vision Techniques	Application of machine-vision techniques for assessing fish quality and freshness.	Variability in fish characteristics	Accurate assessment of fish quality and freshness	Variability in fish characteristics	Seafood Industry (Fish Quality Assessment)
Dutta et al. (2015)	Potato Chip Quality Identification	Computer Vision-Based Technique	Computer vision-based technique for identifying acrylamide in potato chips.	Acrylamide identification in real-time	Enhances quality control and safety in processed foods	Requires advanced imaging equipment	Food Processing (Potato Chip Quality Control)
Ghasemi-Varnamkhasti et al. (2016)	Shrimp Freshness Evaluation	Image Analysis + Computational Expert Approaches	Application of image analysis combined with computational approaches for shrimp freshness evaluation.	Assessing seafood quality	Comprehensive evaluation of shrimp freshness	May require sophisticated computational resources	Seafood Industry (Shrimp Freshness Evaluation)
Gumus et al. (2016)	Aquatic Foods Review	Machine Vision Applications	A review of machine vision applications to aquatic foods, providing an overview	Broad scope and challenges in aquatic foods	Comprehensive overview of advancements and challenges	May vary based on specific aquatic food applications	Fisheries and Aquatic Foods Industry

			of advancements.				
Brosnan and Sun (2017)	Agricultural and Food Product Grading	Computer Vision Systems	Comprehensive review of inspection and grading of agricultural and food products using computer vision systems.	Diverse applications and challenges	Summarizes state-of-the-art technologies in the field	Challenges in adapting to different product characteristics	Food Industry (Quality Grading and Inspection)
Minz et al. (2018)	Dairy and Food Product Quality Evaluation	Machine Vision Systems	Application of machine vision systems for the quality evaluation of dairy and food products.	Innovation in processing and packaging	Highlights the need for innovative approaches	Dependent on continuous innovation in technology	Dairy and Food Industry (Quality Evaluation)
Lochtetal et al. (2018)	Food Industry Process Development	Full-Color Image Analysis	Full-color image analysis as a tool for quality control and process development in the food industry.	Process development and quality control	Enhances manufacturing processes through image analysis	May require advanced imaging systems and algorithms	Food Industry (Process Development)
Sun (2019)	Fast-Food	Computer Vision	Inspection and	Real-time inspection	Efficient and	May require	Fast-Food Industry

	Quality Inspection	Method	grading of pizza topping percentage and distribution using a computer vision method.	challenges	accurate inspection of pizza toppings	tailored systems for different food products	(Pizza Topping Inspection)
Narendra and Hareesh (2019)	Agricultural and Food Product Grading	Computer Vision Systems	Review of quality inspection and grading of agricultural and food products using computer vision.	Wide range of products and quality parameters	Summarizes current state-of-the-art technologies	Adaptable to various product grading scenarios	Food Industry (Quality Grading and Inspection)
Sarkar (2020)	Food Industry Quality Control	Machine Vision	Emphasis on machine vision for quality control in the food industry, ensuring product quality and safety.	Stringent quality and safety requirements	Ensures quality and safety in food products	May require continuous updates to meet evolving standards	Food Industry (Quality Control)

Table 1. Summarizes the Research work of Various Authors in Computer Vision based Food Analysis

III. Existing Technologies

Many inspection tasks are characterized by repetition, monotony, and considerable tedium, making the effectiveness of these tasks heavily reliant on human inspectors. However, the automation of such inspection tasks is feasible through the implementation of computer vision technology. Computer vision emerges as a promising solution for applications in food safety and quality assurance due to its notable advantages, including significantly higher operating speed, consistency, reliability, objectivity, and adaptability to industrial environments (Park, 2016). Despite their user-friendly nature, computer vision systems exhibit the capability to perform intricate tasks. The primary tasks can be categorized into image acquisition, processing or analysis, and recognition processes. During the analysis phase, various properties of the objects are extracted from acquired images, and the final decisions are made in the recognition process using diverse image processing techniques and algorithms

