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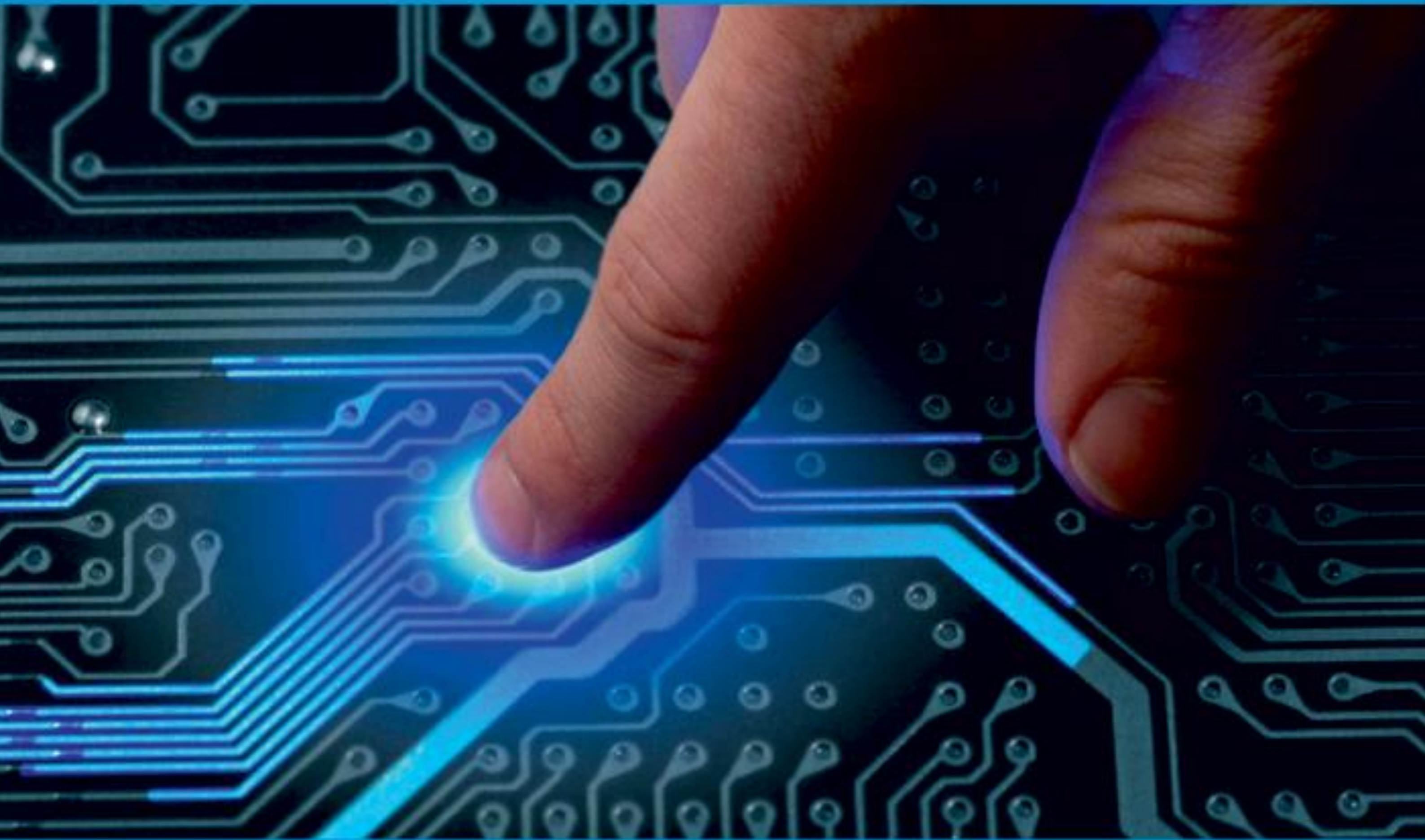

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A Survey on Relationship among Digital Image Processing and Machine Learning

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ABSTRACT*:* Machine learning and image processing are two closely related fields that often overlap in various applications of image-related tasks like Data-driven approaches, Pattern recognition, image classification, object detection, and image segmentation. The field that uses image processing and machine learning are as follows: Medical field, Remote sensing, Machine/Robot vision, face or Pattern recognition, etc. The study and application of various algorithms and techniques for the manipulation and analysis of digital images is known as digital image processing. It aims to enhance images for human perception, extract useful information from images, or automate tasks that involve images. The main objective of this survey paper is that to explore the relationship among both techniques.

