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Understanding Digital Image Processing in Object Identification Against the Development of Information Technology

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Abstract

Digital image processing is one of the important branches of computer science that plays a major role in supporting accurate and efficient object identification. This service aims to analyze the extent to which understanding the concepts and techniques of digital image processing can contribute to the progress of object identification, especially in the context of the increasingly rapid development of information technology. By using a descriptive-qualitative approach and literature study, this service uses various image processing methods such as segmentation, edge detection, and machine learning-based classification and others. The data used in this service is secondary data as an implementation of the object process in digital image processing for students' understanding of object detection. The results show that a deep understanding of image processing not only improves the accuracy of object identification, but also opens up opportunities for application development in various fields such as security, health, agriculture, and the manufacturing industry and this service can provide education for students to learn about the development of information technology in digital images. Thus, digital image processing is an important component in supporting digital transformation and information technology innovation in the future.

Keywords: Digital Image Processing, Object Identification, Information Technology, Image Segmentation, Visual Classification.

1. Introduction

In the era of the industrial revolution 4.0 and digital transformation, digital image processing has become a major pillar in the development of information technology. Digital image processing is the process of manipulating and analyzing images in digital form using computer algorithms, with the aim of improving visualization and extracting valuable information [1], [2] .

Digital image processing is a branch of science that uses computer algorithms to manipulate and analyze objects in digital images. With the rapid development of information technology and artificial intelligence, this technique has evolved from simply improving image quality to becoming a primary tool in feature extraction and object identification. In recent years, deep learning-based approaches, especially convolutional neural networks (CNN) and Vision Transformer (ViT), have succeeded in improving the accuracy and efficiency of tasks such as object segmentation, detection, and recognition [3], [4].

In the information technology era of 2024, object detection becomes an important component in various real applications from autonomous vehicles and surveillance systems to *telemedicine* and *augmented reality devices* . For example, YOLO, Detectron2, and EfficientDet algorithms are becoming industry standards due to their *real-time* and high-precision capabilities that are highly needed in smart *manufacturing* , smart agriculture, and medical applications in detection [5], [6].

In the context of object identification, for example in vehicle license plate detection applications, medical diagnosis, or security systems, such as pre-processing, object segmentation, and feature extraction become very crucial. Segmentation techniques, edge detection (such as Sobel, Canny), and shape and texture extraction methods (Local Binary Pattern, histogram) are used to separate and recognize objects from complex backgrounds [7], [8].

Recent developments also show the integration between classical image processing and artificial intelligence technologies, such as *deep learning* and neural networks. This approach drives object identification systems to be more accurate and adaptive to visual variations, surpassing the capabilities of traditional methods. In the medical field, *deep learning* enables automatic detection of abnormalities from MRI or CT images with a high degree of reliability, while in automotive automated guidance systems leverage computer vision to recognize signs and pedestrians in real-time [9], [10], [11].

In short, digital image processing not only improves image quality, but also becomes the backbone of object detection automation. As AI hardware and

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algorithms evolve, this technology plays a strategic role in modern digital transformation [12], [13].

The goal is to understand how a series of image processing stages—from acquisition, enhancement, segmentation, to object identification—are implemented in the context of modern information technology developments. In addition, this paper will also discuss the latest trends, challenges, and future research directions in digital image processing specifically for object identification. The scope is general in nature as an understanding of technology implementation so that the impacts given can better understand the development of information technology.

2. Activity Method

Preparations and methods in community service activities carried out at SMA Budi Agung, Medan. Where before the activity was carried out, the following preparations were made:

1. Conducting a literature study on Digital Image Processing for Detection and Information on Hidden Knowledge in Images towards the development of information technology.
2. Prepare tools and materials to be able to understand the Digital Image Processing material in detecting an object , where the tools used are in the form of MATLAB programming applications, laptops and infocus.
3. Determine the implementation time and duration of community service activities together with the implementing team . As *the time line* determined by both parties between the presenter and the partner must be adjusted as well as possible, so that the material is delivered efficiently. So that students can understand the material in a short time.
4. In the implementation of this counseling, the implementing team will gather the students of the school , where an introduction will be carried out first from both the implementing team and the students of the school. After that, the speaker begins by providing education and explanation about Digital Image Processing in detecting objects in images and what are its uses for students during the teaching and learning process or outside the teaching and learning process. So that partners or students can understand more about the knowledge of information technology that is currently developing.