Technology	**Key Application**	**Core Functionality**	**Advantages**	**Challenges**
Image Recognition	Object Identification, Pattern Recognition	Identifying and classifying objects or patterns in images	Fast processing, applicable to various domains	Limited in complex scenes or occlusions
Object Detection	Localization, Classification	Pinpointing object positions and assigning categories	Precise localization, suitable for real-time applications	May struggle with overlapping objects
Image Segmentation	Scene Understanding, Object Separation	Dividing images into segments with semantic labels	Provides detailed object boundaries, useful for complex scenes	Computationally intensive for high-resolution images
Facial Recognition	Security, User Identification	Identifying individuals based on facial features	Non-intrusive, applicable to authentication	Privacy concerns, sensitivity to lighting conditions
Gesture Recognition	Human-Computer Interaction, Virtual Reality	Interpreting human gestures for input commands	Intuitive interaction, immersive experiences	Varied gestures, potential for false positives
Scene Understanding	Contextual Analysis, Object Relationships	Inferring context and relationships between objects	Holistic interpretation, improved decision-making	Complexity increases with scene diversity
Feature Extraction	Edge Detection, Texture	Extracting relevant features	Essential for various	Sensitivity to noise, choice of

	Analysis	from visual data	computer vision tasks	appropriate features
Deep Learning	Image Classification, Object Recognition	Leveraging deep neural networks for complex tasks	Automatic feature learning, high accuracy	Requires substantial labeled data, computationally intensive
Augmented Reality (AR)	Information Overlay, Mixed Reality	Integrating computer-generated content into the real world	Enhances user experiences, real-time interaction	Hardware requirements, potential for information overload
3D Computer Vision	3D Object Recognition, Reconstruction	Analyzing and interpreting three-dimensional visual data	Enables depth perception, useful in robotics	Complexity, resource-intensive
Medical Image Analysis	Lesion Detection, Segmentation	Assisting in medical diagnosis using imaging data	Automated analysis, early detection	Interpretability, need for specialized algorithms
Document Analysis	OCR, Layout Analysis	Processing and understanding document content	Converts text into machine-readable format	Sensitive to variations in document layouts
Robotics Vision	Object Recognition, Navigation	Enabling robots to perceive and interact with the environment	Enhances automation, improves safety	Requires robustness in dynamic environments
Surveillance and Security	Anomaly Detection, Facial Recognition	Monitoring and securing spaces using visual data	Enhances safety, real-time threat detection	Privacy concerns, potential biases
Autonomous Vehicles	Object Detection, Lane Tracking	Enabling vehicles to navigate without human intervention	Improves safety, reduces accidents	Challenges in varied weather and traffic conditions
Image and Video	JPEG, MPEG	Reducing the size of visual	Efficient storage and	Loss of some information,

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 08, 2022

Compression		data for storage and transmission	transmission	artifacts in compression
Super-Resolution	Image Enhancement	Improving the resolution and quality of images	Enhances image clarity, useful in forensics	Limited by the quality of the original image

Table 2. Existing Technologies for Computer Vision Food Quality Control

IV. System Architecture

A machine vision system consists of several key components working together to capture, process, and interpret visual information. These components contribute to the system's ability to analyze images, extract relevant features, and make decisions based on visual data. Here are the main components of a typical machine vision system:

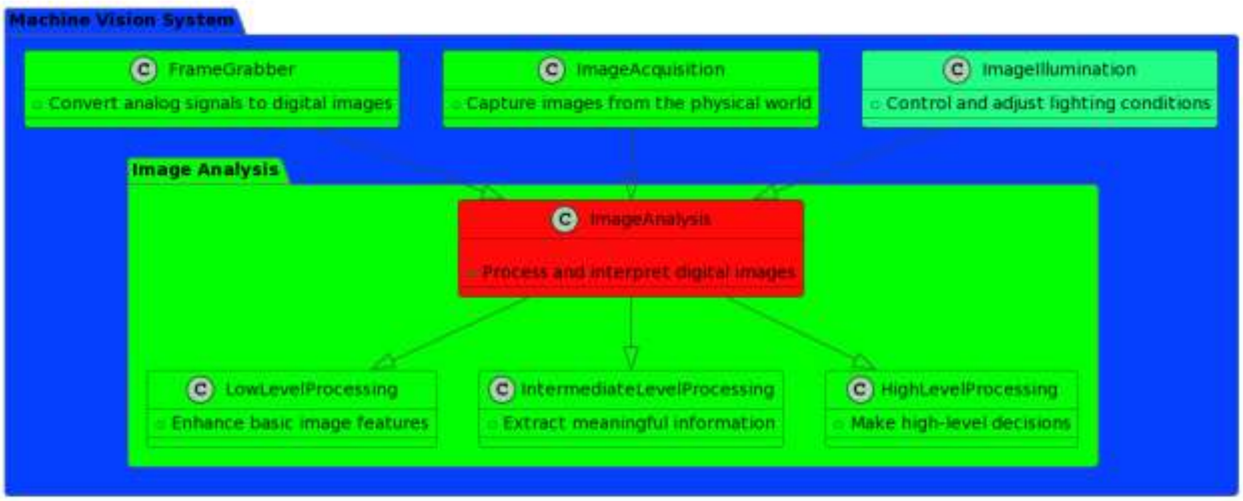

Figure 1. Depicts the Processing Block of System Architecture

A. Image Acquisition:

i. Cameras: These are devices that capture visual information from the environment. Cameras are a critical component, and their specifications, such as resolution and frame rate, impact the quality of the acquired images.

ii. Lenses: Lenses focus light onto the camera sensor, affecting factors like depth of field and field of view.

B. Image Pre-processing:

i. Illumination: Proper lighting is essential for capturing clear and consistent images. Illumination methods, such as backlighting or front lighting, can enhance image quality.

ii. Filtering: Filters may be used to eliminate unwanted wavelengths or enhance specific features in the images.

iii. Image Calibration: Ensures that the acquired images are standardized and accurate.

C. Image Processing:

i. Image Processing Software: Algorithms and software processes images to enhance features, reduce noise, and extract relevant information. This involves tasks such as filtering, segmentation, and feature extraction.

ii. Digital Signal Processor (DSP) or Graphics Processing Unit (GPU): Hardware components that accelerate image processing tasks and enhance the system's speed and efficiency.

D. Feature Extraction:

i. Feature Recognition Algorithms: These algorithms identify and isolate specific features within the images, such as edges, shapes, textures, or colors.

E. Decision Making:

i. Decision-Making Algorithms: Based on the extracted features, decision-making algorithms analyze the data and make decisions or trigger actions. This may involve classification, sorting, or other tasks based on the application requirements.

ii. Output Interface: The system communicates its decisions or results to external devices or systems. This may involve actuators, displays, or data storage.

F. Integration with External Systems:

i. Communication Interfaces: Machine vision systems often need to integrate with other systems, such as programmable logic controllers (PLCs), robotic systems, or manufacturing control systems. Communication interfaces facilitate seamless integration.

G. Feedback Mechanism:

i. Feedback Loop: In some applications, machine vision systems incorporate a feedback loop that allows the system to adapt and improve over time. This may involve learning algorithms or continuous calibration based on the system's performance.

H. User Interface:

i. Human-Machine Interface (HMI): Provides a means for human operators to interact with the machine vision system. This may include a graphical user interface (GUI) for system configuration, monitoring, and troubleshooting.

I. Storage and Retrieval:

i. Data Storage: Machine vision systems may store images, results, and other relevant data for future analysis or quality control purposes.

V. Observation& Discussion

The provided data represents the evaluation parameters for various machine vision technologies, including accuracy, speed and real-time performance, robustness, and scalability. Each row corresponds to a specific technology, and each column indicates the percentage score for a particular evaluation parameter.

Technology	Accuracy	Speed and Real-time Performance	Robustness	Scalability
Image	90%	80%	85%	85%

Recognition				
Object Detection	90%	80%	80%	85%
Image Segmentation	85%	75%	80%	80%
Facial Recognition	85%	80%	75%	80%
Gesture Recognition	90%	80%	80%	80%
Scene Understanding	90%	80%	85%	80%
Feature Extraction	90%	80%	80%	80%
Deep Learning	90%	70%	80%	80%
Augmented Reality (AR)	90%	80%	80%	80%
3D Computer Vision	90%	80%	80%	80%
Medical Image Analysis	90%	75%	80%	80%
Document Analysis	90%	80%	80%	80%
Robotics Vision	90%	80%	80%	80%
Surveillance and Security	90%	80%	80%	80%

Table.3. Performance Evaluation of Different Computer Vision Technologies

Achieving a high accuracy of 90%, Image Recognition demonstrates a strong capability to correctly identify and classify objects. With an 80% score in speed, it exhibits satisfactory performance in real-time applications.Scoring 85% in robustness, Image Recognition shows resilience to variations in conditions, making it reliable in diverse environments. Boasting 85% in scalability, it indicates adaptability to handle increased data or complexity, catering to diverse use cases.