KEYWORDS*:* Digital image processing, Algorithms, Machine learning, Relationship

I.INTRODUCTION

In a number of disciplines, including forensics, medicine, astronomy, remote sensing, and multimedia, digital image processing is essential. It combines methods from computer science, mathematics, and engineering to modify images in the frequency as well as spatial domains. A machine learning algorithm is a set of rules or procedures used by an AI system to perform image related tasks—most often to discover new data insights and patterns, or to predict output values from a given set of input variables. Machine learning algorithms are extensively used in digital image processing for various tasks such as image classification, object detection, segmentation, and image generation. For example, an algorithm would be trained with pictures of cats and other things, all labeled by humans, and the machine would learn ways to identify pictures of cats on its own. Supervised machine learning is the most common type used today.

II. CONCEPTS AND ALGORITHMS

Digital Image processing:

- Digital image processing is the use of algorithms and mathematical models to process and analyze digital images. The goal of digital image processing is to enhance the quality of images, extract meaningful information from images, and automate image-based tasks.

Steps of Digital Image Processing

- **Image Acquisition**: The first step, where an image is captured and digitized.
- **Image Enhancement**: Improving the visual appearance of an image or converting the image to a form better suited for analysis.
- **Image Restoration**: Correcting distortions or degradations that have occurred during the imaging process.
- **Color Image Processing:** It deals with colour images, improving and manageing colour representations for various applications.
- **Wavelets and Multiresolution Processing:** Breaking down the image into various resolution levels for analysis.
- **Compression:** Reducing the size of the image file for efficient storage and transmission.
- **Morphological Processing:** Analyzing the structure of objects in the image.
- **Segmentation:** Partitioning an image into multiple segments or objects.
- **Representation and Description:** Converting segmentation results into a form suitable for computer processing.
- **Object Recognition:** Identifying objects in an image.

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Machine Learning:
Machine learning algorithms are techniques based on statistical concepts that enable computers to learn from data, discover patterns, make predictions, or complete tasks without the need for explicit programming. These algorithms are broadly classified into the three types, i.e supervised learning, unsupervised learning, and reinforcement learning.
Here are some commonly used machine learning algorithms in digital image processing:

Convolutional Neural Networks (CNNs): CNNs are perhaps the most widely used machine learning architecture for image-related tasks. They are designed to automatically and adaptively learn spatial hierarchies of features from the input images. CNNs have been highly successful in tasks such as image classification, object detection, segmentation, and even image generation.

Support Vector Machines (SVMs): SVMs are used for tasks like image classification and object detection. They work well with high-dimensional feature spaces and are particularly useful when dealing with binary classification problems.
Random Forests and Decision Trees: These are used in tasks such as image classification and object detection. They are particularly useful when interpretability is desired or when dealing with structured data within images.
Deep Belief Networks (DBNs): DBNs are used for feature learning and classification tasks in digital image processing. They are composed of multiple layers of latent variables, which help in capturing hierarchical representations of the input data.

Recurrent Neural Networks (RNNs): RNNs are used in tasks that involve sequential data within images, such as video processing or image captioning. They can capture temporal dependencies and are suitable for tasks that require understanding the context of a sequence of images.

Generative Adversarial Networks (GANs): GANs are used for generating new images that resemble the training data. They consist of two neural networks, a generator and a discriminator, trained simultaneously in a competitive setting. GANs have been used for tasks such as image generation, image inpainting, and style transfer.
Autoencoders: Autoencoders are used for tasks such as image denoising, dimensionality reduction, and feature learning. They learn to encode the input image into a lower-dimensional representation and then decode it back to the original image.
These are just a few examples, and there are many other machine learning algorithms and architectures used in digital image processing, often depending on the specific task and the characteristics of the data. Additionally, many advanced techniques involve combinations of multiple algorithms or architectures to achieve better performance.

III. Different Perspectives Of The Techniques

Two types of perspective have identified in this survey, but they represent different aspects of the relationship between machine learning (ML) and image processing:
1. Machine learning used in image processing:
This perspective highlights the utilization of machine learning techniques within the domain of image processing. In this scenario, machine learning algorithms are applied to tasks such as object detection, image classification, segmentation, and image generation. For instance, convolutional neural networks (CNNs) are commonly used for tasks like image classification and object detection, while generative adversarial networks (GANs) are employed for image generation tasks.
2. Image processing used in machine learning:
This perspective emphasizes the role of image processing techniques as a preprocessing step for machine learning tasks involving images. In this context, image processing methods are applied to enhance the quality of images, extract relevant features, or preprocess images before feeding them into machine learning algorithms. Techniques such as image denoising, resizing, normalization, and feature extraction are examples of how image processing is used to prepare image data for machine learning models.

IV. Conclusion

Both viewpoints are valid, as machine learning and image processing often complement each other. Machine learning techniques can be applied within image processing tasks, while image processing techniques can be used as preprocessing steps to facilitate machine learning algorithms' performance on image-related tasks. This symbiotic relationship between machine learning and image processing contributes to advancements in both fields and enables the development of sophisticated applications in areas like computer vision, medical imaging, and remote sensing.

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