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Impact of Artificial Intelligence on Social Science and Human's Behavior: The Review of Computer Vision Development and Impact on Interdisciplinary Applications and Social Platform

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Abstract

Artificial Intelligence (AI) is increasingly influencing social science and human behavior by analyzing vast amounts of data, identifying patterns, and predicting outcomes in various societal contexts. As one of the most important technique, computer vision has progressed significantly beyond the foundational stage of data capture, now enabling advanced systems that interpret, analyze, and transform digital image in many social applications. AI enhances research in psychology, sociology, and economics by modeling human decision-making, emotions, and interactions. This fast development has fostered substantial interdisciplinary engagement, seamlessly integrating machine learning, and computer graphics into vision-based solutions to social problems. This paper offers a comprehensive review of recent developments in the impact of computer vision on social science, with particular emphasis on image processing techniques and their deployment in diverse application domains. It delves into the theoretical principles, algorithms, and enabling technologies that support automated visual data interpretation—including object detection, facial recognition, scene analysis and forecasting. By delivering data-driven insights across fields such as healthcare, autonomous navigation, surveillance, and entertainment, computer vision has become indispensable to modern innovation and change human behaviors. To provide structure to this rapidly evolving technology, this work categorizes the field into four primary pillars: image processing, object recognition, machine learning, and computer graphics—each contributing essential functions such as quality enhancement, feature extraction, adaptive learning, and realistic visualization which plays important role in different social situation. By examining contemporary methodologies, assessing performance benchmarks, and highlighting emerging trends, this work not only captures the current state of the art but also points toward promising avenues for future research in social science. At last, these advancements underline the key role of artificial intelligence in automatic driving and addressing complex challenges in modern society.

Keywords

Social science, Computer Vision, Pattern Recognition, Interdisciplinary Innovation.

1. Introduction

Artificial Intelligence (AI) has rapidly transformed various aspects of human life, influencing not only technology and industry but also the way society's function and individuals behave. As one of the most important sub-area, computer vision serves a wide array of applications that involve obtaining and analyzing visual information from human's daily life. Fundamentally, computer vision aims to replicate aspects of human vision, enabling machines to perceive, interpret, and make decisions based on visual data. With the great and fast development of artificial intelligence applications[1-4], such as face recognition by computer vision [5, 6], multimedia system network[7-16], generative adversarial network[17-19], Large language model models[20-25], auto-driving [26-29], but also in Medical care[30, 31], Spectroscopy[32, 33], human health[30, 34-39], environmental protection[40], scientific research[35, 38, 41-44], radio-frequency identification[45, 46] and design optimization[47] etc., computer vision has emerged into different field, evolving from simple raw data recording to sophisticated techniques for interpreting information from images and videos which is reshaping the way people interact with their environments and with each other. In engineering applications, progress was made by computer vision in surgery of liver transplantation[48-53]. Recent achievements in social Learning [54-61] makes even great insight in real-world application in transportation and traffic planning[62], which largely impact the way of human's living. As one of the most outstanding application field, the very biggest progress has been achieved in computer vision[63-69] with powerful software[70] and hardware support[71-76] like millimeter Wave technology and Robotics[77]. This process requires techniques for feature extraction and event detection, which vary depending on the application domain and the nature of the data being analyzed.

In social science, computer vision provides new tools for analyzing human behavior, cultural trends, and societal changes by processing vast amounts of visual data from social media, urban spaces, and digital platforms. These provides huge number of images for training large models, which involves image processing and pattern recognition[64-67, 69] that both serve as foundational components of computer vision. While image processing emphasizes techniques for enhancing image quality and extracting useful features, pattern recognition focuses on identifying and categorizing objects or patterns within those images. By combining these two areas, social science researchers and engineers can develop model capable of interpreting spatial data, ultimately leading to what is often termed image understanding. The field of computer vision draws significant inspiration from human behavior and visual capabilities, yet fully replicating human-like vision remains beyond current technological limits due to constraints in machine interpretation and processing. Although computer vision and image processing are closely related, they have distinct objectives. Computer vision aims to create models that extract relevant information and facilitate its interpretation, thus enabling image understanding. In contrast, image processing involves computational transformations—such as sharpening and contrast adjustment—that enhance the visual clarity of images. These fields occasionally intersect with Human-Computer Interaction (HCI) [78], an interdisciplinary area concerned with user-centered design, interface ergonomics, and effective human-technology engagement. Nevertheless, computer vision is specifically devoted to analyzing and understanding visual data from human daily life.

