SURVEY ON IMAGE PROCESSING TECHNIQUES AND APPLICATIONS

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ABSTRACT:

Agriculture is one field that has benefited from the extensive use and advancement of image processing in other fields like engineering, medicine, and remote sensing. The vast majority of agricultural problems in the real world cannot be resolved without the assistance of subject matter specialists. It's more challenging, costly, and impossible to achieve. Modern information technology such as image processing, computer vision, and machine vision have been used by the agricultural sector due to their shown capacity to simulate the decision-making of human experts. Using a picture captured with any manner deemed adequate, these procedures generate an output. The results are useful for producers, distributors, and sellers in the agricultural industry. It's useful for making quick, low-cost development. This research provides a concise overview of the various image processing techniques and their many applications in the agricultural area.

Keywords- Image processing; fruit quality; non-invasive method; Agriculture

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1. INTRODUCTION

A more secure food supply was recognized as a potential outcome of using cutting-edge technologies in agriculture. The relatively young field of precision agriculture has made farming more productive, profitable, and environmentally friendly. If farmers have access to these resources, they may make changes that benefit the environment and their bottom line. Poor management of farm inputs can have unfavorable consequences, such as decreased productivity and plant sickness. The biggest challenges in agriculture include irrigation/water stress, fertilizers, herbicides, and low-quality crops. In most cases, it was necessary to consult with a professional, which might be expensive and time-consuming, especially in less developed countries. As it relates to the field of agronomy, image processing offers a low-cost and very precise method of measuring many different attributes. There is a school of thinking that proposes splitting the field of agricultural image processing into two camps: researchers interested in imaging techniques, and those more interested in the applications of these techniques. This study explores the various uses of image processing in agricultural settings.

2. REVIEW OF LITERATURE

Wilf et al. (2016) state that computerized plant identification is a major difficulty in botany because of the wide range of complex plant morphologies. By employing a computer vision system to sort photos into families and orders, they were able to conduct their experiment with amazing accuracy utilizing a dataset of 7597 images of leaf specimens from 2001 different genera. The method makes use of heat maps to display the distribution of the multiple "novels" (the properties already established in the educational leaves).

Vasudevan et al. (2016) used image processing techniques to demonstrate the value of drone and UAV imagery for agricultural management. In order to separate these high-resolution images, the D robot programming framework can be used. A reflectance map of the crops was built using RGB (red, green, and blue), NIR (near infrared), RE (red edge), multi SPEC 4C (multispectral), and thermo MAP (thermal infrared) sensor/cameras, all of which were managed by the robot's OS.

The images of farms that Tripathi and Maktedar (2016) describe being taken by robots were processed using a five-stage disease detection system including input, processing, segmentation, feature extraction, illness categorization, and disease diagnosis. Machine vision techniques were used in this study to help detect novel things in photographs found online.

Tripathi and Maktedar's (2016) study on wheat crop disease detection demonstrated the development of many methods that could be utilized for disease detection with a very high level of accuracy, achieving a 95% accuracy for disease classification after testing over 269 photos of vegetables.

In order to classify and diagnose diseases on fruits, vegetables, and other products, computer vision-based algorithms can be useful, as stated by Tripathi and Maktedar (2016).

Following extensive testing of multiple solutions on a dataset of over 120 photos gathered via mobile device, Tripathi and Maktedar (2016) claim that Support Vector Machine (SVM) results in the highest accuracy (93.79 percent).

Mata-Montero and Carranza-Rojas claim that some age-old id techniques have worked in the past. Single-access keys, crowdsourcing, morphometric strategies, single-access keys, and DNA barcoding are all examples (2016). Machine learning has made enormous progress as a result of OCR, biometrics, and optical sorting, which have all transformed how botanists classify these creatures.

Environmental parameters such as temperature, humidity, soil moisture, and light density were investigated in an experiment done by Kapoor et al. (2016).

Kapoor et al. (2016) built a system to collect soil data, snap a picture, and save it on an SD card using an Arduino interface, a Soil Moisture sensor, a Temperature and Humidity sensor, a serial JPEG camera, and an SD card shield.

Kapoor et al. (2016) conducted an experiment that might determine the demands of the plants under study by using image processing algorithms and Internet of Things (IoT) devices to collect data.

Kapoor et al. (2016) suggest that IOT sensors may be easily put on unmanned ground vehicles or unmanned aerial vehicles to carry out land monitoring due to the devices' support of the CDMA/GSM protocol. Since these materials may be transported by autonomous vehicles and applied to the soil or plants with more precision, this means less waste in terms of money saved and extra care for the soil and plants provided.

According to Suksawat and Komkum (2015), if we examine the edges of a black and white photograph of a pineapple closely enough, we may be able to calculate its size and weight. The three types of pineapples tested all performed quite well, contributing to the overall success percentage of 87.5%. (Nanglae, Sriacha, and Phuket). Variations in height and weight were only 2.30 and 5.24 percent, respectively.

In contrast to the 83% success rate achieved by Suksawat and Komkum's (2015) artificial neural network, the computer vision method achieved 100% accuracy when classifying the fruits. Combining color analysis to improve the image with color comparison against a database is the current state-of-the-art approach, and it is also the most accurate.

