Traditional Digital Image Processing in Artificial Intelligence

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Abstract- *A machine's ability to learn and analyze visual information is comparable to that of a human brain, and it can do it at a far higher level of detail. Image processing is where Artificial Intelligence (AI) really shines, opening up new possibilities for public safety features like face identification and object and pattern detection in real-time video and still images. When it comes to statistically classifying visual information, image processing technology is all about developing data extraction algorithms. In traditional image processing methods, a picture is first denoised, then segmented to create near-object boundaries, analyzed to extract a representative feature, and finally, a classifier compares the extracted feature vectors to the ideal object feature vectors to determine the closest object classification and its corresponding level. The function of artificial intelligence (AI) in digital image processing is the subject of this article.*

I. INTRODUCTION

The primary goal of image processing is to improve or extract information from images through alteration. Two approaches are used in the field of image processing:

- Analog image processing: This method is employed for handling tangible pictures such as prints, photographs, and the like.

- Digital image processing, which makes use of algorithms to alter digital photos.

We use images as the input in both instances. Any time you do analog image processing, the result will be in an graphic representation. Digital image processing, on the other hand, could return either a final picture or data related to it, like a mask, features, bounding boxes, or attributes. These days, image processing finds extensive use in many domains, including biometrics, gaming, medical visualization, surveillance, autonomous cars, and law enforcement [1].

Among the many goals of image processing are the following:

- Visualization—It makes processed data more understandable and meaningful by, for example, giving invisible items a visual form.
- Restoration and sharpening of photos — Raises the bar for processed images. To aid in the search for photographs, there is image retrieval. Get the size of things in a picture with object measurement.

- Pattern recognition—finds things in a picture, labels them, and determines where they are in relation to one another and the scene.

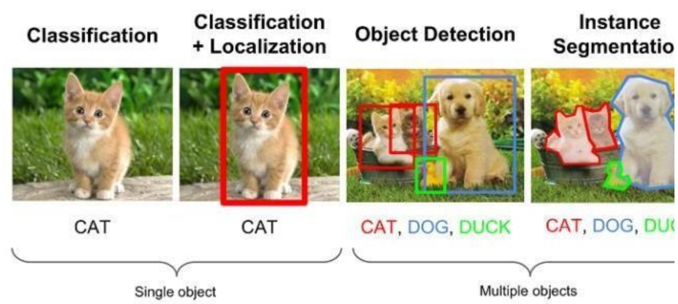


Figure 1: Examples of pattern and object recognition operations There are eight key phases included in Image Processing:

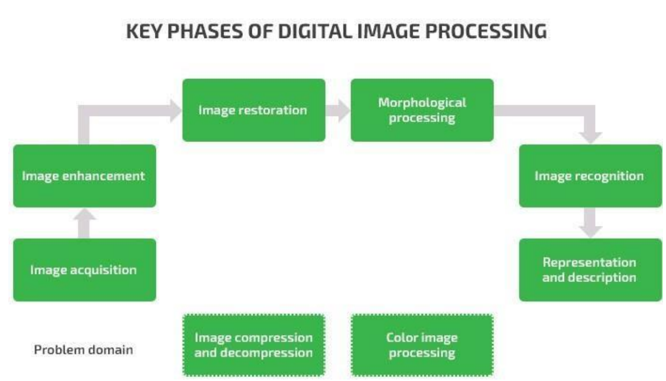


Figure 2: Key Phases of Digital Image Processing Now we will look closer at each of these phases.

1) Picture taking — This is the first step in taking a picture using a camera or other sensor and turning it

into a usable format, like a digital picture file. Scraping is a well-liked technique for acquiring images.

2) Improving the quality of the collected image enables the extraction of hidden information for subsequent processing.

3) picture restoration can boost an image's quality by restoring it from a previous state free of corruption. Noise, blur, missing pixels, watermarks, camera misfocus, and other corruptions that could impact neural network training can be eliminated using this method, which is mostly based on mathematical models and probability.

Figure 3: An example of an image with a watermark

1) Processing images with many colors and several color spaces is known as color image processing. In this context, "RGB processing" or "pseudocolor processing" refers to the image type in question.

2) Image compression and decompression — This technique enables the alteration of picture dimensions and quality. Images can be compressed to reduce their size and quality, and then decompressed to return them to their original state.

The method of image augmentation frequently makes use of these strategies. In times of data scarcity, we can replenish our dataset with somewhat more detailed photos. Our neural network model's ability to generalize data and produce accurate outputs can be enhanced in this manner [3].