Both human and computer vision serve the same functional purpose: interpreting spatial data to understand objects, scenes, and actions in real time and real world[79]. Yet, despite ongoing advancements, computer vision still falls short of the human visual system's adaptability and contextual awareness. Developing algorithms that mirror the accuracy, flexibility, and complexity of human perception remains a significant challenge. Researchers grapple with various obstacles, including the fine-tuning of parameters, ensuring algorithmic robustness under diverse conditions, and maintaining reliable outcomes across multiple scenarios. The performance of computer vision systems also presents complexities and involves comprehensive assessments of accuracy, robustness, and adaptability. Such evaluations test how algorithms respond to different conditions and measure their ability to sustain performance over time. In light of these challenges, the field dedicates considerable effort to refining computer vision models. These applications range from industrial automation and remote sensing to robotics, human-computer interaction, and assistive technologies for individuals with visual impairments. Ultimately, advances in computer vision depend on improvements in computational power and algorithmic design. As technology continues to

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evolve, the scope of computer vision expands, providing novel ways to interpret and analyze visual information. However, the widespread use of computer vision also raises ethical concerns, particularly regarding privacy, surveillance, and algorithmic biases that can reinforce social inequalities. This survey underscores the vital role of computer vision in closing the gap between human visual capacity and machine-based analysis, driving innovation across numerous industries, and the impact on human's life and behavior.

2. Progress and achievements

The major development of computer vision leverages advanced algorithms and optical sensors to replicate certain capabilities of human vision[71], enabling the automatic extraction of valuable information from human behavior. In contrast to traditional techniques, which can be time-consuming and often necessitate complex laboratory analysis, computer vision can interpret visual data with greater speed and efficiency. This technology is often coupled with specialized lighting setups to optimize image capture and improve analytic accuracy. By acquiring digital images and refining their quality through preprocessing, computer vision systems can isolate target objects from backgrounds, measure key features, and then accurately interpret the resulting data.

The rapid expansion of social media platforms has led to an overwhelming influx of human-centric images, creating a significant demand for advanced image processing technologies. Recent progress in image processing has led to the development of exceptionally accurate digital recognition systems, revolutionizing how visual data is analyzed across a wide range of sectors [80]. These advancements streamline data collection and refine image interpretation, paving the way for new applications such as automated quality control, medical imaging, and autonomous navigation[81]. As a result, computer vision has evolved into a powerful technology capable of rapidly processing images and extracting crucial information, thereby offering a structured and efficient alternative to traditional visual analysis. Several examples highlight these innovations in image processing. One instance involves restoring audio from phonograph recordings using precision metrology and digital image processing to measure groove shapes without direct contact. Another application addresses the analysis of food and beverage imagery, employing feature selection, extraction, and classification methods to evaluate role portrayal and industry impact. Finally, convolutional Neural Networks (CNN) for object detection demonstrate how artificial neural networks (ANN) can effectively handle edge detection in various image processing tasks [82, 83].

Digital image processing has evolved into a leading discipline within computer vision, largely due to progress in mathematics, linear algebra, statistics, scientific computing, and computational neuroscience. These fields furnish the theoretical underpinnings for developing and refining image processing techniques. Recent advances include depth map estimation methods that utilize Bayesian techniques[84] to recover 3D structures, yielding strong performance with training data but encountering challenges in natural image settings[85, 86]. Similarly, image quality assessment for retargeting methods benefits from top-down approaches, which ensure consistent outcomes based on specific metrics. Research in this area also extends to psychophysical studies on human visual perception under varying lighting conditions, facilitated by dynamic displays and HDR technology, enabling detailed pixel differentiation across a broad luminance range. In practical applications, driver assistance systems employ contrast sensitivity techniques to gauge driver visibility, offering real-time guidance for speed adjustments in low-visibility scenarios. Image-based illumination enhancement represents another significant development: color pixel correction and decomposition surpass traditional histogram equalization by producing clearer images in low-light or high-contrast environments. Pattern recognition, a core component of computer vision,

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concentrates on object identification through image transformation techniques that enhance visual quality and enable precise interpretation. By extracting information from sensor-based imagery and informing subsequent decisions, it aspires to replicate aspects of human vision. The typical computer vision workflow includes image acquisition, preprocessing, feature extraction, segmentation or detection, high-level processing, and eventual decision-making.

