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Image Enhancement and Modification Application Using Sharpening, Grayscale, and Additional Visual Effects on Android

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Abstract

The development of photographic technology on Android devices has increased the frequency of digital image usage in various sectors, such as social media, education, documentation, and other visual needs. However, the quality of the images produced is sometimes not as expected. Issues such as lack of sharpness, inconsistent lighting, and less visually appealing displays still frequently occur. Therefore, this research aims to create an Android-based application that can enhance and modify the quality of digital images through sharpening, grayscale, and several additional visual effects. The sharpening method is applied to improve image clarity and emphasize edge details of objects in the image, while grayscale conversion is useful for transforming color images into grayscale images that are more concise yet still informative. In addition, this application is equipped with extra visual effect features such as sepia, as well as brightness, contrast, and blur adjustments, enabling users to customize the image appearance according to their aesthetic and visual quality needs. The application is developed using the Java programming language and implemented in Android Studio. The test results show that this application is able to enhance image clarity, improve visual aspects, and provide various effects similar to those found in modern image editing applications. Therefore, this application can serve as a practical, effective, and easy-to-use tool for enhancing and modifying the quality of Android-based digital images.

***Keywords**: Digital Image Processing, Sharpening, Grayscale, Visual Effects, Android Application*

1. Introduction

The development of digital image processing technology has had a significant impact on various fields, ranging from photography and multimedia to applications in the medical field and pattern recognition. Innovations in smartphone camera technology allow users to capture images anytime and anywhere. However, the quality of the images produced does not always meet expected standards. Factors such as suboptimal lighting conditions, object movement during image acquisition, and limitations of camera sensors often cause images to appear blurry, less sharp, or to lose important details[1].

A digital image is a visual representation of real-world objects in digital data form that can be processed by computers. Digital images are composed of small elements called pixels, which are arranged in rows and columns. Each pixel has a specific numerical value that represents the intensity of light or color at a particular position[2].

In general, digital images have relatively large data sizes. The higher the image quality, the greater the storage capacity required. In the current digital era, images have become an important medium for information delivery because visual information is easier to understand and has a strong visual appeal. One technique commonly used to improve image quality is the sharpening method, which aims to emphasize edges and fine details by increasing intensity differences between pixels around object boundaries[3].

In addition to sharpening, the grayscale technique is also widely used in digital image processing. This technique converts color images into grayscale images while preserving the main structure of the image. Grayscale processing is often used as an initial step in advanced image processing because it simplifies data without eliminating essential information[4].

Along with the increasing use of social media and the growing demand for visually appealing content, the addition of extra visual effects has become increasingly important. Effects such as sepia, brightness and contrast adjustments, vignette, and various artistic effects not only enhance image quality but also add aesthetic value. Therefore, modern image processing applications no longer focus solely on technical quality improvement but also emphasize creative and visual aspects. The Android platform is selected in this study because it is open-source and has a very large user base, allowing the developed application to be easily implemented and widely utilized by the public[5].

The rapid advancement of mobile device technology, particularly Android-based smartphones, has driven a significant increase in the production and consumption of digital images. Smartphone cameras are no longer used solely for personal documentation but are also utilized in professional fields such as education, digital promotion, citizen journalism, and creative content production. This condition makes digital image quality a crucial factor influencing the effectiveness of visual information delivery. Images with low quality can reduce informational value, decrease visual appeal, and negatively affect user perception of displayed objects[6].

Although smartphone camera technology continues to improve, hardware limitations, environmental conditions, and user errors during image capture remain major factors causing suboptimal image quality. Inadequate lighting, excessive shadows, and improper camera focus often result in images that are blurry, lack sharpness, and are visually unbalanced. Therefore, digital image processing is required to enhance image quality after the acquisition process. Digital image processing allows initially suboptimal images to be improved so that they become clearer, more informative, and visually appealing [7].

Digital image processing encompasses various techniques aimed at enhancing visual quality and extracting information from images. These techniques include contrast enhancement, sharpness improvement, noise reduction, and color transformation. Among these methods, sharpening and grayscale are fundamental techniques that are widely used because of their relatively simple implementation and significant visual impact. Sharpening plays an important role in highlighting object edges and details, while grayscale simplifies color information so that the main structure of the image becomes easier to observe [8].

In addition to technical quality enhancement, the demand for visually appealing displays has also increased, especially with the growth of social media and digital content-sharing platforms. Additional visual effects such as sepia, brightness and contrast adjustments, and other artistic effects are essential elements in creating images with high aesthetic value. Modern image processing applications are not only required to produce clear images but also to provide flexibility for users to customize image appearance according to their visual preferences [9].