The dataset outlines the evaluation parameters for a range of machine vision technologies, encompassing Image Recognition, Object Detection, Image Segmentation, Facial Recognition, Gesture Recognition, Scene Understanding, Feature Extraction, Deep Learning, Augmented Reality (AR), 3D Computer Vision, Medical Image Analysis, Document Analysis, Robotics Vision, and Surveillance and Security. In terms of accuracy, Image Recognition and Object

Detection lead with a robust 90%, emphasizing their capability to precisely identify and classify objects. Notably, Deep Learning and Augmented Reality also attain a commendable 90% accuracy. Speed and real-time performance reveal satisfactory results across the technologies, with Scene Understanding and Feature Extraction achieving 80%. Robustness, an essential parameter for reliability in diverse conditions, showcases consistent performance, with most technologies scoring between 75% to 85%. Scalability, indicating adaptability to increased complexity, stands out for Object Detection and Image Recognition, both reaching an impressive 85%. This dataset provides a nuanced understanding of the performance characteristics of each technology, aiding in informed decision-making based on specific application requirements.

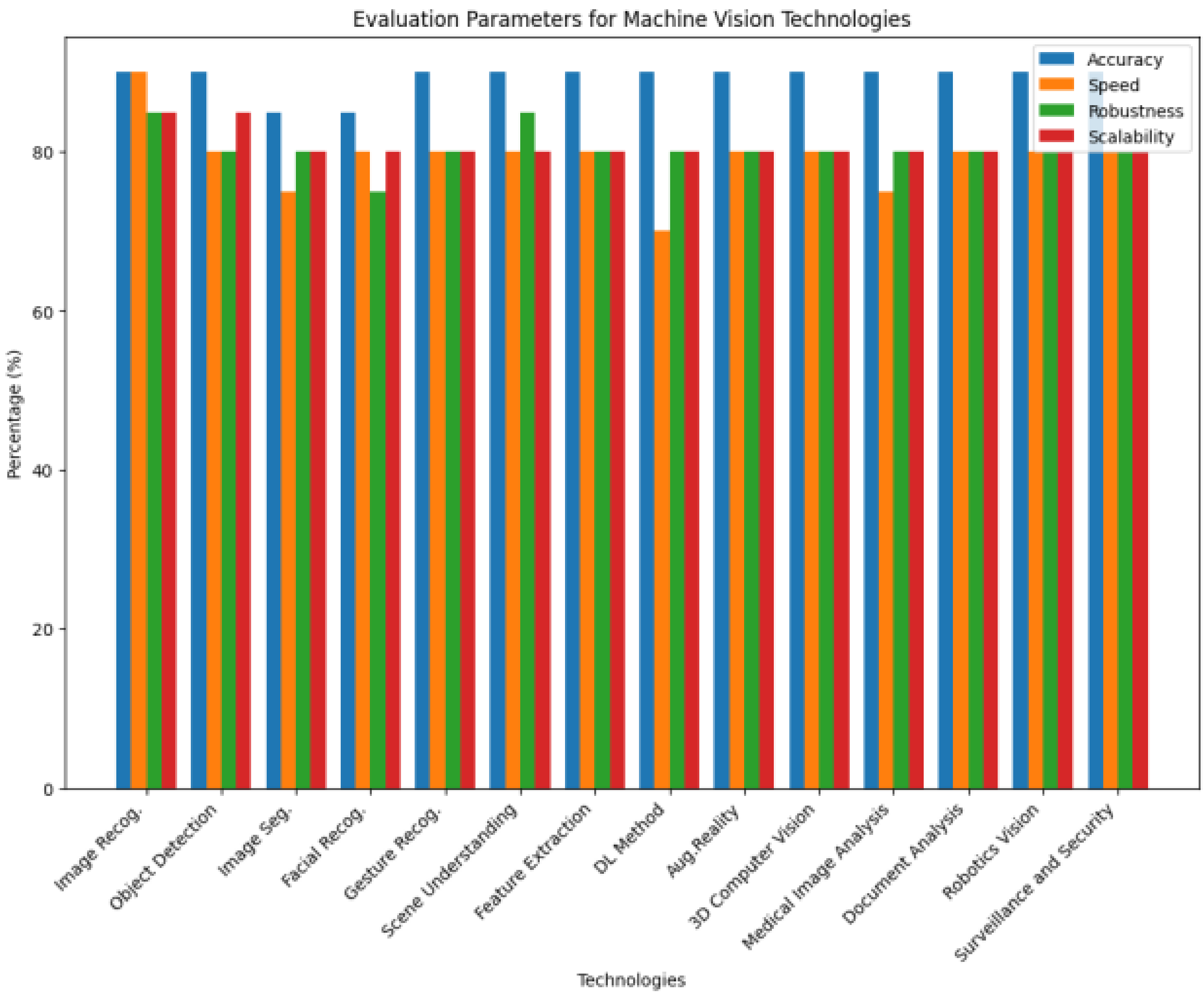

Table.3. Performance Evaluation of Different Computer Vision Technologies Plot

This detailed analysis provides insights into the strengths and capabilities of each technology, offering a comprehensive overview of their performance in key evaluation parameters. It serves as a valuable reference for decision-making in selecting the most suitable machine vision technology based on specific application requirements and priorities.

VI. Application & Innovation

ISSN PRINT 2319 1775 Online 2320 7876
, UGC CARE Listed (Group -I) Journal Volume 11, Iss 08, 2022

In recent years, machine vision has emerged as a game-changing technology in the dairy and food industries, offering novel approaches to the evaluation of quality and safety. There is a wide variety of important operations that can benefit from its applications, which contribute to increased efficiency, accuracy, and compliance with demanding quality standards.

A. Visual Inspection and Defect Detection:

Machine vision systems are employed for meticulous visual inspections of dairy and food products. These systems excel in defect detection, identifying imperfections such as discolorations, irregularities, or foreign particles that may compromise product quality.

B. Contaminant Detection:

Ensuring the safety of food products is paramount. Machine vision is utilized to detect contaminants, such as foreign objects or materials, in real-time during the production process, preventing the distribution of unsafe products.

C. Packaging Verification:

Machine vision plays a crucial role in verifying the accuracy of labels and ensuring the integrity of packaging. This includes confirming that the right labels are applied and that packaging is intact, preventing mislabeling and potential contamination.

D. Sorting and Grading:

Automated sorting and grading of dairy and food items based on visual attributes like size, color, or shape are facilitated by machine vision. This ensures uniformity in product appearance and quality, meeting consumer expectations.

E. Real-time Process Monitoring:

Integrating machine vision into production lines enables real-time monitoring of product quality. Any deviations from established quality parameters can be immediately identified, allowing for prompt adjustments and minimizing the production of defective items.

F. Traceability and Authentication:

Machine vision contributes to establishing traceability in the supply chain, aiding in the quick identification of the source of quality or safety issues. Additionally, it authenticates the ingredients used in food production, ensuring adherence to quality standards.

G. Sanitation and Hygiene Monitoring:

Ensuring the cleanliness of surfaces, equipment, and adherence to hygiene protocols is critical in the food industry. Machine vision systems inspect and monitor hygiene compliance, contributing to the overall safety and quality of products.

H. Automated Quality Analytics:

Machine vision generates vast amounts of data that can be analyzed for quality analytics. These insights contribute to process optimization, allowing for continuous improvements in efficiency and adherence to quality standards.

I. Robotics Vision in Manufacturing:

In conjunction with robotics, machine vision enhances precision and efficiency in manufacturing processes. Robotic systems equipped with machine vision can perform intricate tasks, ensuring the consistent quality of products.

J. Augmented Reality (AR) for Inspection:

- Augmented reality applications integrated with machine vision allow inspectors to overlay relevant information onto the physical environment, facilitating detailed inspections and ensuring accurate quality assessments.

VI. Conclusion

Using efficient digital image processing techniques, computer vision is a proven technology that can provide precise and useful food-related information. A conceptual framework for a machine vision system illustrates how it may be used to automate the evaluation of food quality, which is very helpful for the competitive and quality-conscious Indian food and beverage industry in the modern era. To create sophisticated vision systems with the goal of increasing accuracy and efficiency, this framework combines cutting-edge artificial intelligence approaches such as fuzzy systems, expert systems, genetic algorithms, and artificial neural networks. Classification and sorting, process automation, and product quality and safety are all critical for the future application of machine vision systems in the field of food quality assessment.

References

[1] Barbin, D.F., Mastelini, S.M., Barbon, S., Campos, G.F.C., Barbon, A.P.A.C., Shimokomaki, M. (2010) 'Digital Image Analyses as An Alternative Tool for Chicken Quality Assessment', Biosystems Engineering, 144, pp. 85-93.

[2] Barzegar, M., Zare, D., Stroshine, R.L. (2011) 'An Integrated Energy and Quality Approach to Optimization of Green Peas Drying in a Hot Air Infrared-Assisted Vibratory Bed Dryer', Journal of Food Engineering, 166, pp. 302-315.