Convolutional neural network–based object detection has gained significant prominence in various applications and research areas[87, 88]. In particular, two-stage detectors such as the Region-based Convolutional Neural Network (R-CNN) family [89] are frequently highlighted. These multi-step processes form a coherent pipeline for handling visual data and accurately identifying objects. Within many computer vision frameworks, two primary methodologies are employed: 3D morphological analysis and pixel optimization. While 3D morphological analysis has become a mainstay for image processing and pattern recognition, pixel optimization focuses on the detailed examination of pixel structures—including their morphology and inherent properties—to improve the understanding of vector functions. Often, both methods are applied to extensive datasets capturing multiple layers of geometric composition. This approach demands efficient and precise algorithms that can effectively extract crucial quantitative details and interpret complex color clusters.

Combining 3D morphological analysis with artificial intelligence techniques[64]—such as fuzzy logic, artificial neural networks, and genetic algorithms—further enhances the performance of computer vision solutions, particularly in large-scale data scenarios. These AI-driven methods enable intricate tasks that would otherwise require substantial human input. In practical applications, computer vision commonly employs two central processes for handling image data: segmentation and retrieval. Segmentation divides an image into separate regions of pixels that share specific characteristics (e.g., color, texture, or grayscale level), a critical step for accurate object detection and interpretation. It isolates each region for independent analysis, underpinning applications involving object recognition and classification. Retrieval then uses these segmented regions to locate visually similar images, forming the basis of content-based image retrieval systems and enriching the capabilities of image-based search engines. Collectively, segmentation and retrieval enable comprehensive data processing and categorization across a broad range of applications—from automated quality inspection to advanced search functionalities. Image segmentation frequently employs techniques based on intensity, color, and shape, as well as edge or border detection, all contributing to more accurate object recognition. Although segmentation accuracy is typically illustrated using small image samples in research, large-scale image databases often require specialized parameters for optimal classification. Advanced methods may incorporate gradient texture analysis, feature space exploration, and unsupervised clustering to precisely localize objects and delineate boundaries. Ultimately, segmentation aims to generate a resemblance map from established object detection models or hierarchical segmentation procedures, supporting a salience mapping framework that highlights key regions in an image. As shown in Figure 1, the model computes pixel salience values and maps them to specific coordinates within a hierarchical salience map. In some cases, researchers employ aggregation models that use established saliency techniques to assign salience scores to each pixel and segment, grouping them into prominent clusters.

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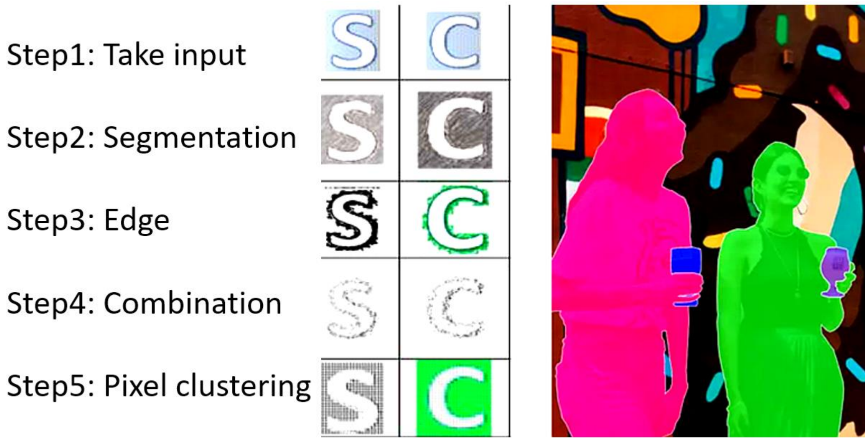

Figure 1. Segmentation in image processing: 1. Input image, 2. segmented map before integration, 3. Edge map before integration, 4. Segmented map and edge map after combination, 5. Pixel clustering