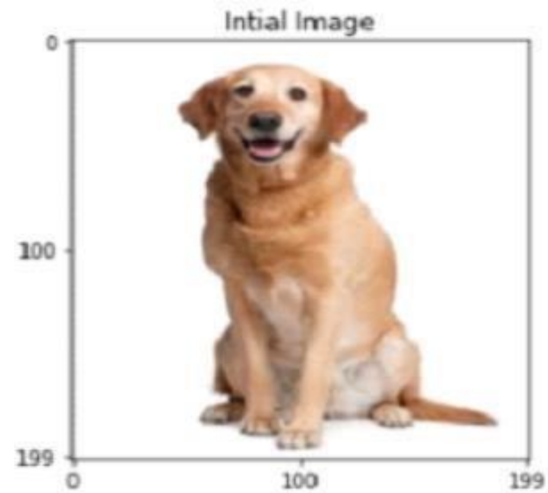
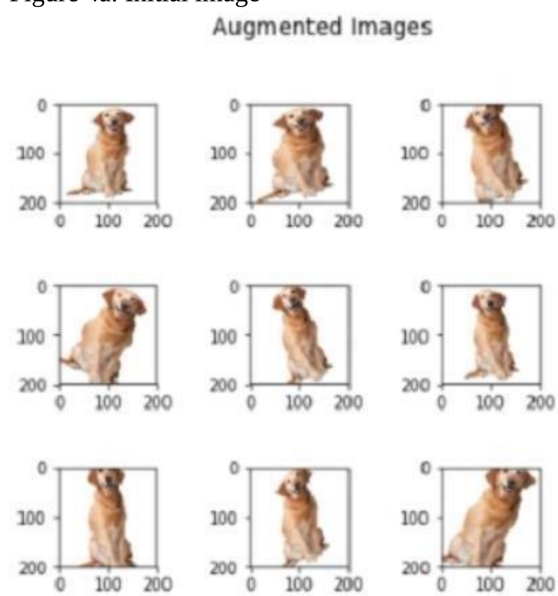


Figure 4a: Initial image



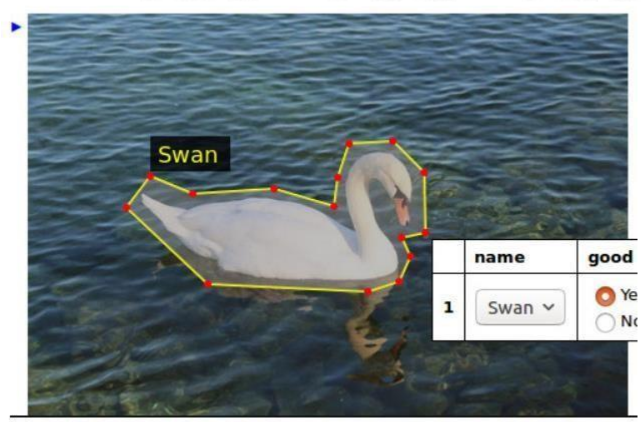


Figure 4b: Augmented images

One approach is morphological processing, which uses images to define their structure and form. It can be utilized while building datasets to train artificial intelligence algorithms. When describing what we want our AI model to detect or identify, morphological processing and analysis might be particularly useful.

An illustration of the morphological analysis annotation procedure is shown in Figure 5.

2) Identifying individual items in a picture by their unique characteristics is known as image recognition. Object detection, object recognition, and segmentation are common AI image recognition approaches. Where AI solutions really shine is in this domain. We may begin to construct, train, and test a real AI system after we finish all of these image processing steps. From gathering initial data to integrating the final AI model into the system, deep learning development encompasses the whole gamut of activities [4].

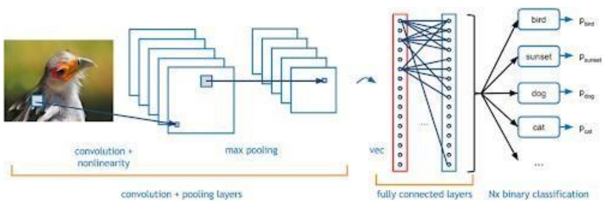


Figure 6: Image recognition with a CNN

1) Visualizing and characterizing processed images is the process of representation and description. An array of numerical values and numbers representing the data used to train an AI model is what an AI system's raw output looks like. In most cases, a deep neural network will not generate any representations of the output data. These numerical arrays can be transformed into understandable visuals that are ready for additional investigation with the aid of specialized visualization tools.

Machine learning and artificial intelligence (AI) boost processing speed without sacrificing quality. Complex tasks like word recognition, object detection, and facial recognition are now within our reach, all thanks to AI systems. The correct tools and processes are essential if we want high-quality results, but [5].

II. Approaches, Procedures, and Resources for Image Processing Due to the inherent noise in most photos captured using conventional sensors (e.g., cameras), post-processing is often necessary. The majority of image processing algorithms use some kind of filtering or edge detection [6].

One way to enhance and change the input image is by using filtering. Image noise can be reduced, specific features can be emphasized or removed, and many other effects can be achieved with the use of filters. Some common methods for filtering data are linear, Wiener, and median filters. Data extraction and picture segmentation are both handled by filters in edge detection. Through the detection of brightness discontinuities, this method aids in the discovery of meaningful object edges in processed images. The most well-known edge detection methods include Roberts, Sobel, and Canny processes.