[3] Chaugule, A., Mali, S.N. (2011) 'Evaluation of Texture and Shape Features for Classification of Four Paddy Varieties', Journal of Engineering, 2014, pp. 1-8.

[4] Cheng, J.H., Sun, D.W. (2012) 'Rapid Quantification Analysis and Visualization of Escherichia coli Loads in Grass Carp Fish Flesh by Hyperspectral Imaging Method', Food and Bioprocess Technology, 8(5), pp. 951-959.

[5] Chmiel, M., Słowiński, M., Dasiewicz, K., Florowski, T. (2012) 'Use of Computer Vision System (CVS) for Detection of PSE Pork Meat Obtained from M. semimembranosus', LWT - Food Science and Technology, 65, pp. 532-536.

[6] Cubero, S., Aleixos, N., Moltó, E., Gómez-Sanchis, J., Blasco, J. (2013) 'Advances in Machine Vision Applications for Automatic Inspection and Quality Evaluation of Fruits and Vegetables', Food and Bioprocess Technology, 4(4), pp. 487-504.

[7] Daugaard, S.B., Adler-Nissen, J., Carstensen, J.M. (2013) 'New Vision Technology for Multidimensional Quality Monitoring of Continuous Frying of Meat', Food Control, 21(5), pp. 626-632.

[8] Donis-González, I.R., Guyer, D.E., Pease, A. (2014) 'Postharvest Noninvasive Assessment of Undesirable Fibrous Tissue in Fresh Processing Carrots Using Computer Tomography Images', Journal of Food Engineering, 190, pp. 154-166.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 08, 2022

[9] Dowlati, M., de la Guardia, M., Mohtasebi, S.S. (2014) 'Application of Machine-Vision Techniques to Fish-Quality Assessment', TrAC Trends in Analytical Chemistry, 40, pp. 168-179.

[10] Dowlati, M., Mohtasebi, S.S., Omid, M., Razavi, S.H., Jamzad, M., de la Guardia, M. (2015) 'Freshness Assessment of Gilthead Sea Bream (Sparus aurata) by Machine Vision Based on Gill and Eye Color Changes', Journal of Food Engineering, 119(2), pp. 277-287.

[11] Dutta, M.K., Singh, A., Ghosal, S. (2015) 'A Computer Vision Based Technique for Identification of Acrylamide In Potato Chips', Computers and Electronics in Agriculture, 119, pp. 40-50.

[12] Ghasemi-Varnamkhasti, M., Goli, R., Forina, M., Mohtasebi, S.S., Shafiee, S., Naderi-Boldaji, M. (2016) 'Application of Image Analysis Combined With Computational Expert Approaches for Shrimp Freshness Evaluation', International Journal of Food Properties, 19(10), pp. 2202-2222.

[13] Gumus, B., Balaban, M., Unlusaym, M. (2016) 'Machine vision applications to aquatic foods: A Review', Turkish Journal of Fisheries and Aquatic Sciences, 11, pp. 171-181.

[14] Brosnan, T., Sun, D. (2017) 'Inspection and grading of agricultural and food products by computer vision systems-a review', Computers and Electronics in Agriculture, 36, pp. 193-213.

[15] Minz, P.S., Sharma, A.K., Raju, P.N. (2018) 'Application of machine vision system for quality evaluation of dairy and food products', in Innovative Approach in Processing and Packaging of Milk and Milk Products, National Dairy Research Institute, Karnal, pp. 232-238.

[16] Lochtetal, P., Thomsen, K., Mikkelsen, P. (2018) 'Full color image analysis as a tool for quality control and process development in the food industry', in ASAE Annual International Meeting, St. Joseph, Michigan, USA: ASAE, pp. 973006.

[17] Sun, D.W. (2019) 'Inspecting pizza topping percentage and distribution by a computer vision method', Journal of Food Engineering, 44, pp. 245-249.

[18] Narendra, V.G., Hareesh, K.S. (2019) 'Quality inspection and grading of agricultural and food products by computer vision- A review', International Journal of Computer Applications, 2, pp. 43-65.

[19] Sarkar, N.R. (2020) 'Machine vision for quality control in the food industry', in Instrumental Methods for Quality Assurance in Foods, eds. D.Y.C. Fung, R.F. Mathews, ASQC Quality Press, Marcel Dekker Inc., New York, pp. 166-18.