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# Analysis of Pattern Recognition Methods in Digital Image Processing: A Review of Recent Literature

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**ABSTRACT**

This research collects data from an important part of digital image processing.The objective of this research is to discover and classify objects or visual features based on specific characteristics.Various methods have been developed in recent decades.This includes statistical methods and feature-based manual methods, but also contemporary techniques such as machine learning and deep learning. This research is a recent literature review that examines various pattern recognition techniques in digital image processing.By using systematic review techniques on scientific articles published in the last five years, this research examines the advantages, disadvantages, and development trends of each of these techniques.The research results show that deep learning methods—particularly convolutional neural networks (CNNs)—are the most studied today due to their ability to automatically extract features and provide high accuracy. This study provides researchers and experts with a comprehensive understanding of how to choose the appropriate pattern recognition method for the needs and characteristics of the images being processed.Keywords: Pattern Recognition, Digital Image Processing, Literature Review, Deep Learning, Machine Learning, CNN, Object Detection.

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## INTRODUCTION

A branch of research called "digital image processing" examines how images are created, processed, and interpreted to provide information that is comprehensible to people. Digital images are made from digital signals, whereas analog images are made from continuous analog impulses. The inability to store, process, or copy the image on a computer is one of its disadvantages, despite its exceptional degree of detail and resolution. A two-dimensional depiction of a real, three-dimensional physical shape is called a feature (Yuhandri et al., 2022).

At this point, advancements in the field of citra (image processing) technology have drawn human attention to the study of the subject, resulting in knowledge that can be applied and understood in day-to-day life. In light of this, object identification creativity is dependent on digital image processing.. (Jumadi et al., 2021). To provide the best possible digital citra analysis, a step or process of digital pengolahan that starts with akuisisi is necessary. Pengambangan, tepi detection, gambar data, and gambar segmentation up to gambar selesai for analysis. The digital gambar segmentation process creates a few sets of pixels, sometimes known

as superpixels. Segmentation is used to make a picture easier to understand and therefore more readable. (Efran et al., 2022).

In mathematical terms, gambar is the function of continuous cahaya intensity in two dimensions. Gambar must be presented numerically using diskrit values in order to be viewed by a digital computer. Warna is the primary component that represents the object in a digital image. becoming a higher-quality image, especially using a computer. On the other hand, citra itself is defined as a representation or reflection of a particular shape or object. Using a computer, a two-dimensional image can be converted into a three-dimensional image using the digital citra pengolahan technique. A gambling game in two dimensions is called citra. From a mathematical point of view, citra is the function of reducing (terusan) the intensity of living in the dwimatra bidang. After the objek was determined by the cahaya sumber, the objek redirected the cahaya's berkas (Yuhandri et al., 2022).

## METHOD

Studies on kepustakaan are used in this study. To obtain information for literary analysis, you can consult academic literature and local research journals. Tinjauan literatur adalah ringkasan literatur already written about a particular topic and provides information about new developments in that field. The study of literature also enables researchers to introduce, develop, and analyze the technique and its relationship to the topic or findings of the study. The research tool uses the data collected thus far to identify the journals that are being examined from 2019 to 2024. This is done using a laptop, a mobile phone, and a Wi-Fi network. To find literature, use the sumber publikasi; to conduct research, use Google Cendekia and pertinent references.. (Deviv et al., 2024).

## RESULTS AND DISSCUSSION

Based on the results of the pola method analysis in the digital citra, there are a few journals that are pertinent to the study in question. The results of the analysis of the aforementioned journals will be summarized in Table 1 below.