Nevertheless, such aggregation models can overlook the interplay between neighboring pixels, which may reduce segmentation accuracy in densely populated or complex visual scenarios. For instance, while pixel-wise aggregation aids in establishing model parameters, it may neglect local dependencies critical for delineating object boundaries and transitions in detailed image structures. To address these gaps, current research in computer vision segmentation is exploring more sophisticated models that factor in the relational dynamics among pixels, thereby enhancing the reliability and depth of visual analysis across diverse applications. As computer vision continues to advance, these innovations in segmentation and pattern recognition serve as the foundation for more adaptive, context-aware systems, enabling them to navigate and interpret real-world environments with increasing precision.

To address these challenges, Conditional Random Fields (CRF) is proposed to aggregate calibration maps from multiple methods while incorporating values from neighboring pixels. This CRF-based approach enhances parameter optimization during training by emphasizing the reliability of each pixel within the framework. Data extraction involves capturing objects through cameras, sensors, or satellite devices, either as single images or image sequences. The primary objective is to distinguish foreground objects from background elements. This process can yield three types of outputs: (a) objects retain their original color, (b) objects are converted to black and white, or (c) objects are rendered transparent. This technique is able to identify human emotion and predict human's behavior or habit in some situations.

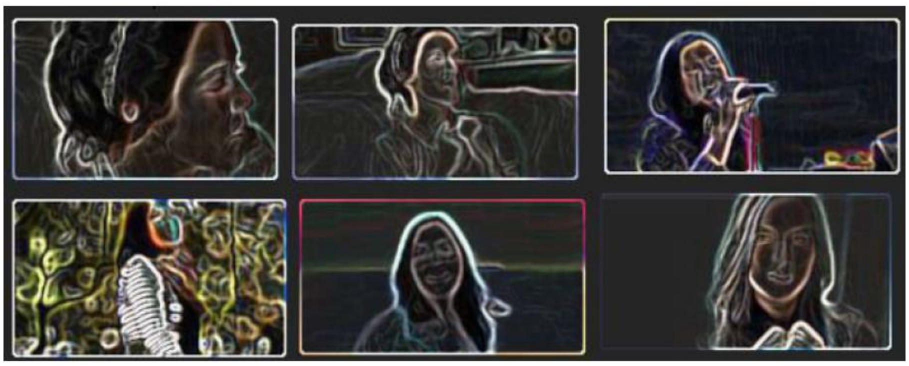

Figure 2. Shape feature extraction process, from a simple sketch to a complex image.

Figure 3 illustrates several examples of image retrievals from a large open database. The extraction process in computer vision, as shown in Figure 2, involves multiple stages: (a) converting object instances to black and white, (b) resizing objects based on a scale factor, (c) applying transparency or color combinations to specific elements, and (d) scaling and repositioning objects—often resulting in appearances that differ from their original forms.

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Pixel-level precision is critical in determining image sharpness, making optimization essential for tasks such as object detection, segmentation, and recognition. Boundary-based techniques employ edge detectors to delineate object boundaries by identifying rapid intensity changes along region edges. In color segmentation, this process is performed on each RGB channel, with the resulting edges combined to produce the final edge image. In contrast, local-based techniques group pixels based on uniformity criteria, as seen in region-growing and split-and-merge methods. Region-growing expands from core points into larger areas when pixels share similar features, such as color or grayscale values. Conversely, split-and-merge techniques initially subdivide an image into smaller regions that are subsequently merged according to specific criteria. However, these region-based methods face two main limitations: they heavily rely on initial global criteria that influence regional growth, and they depend on the initial segments and original pixel values, which can affect the accuracy of object detection. Object detection itself is used to identify objects in both recorded and real-time datasets but often exhibits a margin of error when objects deviate from the algorithm's predefined patterns. To improve accuracy, supplementary algorithms are often deployed to detect finer features; for instance, face detection systems typically identify lower-resolution facial elements, such as eyes, eyebrows, and mouths, thereby enhancing overall precision. Peripheral features like ears and neck, however, tend to receive less attention.