Understanding digital image processing in detecting objects will display detections that use GUI in MATLAB programming, such as tomato identification, flower identification, leaf classification, vegetable type classification, pattern recognition, detecting lungs, MRI image segmentation in the human brain and detecting human faces, both eyes, nose and mouth. Understanding the material from this digital image is a development of comprehensive information technology science from various sectors of life. The methods used are segmentation methods, *K-Means* , Extraction (GLCM) and *Active Contour* while the tools used are the use of MATLAB tools, laptops and infocus. So that it can facilitate detection, counseling and others [14], [15], [16].

3. Results and Discussion

The results and discussions that will be displayed are the results of detection carried out by the presenter on partners (students) , as an addition to deeper partner knowledge of the development of information technology at this time in various sectors including digital image processing . The results and discussions can be seen below.

3.1 Identification of tomatoes

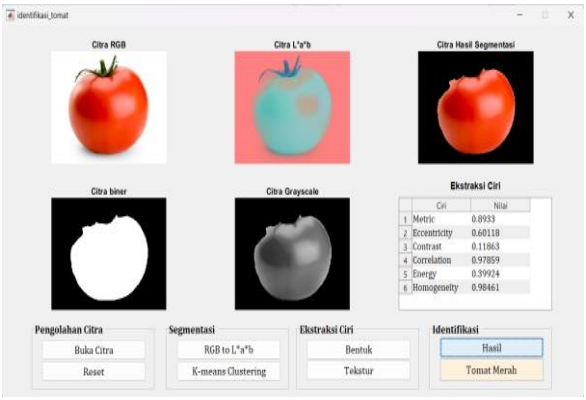

Figure 1. Results of tomato fruit identification

In Figure 1. Above is the result of tomato fruit identification consisting of red and green tomatoes. The method used is the K-Means method and extraction to be able to determine the type of tomato accurately. The selection of agricultural and plantation products often depends on human perception of fruit color. Manual identification through visual observation has several disadvantages, such as long time, fatigue, and differences in quality perception [17]. The contribution generated from tomato fruit identification is that the system can identify and determine the type of fruit by measuring the values of the shape and texture features of tomatoes.

3.2 Identify flower types

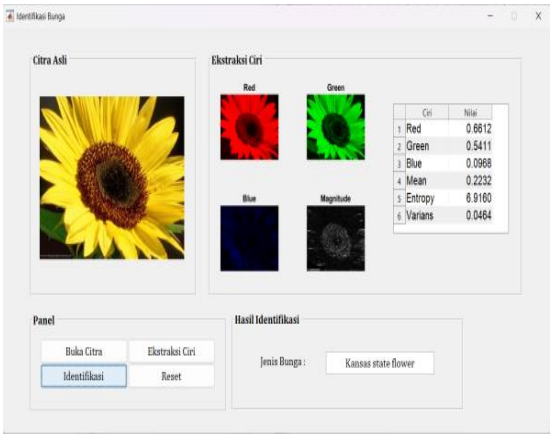

Figure 2. Results of flower type identification

In Figure 2. Above is the result of flower type identification consisting of Kansas state flower and Marguerite daisy. The contribution generated from flower type identification is that the system can identify and determine flower types by measuring the feature extraction values of flower types . The methods used are the GLCM extraction method and artificial neural networks (ANN).

3.3 Classification of Leaf Types

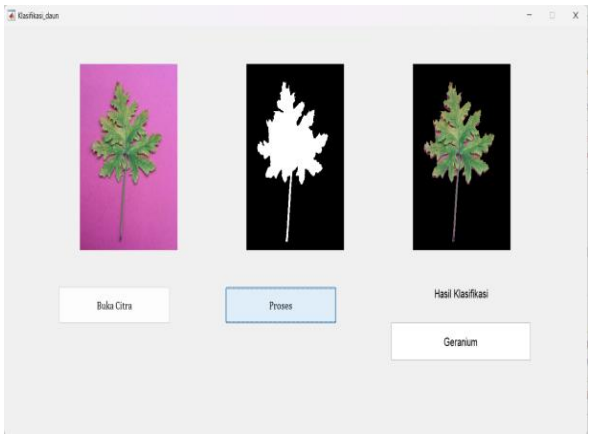

Figure 3. Leaf Type Classification Results

In Figure 3. Above is the result of leaf type classification consisting of Bougainvillea, Geranium, Magnolia soulangeana and Pinus leaves. Leaf diseases can cause significant crop failure and have an impact on the economy of farmers and the agricultural industry [18]. The contribution generated from the leaf type classification is that the system can identify and determine the type of leaf by measuring the extraction values of the characteristics of the leaf type.