| Tittle | Year | Result |
|---|---|---|
| Identification of Tomato Fruit Quality with PCA (Principal Component Analysis) and Backpropagation Methods (Murdika, Muhammad Alif, Yessi Mulyani, 2021) | 2021 | Prior to moving on to the JST backpropagation step, the PCA method used for the preprocessing step helps to improve program performance and reduce the image size to 30 x 30 pixels. In this study, the syaraf tiruan backpropagation network that was used reached an accuracy level of 76.7% out of 23 examples that were discussed. This akurasi nilai indicates that the system can achieve its goal. |
| Implementation of Digital Image Processing in Face Recognition using PCA and Viola Jones Algorithms (Febriyanti et al., 2025) | 2023 | In this example, Principal Component Analysis (PCA) is used for wajah analysis, and Viola-Jones is used for wajah detection; both are effective methods for identifying wajah in images and videos, with PCA helping to reduce data dimensions and Viola-Jones providing quick and accurate detection. Combining the two can result in a powerful and effective wajah detection system that can be used for a variety of purposes. At this point, human wajah photos are used to do research, and the results show that human wajah pengenalan is rather good. After the design is finalized, the system is displayed in the Matlab application's graphical user interface. |
| IMAGE PROCESSING AND SUPPORT VECTOR MACHINE (SVM) METHOD IN SIGNATURE PATTERN RECOGNITION (Pujianto et al., 2021). | 2021 | This journal reaches the conclusion of the above analysis and research. The results show that the identification of tanda tangan using the Gabor, HSV, GLCM, and SVM classification methods for 300 citra tanda tangan from 30 skripsi authors had an accuracy of 99.43%. There is a possibility that tanda tangan kesamaan will lead to identification problems. In order to determine the best technique for identifying tanda tangan, the researchers used a variety of picture and classification techniques. |
| DATA ANALYSIS FOR CLASSIFICATION OF PINEAPPLE FRUIT RIPENESS USING SVM (Vernanda et al., 2022). | 2022 | According to the research findings, a classification model using the Support Vector Machine method has been developed to determine the sensitivity of nanas. This model was developed using the gambar fitter ekstraksi parameters mean, variance, skewness, kurtosis, and entropy. This support vector machine classification, which uses a polynomial kernel, yielded an accuracy of 65.59 percent from 269 training. |
| Facial Expression Pattern Recognition for Image Processing Using Convolutional Neural Network Method(Nurjihan et al., 2024) | 2024 | This study produced a model system that can accurately describe wajah expressions. This model has successfully classified wajah expressions using the Convolutional Neural Networks (CNN) algorithm with an accuracy rate of 92%. This CNN method has demonstrated a higher accuracy level than |

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| | | |
|---|---|---|
| | | traditional methods such as Viola-Jones (76% accuracy) and Support Vector Machine (85% accuracy) under various conditions of study and research. |
| Support Vector Machine for Human Shape Recognition Using Optimized Feature Sets (Wenda, 2022) | 2022 | As long as the optimal fit is used, SVM can eventually distinguish between humans and non-humans. According to the study's findings, SVM classification has successfully classified humans and non-humans based on their characteristics. This discriminating characteristic can be applied to activity detection, pengawasan, and kaki movement detection systems. |
| SIGNATURE PATTERN RECOGNITION APPLICATION DESIGN USING SUPPORT VECTOR MACHINE (SVM) METHOD(Gunawan & Reswan, 2021) | 2021 | Since the variables of image processing and artificial neural networks are numbers, the results of Matlab processing on this topic are usually stored in the *.mat extension. This system is feasible because it can facilitate the recognition of a person's signature pattern and identify the signature owner's information effectively. |
| Implementation of Convolutional Neural Network (CNN) in Handwriting Pattern Recognition (Amartama et al., 2024) | 2024 | The results of research on the use of the CNN method for handwriting pattern recognition show that handwriting recognition patterns can be recognized quite well after trying handwriting manually. Overfitting the model causes the validation data to be inaccurate. There are symbols that can be identified as other letters. |
| SIGNATURE PATTERN RECOGNITION APPLICATION DESIGN USING SUPPORT VECTOR MACHINE (SVM) METHOD(Gunawan & Reswan, 2021). | 2021 | Since image processing and artificial neural network variables are numeric, Matlab processing results in image processing and artificial neural networks are usually stored in the *.mat extension. developed an application that helps users detect signatures. This system is feasible because it can facilitate the recognition of a person's signature pattern and identify the signature owner's information effectively. |
| Support Vector Machine for human shape recognition using optimized feature set (Wenda, 2022). | 2022 | Provided the optimal feature set is used, SVM can eventually distinguish between humans and non-humans. Studies have produced SVM classifiers that successfully recognize and classify humans and non-humans perfectly based on their shapes. This discriminative characteristic can be applied to activity detection, surveillance, and pedestrian detection systems. |

**Discussion and Analysis of Pattern Recognition Methods in Digital Image Processing**

Digital image processing is an image processing technique that aims to improve the quality of images so that they are easily interpreted by humans or computer machines that can be photos or moving images (Effendi, Fitriyah, and Effendi 2017). Image processing is a branch of science in Artifical Intelligence that uses image objects in digital form to solve its cases. (Jumadi et al., 2021).