A bitmap represents an image as a collection of pixels, each assigned a specific color, and is commonly used for photographs and digital images. However, bitmap quality degrades when enlarged: scaling a bitmap image, say by a factor of four, results in enlarged pixels that lead to a blurred or pixelated appearance. Critical parameters when working with bitmap images include resolution, which refers to the total number of pixels, and color depth, indicating the range of colors each pixel can display. Bitmap images are generated using scanners, digital cameras, or video capture devices and are vulnerable to various types of noise. To mitigate this, standardized bitmap templates—easily processed by computers—are often used as benchmarks. In contrast, raw bitmap images may contain acquisition errors, resulting in unstructured pixel values that do not accurately represent the original scene. Noise can enter bitmap images through different mechanisms: for instance, scanning a film photograph may introduce noise from film grain, damage, or scanner interference, while images captured directly in digital format may be affected by CCD detectors or electronic data transmission issues.

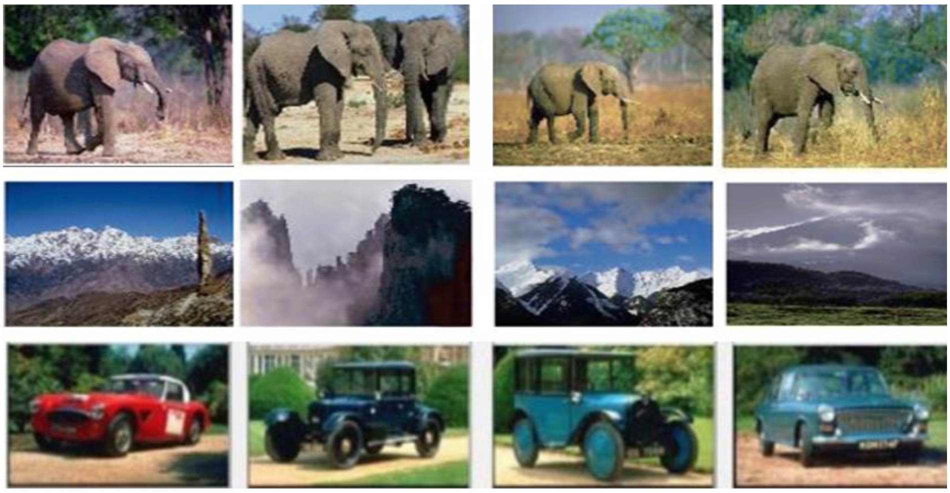

Figure 3. Example of image retrieval using a query image from large datasets such as PASCAL MTH and MSD, which extracts info from daily life and also impact the society

Image processing research is focused on developing machine learning and computational methods capable of recognizing patterns in increasingly diverse objects. Machine learning plays a crucial role in applications such as spam filtering, optical character recognition[90, 91], search

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engines, and computer vision. Various algorithms have been devised to reduce noise by averaging pixel values within local regions, thereby mitigating local variations and producing clearer, more accurate images. As social media continues to evolve, image processing remains at the forefront of technological advancements, shaping how digital content is created, shared, and interpreted. This ongoing development opens new avenues for artificial intelligence (AI)-driven applications, enabling more efficient, secure, and user-friendly experiences across digital platforms.

3. Conclusion and outlook

Understanding the impact of computer vision on social structures and human behavior is crucial to ensuring its responsible use and mitigating potential risks while leveraging its benefits for scientific and societal advancement. Computer vision has evolved into a fundamental discipline driving a wide range of modern technologies. By transforming raw images and videos into actionable insights, it enhances sensing, modeling, and prediction, advancing fields such as remote sensing, robotics, healthcare (like covid-19[92]), and satellite communications. Beyond pattern detection and object recognition, recent advancements harness sophisticated machine learning algorithms to refine system performance, improve adaptability across diverse conditions, and enable real-time operation. As the field progresses, future efforts will likely focus on optimizing computational efficiency, increasing resilience to environmental variability, and seamlessly integrating with emerging technologies—from edge computing to augmented and mixed reality. Ultimately, continuous innovation in computer vision will not only improve the accuracy and speed of image-based analysis but also expand its impact across industries, enabling more precise decision-making and powering the next generation of data-driven solutions. As computer vision continues to evolve, its impact on social structures, employment, and communication will expand, necessitating responsible implementation to balance technological benefits with ethical considerations. Understanding its influence helps ensure a future where AI-powered visual intelligence enhances human well-being while respecting privacy and fairness.

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