3.4 Classification of types of vegetables

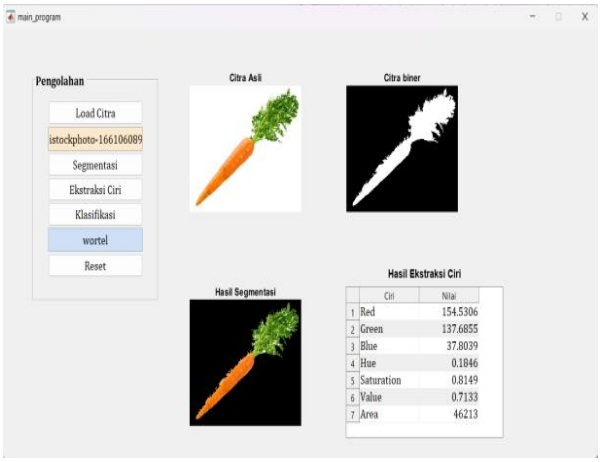

Figure 4. Results of Vegetable Type Classification

In Figure 4. Above are the results of the classification of vegetable types consisting of cabbage, mustard greens, carrots. The contribution resulting from the classification of vegetable types is that the system can identify and determine the type of vegetable by measuring the extraction values of the characteristics of the vegetable type. The methods used are the GLCM extraction method and artificial neural network (ANN) segmentation and classification.

3.5 Recognition of color patterns and object shapes

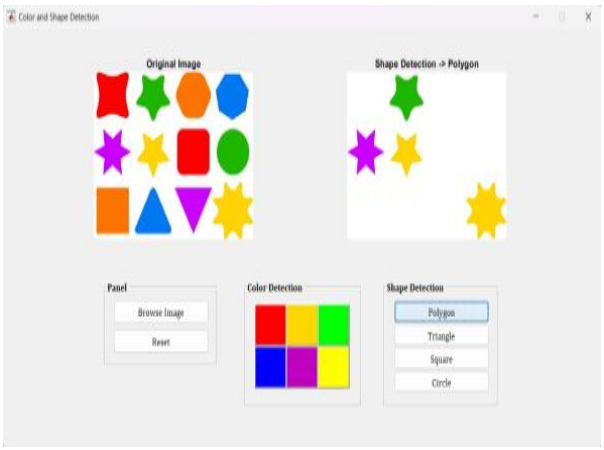

Figure 5. Results of color and shape pattern recognition

In Figure 5. Above is the result of recognizing color and shape patterns on an object processed with digital images. Each filter functions to detect certain patterns, such as edges, textures, or shapes of objects [19]. The contribution resulting from recognizing color and shape patterns on an object is that the system can recognize and determine color and shape patterns by measuring the RGB intensity value (255) on the pattern.

3.6 Detecting Lungs

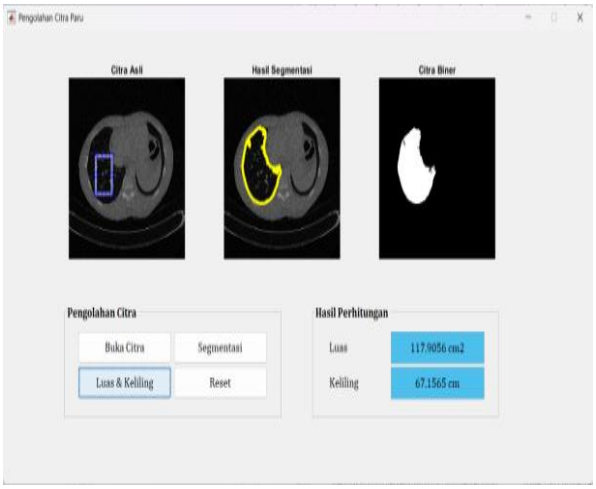

Figure 6. Lung detection results

In Figure 6. Above are the results of lung detection processed with digital images. The contribution resulting from lung detection is that the system can detect and determine the size of the area and circumference by measuring the area of the object region using the Active Contour method on the object. The methods used are the GLCM extraction method and artificial neural network (ANN) segmentation and classification.