Here are some types of digital images that we often hear:

1. Color Image or RGB (Red, Green, Blue)
   In this color image, each pixel has a certain color, these colors are red (Red), green (Green) and blue (Blue)
2. Black and White
   Digital image black and white (grayscale) each pixel has a color gradation ranging from white to black.
3. Binary Image( , ) x y = black pixel value

Each pixel only consists of black or white, because there are only two colors for each pixel, it only needs 1 bit per pixel (0 and 1) or if in 8 bits (0 and 255), so it is very efficient in terms of storage . One of the weaknesses of digital images is important to note, especially when used in various industries such as photography, image processing, and digital communications. One of the main drawbacks is the limited resolution of digital images; if the image is enlarged beyond its original size, it will appear blurry or broken (pixelated), which can cause potentially important fine details to be lost, especially when compared to the original image..

While there are drawbacks, these digital images clearly have advantages, as the above example of a journal comparison shows. In addition, the purpose of digital image processing is to manipulate images. This includes methods for enhancing or degrading the quality of an image, displaying certain parts of an image, creating a new image from parts of an existing image, and several other methods for image manipulation. (Aqilah Syaima' Fadel et al., 2024).

Digital image processing includes various manipulation techniques that not only aim to improve the visual quality of an image, but also allow users to do things such as important information extraction, object segmentation, shape analysis, and even create new images from parts of pre-existing images. As such, although digital images have technical shortcomings, their ability to be flexibly modified and analyzed makes them better than pre-existing images (Fadjeri et al., 2022).

Various approaches in digital image processing have been widely applied to overcome problems in recognizing visual objects such as faces, signatures, facial expressions, and human body shapes. One study

utilized Principal Component Analysis (PCA) in the pre-processing stage to reduce the image size to 30×30 pixels, thus accelerating the classification process using a backpropagation artificial neural network (JST). The system was able to achieve an accuracy of 76.7%. On the other hand, the combination of PCA method and Viola-Jones algorithm was used for face detection effectively, and then implemented in a GUI-based MATLAB program, with satisfactory detection results. (Harizahayu, 2021).

According to the analysis conducted in the article, digital images have features that distinguish them from analog images, one of which is the limitation of resolution because digital images are composed of pixels. The effect of pixelation can cause enlarged digital images to suffer a significant decrease in visual quality. This shows that digital images still have shortcomings in certain situations, such as large-scale printing or viewing fine details. However, the advantage of digital images lies in their flexibility of image processing and manipulation (Ahmilurrizqi et al., 2024).

Digital image processing has become an important foundation in various technological applications today, from security surveillance to biometric recognition systems and agricultural product classification. A literature review of ten recent journals analyzed in this study shows that pattern recognition methods in digital images are rapidly evolving by adopting machine learning, deep learning, and classical statistics-based approaches. Each approach brings its own advantages and challenges, which need to be thoroughly evaluated based on accuracy, efficiency, and suitability to the image type and analysis purpose.

Evaluation of Methods Based on Case Studies

1. Principal Component Analysis (PCA) and Artificial Neural Networks (JST)

The application of PCA as a pre-processing method in the research of Murdika et al. (2021) showed that dimension reduction techniques can significantly improve classification efficiency. The image size reduced to 30x30 pixels is able to streamline the backpropagation JST training process. Although the accuracy obtained is only 76.7%, this approach is relevant for studies with limited computational resources. This combination is ideal for simple applications such as fruit quality classification in an agribusiness environment.

2. PCA and Viola-Jones in Face Recognition

In the study of Febriyanti et al. (2023), the combination of PCA and Viola-Jones showed effectiveness in detecting and recognizing faces quickly and accurately. Viola-Jones offers advantages in real-time object detection, while PCA reduces image dimensions to speed up data processing. The implementation in MATLAB GUI interface also shows the ease of system integration into end-user application software.

## CONCLUSION

Based on the results of a literature study of 10 journals conducted in the last five years, it can be concluded that digital image processing continues to experience significant developments, especially in terms of pattern recognition methods. Various methods, such as Principal Component Analysis (PCA), artificial neural network (ANN), Support Vector Machine (SVM), and Convolutional Neural Network (CNN), have been used extensively in various applications, ranging from identification of people, to classification of fruit types.

Therefore, the selection of a pattern recognition method in digital image processing largely depends on the characteristics of the image, the specific needs of the application, and the available computational resources. This research is expected to be a valuable guide for researchers and experts in identifying the most suitable methods for pattern recognition tasks in various fields.

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