Pujari et al. (2015) developed a strategy for detecting and characterizing fungal plant diseases. Computers were used to examine images of plants for clues that could be used to determine their taxonomic classification. The experiment was successful since the fungus was able to infect fruit, vegetable, and grain crops. They were able to accurately identify the diseases 91.37% of the time (for GLCM) and 86.715% of the time (for GLRLM) using NN methods, a GLCM, a GLRLM, and statistical procedures (for GLRLM). When they used their block-wise strategy, they were able to improve disease diagnosis accuracy to 94.085%.

3. IMAGE PROCESSING TECHNIQUES

Images can be processed to improve their quality, have undesired elements removed, or be transformed into something altogether new. Image processing is often used to eliminate distracting backgrounds from photographs. The vast and complex field of image processing can be approached in an endless number of ways, each of which produces its own distinct results. This section discusses the most typical applications of image processing and how to implement them.

Image Enhancement

Improving the quality of an image is a common task in the field of image processing. This ability is in high demand in the security, remote sensing, and computer vision industries. Image contrast and brightness adjustments are common ways to make subtle changes. The difference between an image's brightest and darkest areas is known as its contrast. An image's legibility can be improved by increasing the contrast between its foreground and background. An image's brightness describes how light or dark it is. To make an image easier on the eyes, its brightness might be raised. In most image editing tools, you have the option of automatically or manually adjusting the contrast and brightness of your photographs. On the other hand, tweaking the contrast and brightness of an image is a breeze. A high-contrast, high-brightness image may become blurry when upscaled because to the decreased pixel density that results from the process (pixel density). The solution to this issue is picture super-resolution, a new and far more complex idea that takes a low-resolution image and makes it high-resolution (s). Deep learning techniques are widely used here.

Image Restoration

The quality of an image might decrease for a number of reasons, and this is especially true for photographs shot before cloud storage became widely available. Scanning prints from old instant cameras often results in blurry images because of specks and scratches. Specifically, the possibility of applying cutting-edge image restoration techniques to repair faded or otherwise damaged historical documents is highly exciting. Using cutting-edge picture restoration techniques based on Deep Learning, it is possible to recover vast amounts of previously concealed information from damaged documents. By dividing it up into smaller pieces, or "segments," an image becomes easier to work with. Image segmentation is a common preprocessing technique for object detection. The many parts of the diagram represent various ideas.

Object Detection

Surveillance and other safety-related applications make extensive use of the problem of object detection, which involves identifying specific things in a picture. Convolution Neural Networks derived from Deep Learning models are now the most popular method for object recognition, however there are many more approaches (CNNs). Since CNNs' core convolution function enables the computer to "see" parts of an image at once rather than dealing with individual pixels, they are ideally suited for use in image processing. Above, we see how object-detection CNNs offer a bounding box around the object to indicate its position in the image and the object class to which it belongs.

Image Compression

"Image compression" is a technique used to lessen the amount of space an image takes up on a computer's hard drive without compromising the image's quality. This can be done for two reasons: to reduce the amount of bandwidth required to transport the image, or to reduce the amount of storage space required, which is especially helpful when employing mobile and edge devices to conduct image processing algorithms. Lossy compression algorithms, used for images in the past, sacrifice some image quality for a smaller file size. As an example, the JPEG file format uses the Discrete Cosine Transform to compress images. Today's available image compression methods use Deep Learning to compress images by encoding them into a sparser feature space. This space is then recovered by a decoding network. Autoencoders are models that can decode an image using a previously learned lossless encoding method.

Image Generation

Since Deep Learning algorithms require a large amount of labeled data for training, the creation of new images is equally vital in image processing. Numerous approaches to image generation make use of Generalized Adaptive Networks (GANs), a well-liked type of neural network design. In order to distinguish between fake and real images, a GAN uses two separate models, the discriminator and the generator. Given that the discriminator has been trained to spot computer-generated imagery, the generator attempts to fool it by producing authentic-looking fakes. After several iterations of this adversarial game, the generator is able to produce realistic images that can be used to train new Deep Learning models.

Image-to-Image Translation

The "image-to-image translation" family of vision and graphics tasks uses a training set of paired images to try and infer the relationship between an input image and an output image.

4. APPLICATIONS OF IMAGE PROCESSING

1) Image polishing and restoration

The procedure through which one can change the outward form and tactile sensation of an object It makes significant adjustments to the vision and aids in getting the job done. Photos can be adjusted in several ways: sharpened, blurred, edge detection, retrieval, and recognition are only a few examples.

2) Medical Field

Digital image processing is essential for many medical uses. The diagnosis of cancer and other diseases is made using a number of techniques, such as segmentation and texture analysis. In the realm of medicine, image processing often involves working with and analyzing 3D datasets of the human body, which are often acquired through a CT or MRI scanner. It's also helpful for conducting studies and diagnosing illnesses, as well as arranging medical procedures like surgery. Gamma imaging, positron emission tomography (PET) scanning, X-ray imaging, computed tomography (CT) imaging, and ultraviolet (UV) imaging are all examples of medical image processing applications.