3.7 3D MRI Image of the Human Brain

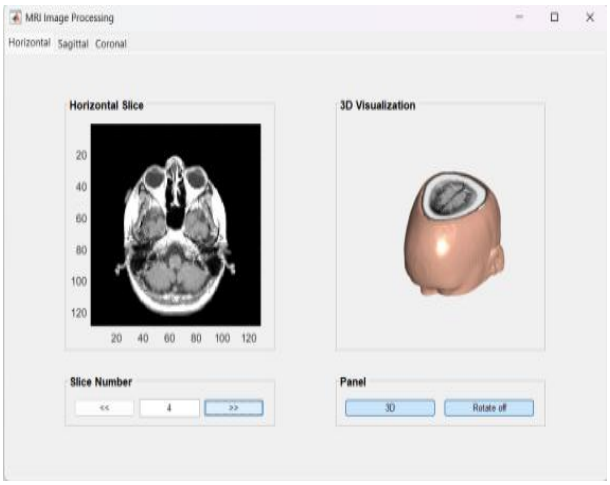

Figure 7. 3D MRI Image of the Human Brain

In Figure 7. Above is the result of a 3D MRI image of the human brain processed with digital images. The resulting contribution is that the system can detect, see and determine objects precisely in the human brain.

3.8 Detecting Face

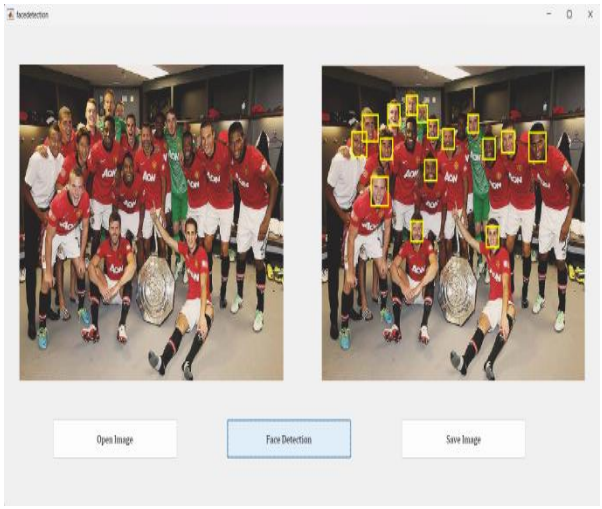

Figure 8. Face detection

In Figure 8. Above are the results of the detection image of a human face processed with digital images. recognize a person's identity precisely, quickly, accurately and consistently [20]. The resulting contribution is that the system can detect, see and determine objects precisely on a human face.

The results obtained in this Community Service are:

1. Increasing students' knowledge and understanding in the use of Digital Image Processing in detecting, classifying, determining and providing knowledge stored in objects.

2. Improving students' skills in using Digital Image Processing for the development of information technology.

3. It can be a reference for students that the progress of technology is not only limited to one aspect but has been comprehensive in various aspects of human life, so that students can also think about how to understand system performance and can participate in current technological developments. The following photos were taken while doing community service among students as knowledge.

Figure 9. Understanding digital image processing in object identification in relation to the development of information technology.

4. Conclusion

The understanding that has been analyzed both through direct interviews with partners (students) to be able to measure the results of the service, then the results that can be concluded in the form of Interest, enthusiasm and curiosity of Students in understanding digital image processing material in detecting objects against the development of information technology are so high, compared to before the workshop was held. The level of understanding of students is very good for knowing and getting to know more deeply about technology at an early age and can increase the motivation of Students in increasing interest in learning to get to know Digital Image Processing, based on this it shows the importance of providing an understanding of technology to students to be able to follow and play an active role in the development of technology in various sectors.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	W
Wahyu Saptha Negoro	✓	✓	✓	✓	✓	✓		✓	✓
Asbon Hendra Azhar		✓				✓		✓	✓
Ratih Adinda	✓		✓	✓			✓		
Destari Soeheri		✓		✓		✓			✓

Conflict of Interest Statement

Authors state no conflict of interest.

Data Availability

The data that support the findings of this study are available from the corresponding author, [initials, WSN], upon reasonable request.

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