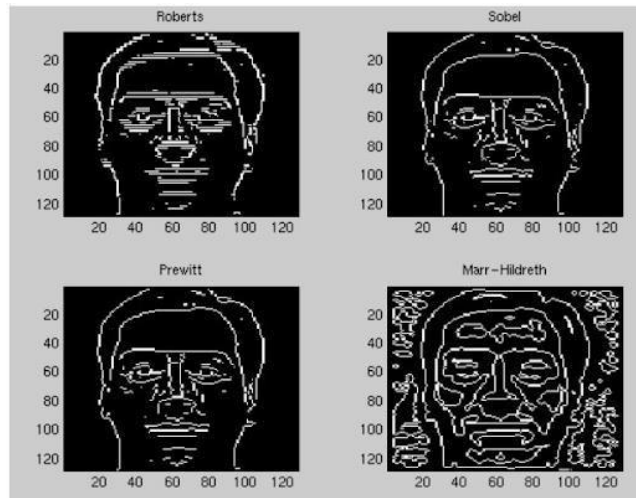


Figure 7: Examples of edge detection

By utilizing specialized libraries and frameworks, we can streamline the process of implementing AI-based image processing functions into our product and make these techniques more accessible. What follows is an examination of some widely used open- source libraries that make use of artificial intelligence techniques to complete various image processing tasks.

Section I

A: OpenCV :Many well-known algorithms for computer vision and machine learning, as well as tools for their development and maintenance, are available in the widely-used OpenCV package. The library is compatible with all major desktop and mobile OSes and comes with Python, C++, and Java interfaces. Among its many components are modules for machine learning, image processing, and object detection. Image data acquisition, compression, enhancement, restoration, and extraction are all possible with this package.

B. Visualization Collection :Built on top of the Open Graphics Library, the Visualization Library is a C++ middleware solution for both 2D and 3D applications. With this toolkit, you can create high-performance, portable apps that run on Windows, Linux, and Mac OS X. Working with it is a pleasure.

C. VGG Image Marker :The Visual Grammar and Image Annotator (VIA) is an online tool for annotating objects. After installation in a web browser, it becomes possible to annotate items discovered in photos and videos. VIA is compatible with all current browsers and doesn't necessitate any further installation or setup.

Section II: Frameworks for Machine Learning and Image Processing Developing our own unique deep learning algorithms allows us to go beyond the capabilities of basic AI systems. models for processing images. Because of this, the development will go a little more smoothly and quickly. In addition, we have access to specialized frameworks and platforms. We will now examine a few of the most widely used ones: Chapter One: Tensor Flow

Tensor Flow, developed by Google, is an open-source framework that many people use for ML and DL. Our own deep learning models can be built and trained with the help of TensorFlow. Projects involving computer vision and image processing can also make use of the libraries that come with this framework.

B. PyTorch :The Facebook AI Research group (FAIR) developed the open-source deep learning framework known as PyTorch. This framework is compatible with languages like Python, C++, and Java. Application development in computer vision and NLP make advantage of it.

C. The Image Processing Toolbox for MATLAB

Matrix laboratory is shortened to MATLAB. It's a well-liked platform for addressing mathematical and scientific challenges. For processing, displaying, and analyzing images, it comes with an Image Processing Toolbox (IPT) that offers numerous methods and workflow applications. Standard image processing procedures can be automated with MATLAB IPT. Among the many uses for this toolbox are 3D image processing, image enhancement, segmentation, and noise reduction. Many IPT functions can generate C/C++ code, making them useful for desktop prototyping and embedded vision system deployments [7].

D. Microsoft's Computer Vision Program

One of Microsoft's cloud services, Computer Vision, gives users access to sophisticated algorithms for processing images and extracting data. To name a few things it can do:

- Remove text from photographs
- Regulate image content
- Evaluate the picture's visual properties

E. Google Cloud Vision

The Google Cloud platform includes Cloud Vision, which offers a suite of image processing capabilities. It provides an application programming interface (API) for incorporating capabilities including object identification, picture labeling and categorization, and object localization. To accomplish various image processing tasks, Cloud Vision draws on pre- trained ML models as well as builds and trains its own ML models [8].

F. Google's Collaboratory

One free cloud service for building deep learning apps from the ground up is Google Colaboratory, or Colab. Popular libraries like Keras, OpenCV, and TensorFlow are made easier to use with Colab. You can also get free GPU resources via Colab. Our model training and testing processes necessitate a big image database in addition to several libraries, frameworks, and platforms.

Our own machine learning apps and algorithms can be trained using one of many public databases that include millions of annotated photos. Pascal VOC and ImageNet are the two most widely used.

CONCLUSION

Deep learning algorithms and neural networks allow us to train robots to see and understand visual information in a specific task-specific manner. In and of itself, image processing has benefited several technological domains, most notably the ability to analyze images and extract relevant data. Medicine, agriculture, retail, law enforcement, geographical remote sensing, robotics, computer-human communication, healthcare, and satellite communication are just a few of the many areas that stand to benefit greatly from the rapid adoption of AI- based image processing.

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