3) UV Sensing

The usage of remote sensing has increased in popularity and demand as a result of technological advancements in the field of natural disasters. developments in geospatial technology and the benefits of making recent, high-quality imagery easily accessible online. Satellites or other high-altitude platforms survey the area on Earth to gather information for remote sensing. The detection of earthquake-related infrastructure damage is one of the most promising uses of digital image processing in remote sensing. It is essential to the research that edges be extracted, analyzed, and enhanced in different ways depending on the type of edge being considered. Since earthquakes can affect a wide area, it is not always possible to assess the damage by looking at it. It will be a lengthy and difficult procedure. To aid assess the damage and plan a swifter reaction, digital image processing can take a bird's-eye view photograph.

4) Transmission and encoding

Thanks to advancements in technology, we can now view live CCTV footage or video feeds from any location in the world. This exemplifies the significant progress made in both image transmission and encoding. Photographs can now be encoded in a wide variety of formats and streamed online at a wide range of bitrates. The term "transmission" refers to the method of producing a microscopical image by means of light microscopy or transmission electron microscopy that reveals the amount of light or other radiation that has penetrated the substance. Compressing an image also reduces the amount of information needed to describe it, making it more suitable for transmission and speeding up the image processing process.

5) Robot vision

Robot vision refers to the practice of equipping robots with cameras and computational algorithms to analyse visual information gathered from the environment. The digital photo processing is done by a group of robots. Robots employ image processing techniques for navigation. Without the aid of digital image processing, robots are essentially blind. Robots rely on their vision systems to help them accomplish challenging tasks in a dynamic setting. To the robot's computer, digital cameras can send arrays of high-resolution pixels thanks to their advanced technology. Digital image processing algorithms allow for the improvement and comprehension of such pictures.

6) Pattern recognition

In order to build image recognition patterns and provide the computer needed for image processing with the intelligence required for human recognition, image processing is being used. Extracting meaningful characteristics from video or image data is a common use of pattern recognition. Additionally, it has numerous uses in computer vision, such as in biomedical and biological imaging. Application simplification for things like face recognition, handwriting recognition, and CAD systems is a big benefit of AI.

7) Video processing

In video processing, frames or images are combined one after another to create fast motion. Additionally, motion detection, noise reduction, and color space conversion are available. In video processing, video files or video streams serve as input and output signals, and video filters are commonly utilized; thus, video processing is a subset of signal processing, most notably image processing. Televisions, video recorders, DVD players, video codecs, video players, and video scalers all make use of video processing techniques.

8) Hurdle detection

Recognizing different classes of objects in an image and then computing the separation between the robot and obstacles are both commonplace applications of image processing. All that's needed to accomplish the job is a camera sensor and some familiarity with image processing basics.

9) Line follower robot

The majority of robots in use today are "line follower robots," or robots that navigate by following lines. A line-following robot is an autonomous computer-controlled vehicle that may be programmed to follow a line or curve in an electronic image. Line-following robots can be controlled in a number of well-established ways, such as with infrared (IR) or light-dependent resistor (LDR) sensors. This facilitates a robot's ability to follow its programmed path and carry out its assigned tasks.

10) Color processing

Each individual pixel in a digital color image carries some sort of color information. There are three levels of luminance and chrominance that can be assigned to every pixel in a color image. Each shadowing band's luminance is recorded in the digital image data. It also involves delving into the transmission, storage, and encoding of color images.

5. SIZE AND PREDICTION OF THE GLOBAL SMART AGRICULTURE SECTOR

Farmers place a premium on things like produce quality and canopy. It may be difficult to invest the time and effort needed to find a qualified professional who is also within your pricing range. The problem of obtaining reasonably priced legal counsel may one day be resolved by image processing and easy access to the appropriate technologies. Recent forecasts put the worldwide 3D imaging market at $26 billion by 2024, growing at a CAGR of 23.7%.

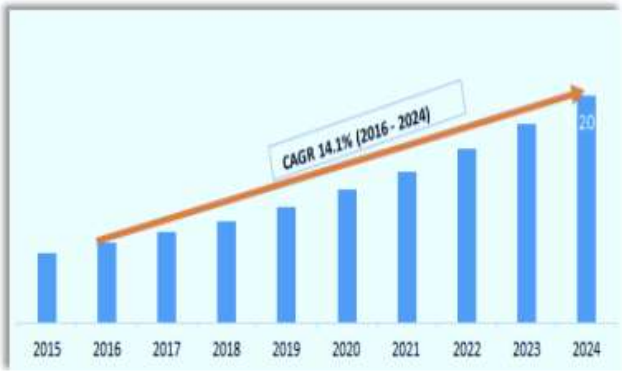

Figure Predictive Trends in Global Smart Agriculture

6. CONCLUSION

In addition to covering the basics of image processing, this dives deeper into the subject by exploring its many practical applications. These methods aid in the development of intricate automated models and the improvement of data accuracy. Factors like the need for image improvement and segmentation can impact automation accuracy. The right image processing components can generate reliable high-level assessments.

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