Based on this background, this study focuses on the development of an Android-based digital image processing application that integrates sharpening, grayscale, and various additional visual effects into a single, user-friendly system. By utilizing the open-source Android platform with its large user base, this application is expected to serve as a practical and efficient solution for users to enhance and modify digital image quality directly through mobile devices [10].

2. Research Methods

This study applies an experimental method combined with software development to design and create a digital image processing application based on the Android operating system. The research focuses on the application of sharpening and grayscale methods, as well as the addition of various extra visual effects aimed at enhancing and modifying the visual quality of digital images. The entire research process is carried out in a structured manner through several stages, namely system design, algorithm implementation, testing, and result evaluation.

Research Stages

The designed application has a simple structure consisting of three main parts: image input, image processing, and output. In the input stage, users are given the option to capture an image using the device camera or select an image stored in the gallery. Next, the image is processed using the sharpening method, grayscale conversion, and the application of various additional visual effects. After the processing stage is complete, the resulting image is displayed on the screen and can be saved back to the device's memory.

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The user interface is designed with a simple and user-friendly concept. The interface is equipped with buttons to select and apply the available filters and effects, such as buttons to activate the sharpening effect, convert the image to grayscale, and choose additional effects such as sepia, brightness adjustment, contrast adjustment, and several other artistic effects.

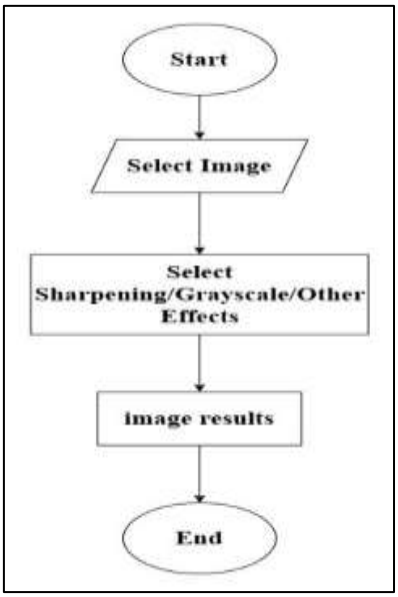

Figure 1. Flow Diagram

In the diagram above, the process begins (Start) when the system or application is turned on and ready to receive input from the user. The user then selects an image (Select Image) from the gallery or device storage, which is then read and loaded by the system into the application. After the image is successfully loaded, the user chooses the desired type of effect (Select Sharpening/Grayscale/Other Effects), such as sharpening to clarify details, grayscale to convert the color image into black and white, or other effects according to the available features. At this stage, the system performs the main process, which involves processing pixel values using digital image processing algorithms. Next, the processed result is displayed (Image Results) so that the user can review the changes made to the image. The process ends (End) when the system has completed all stages and is ready to receive new commands if the user wishes to repeat the process with a different image or effect.

Implementation of Sharpening and Grayscale Methods

The sharpening method is applied using a convolution technique on the digital image. In this process, a kernel matrix is used to enhance the edges and details in the image by increasing the differences in pixel values around object boundaries. This process is carried out by multiplying each pixel value in the image by the elements of the kernel matrix and then summing the results to obtain a new, sharper pixel value. Meanwhile, the grayscale method is performed by converting the Red (R), Green (G), and Blue (B) color values of each pixel into a single grayscale intensity value. This intensity is obtained through a combination of the three color components using a standard grayscale conversion formula, resulting in a black-and-white image that still preserves the main shapes and structures of the objects in the image.

Addition of Extra Visual Effects

In addition to sharpening and grayscale methods, the application also provides various additional visual effects aimed at enhancing aesthetic quality and flexibility in image modification. These effects are designed to meet user needs for creative image editing, particularly in the context of social media content creation and visual documentation. With multiple effect options available, users can explore different visual appearances without relying on third-party image editing applications[11] .

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The sepia effect is implemented to produce a classic and vintage visual impression by adjusting the composition of red, green, and blue color channels to create a warm brownish tone. This effect is particularly useful for artistic photography and historical-style image presentation. Brightness adjustment allows users to control overall image illumination, helping to correct images that are too dark or too bright. Meanwhile, contrast adjustment enhances the difference between light and dark areas, making objects appear clearer and more visually distinct[12].

In addition, the blur effect is applied to reduce sharp pixel transitions, resulting in smoother image appearance and reduced minor noise. The vignette effect is added to gradually darken image edges, directing visual focus toward the image center. Each effect is implemented using mathematical pixel manipulation techniques and processed independently, allowing users to combine multiple effects according to their preferences. This modular approach ensures efficiency and flexibility in the image processing workflow [13].

Image Processing

Image processing refers to the analysis and processing of images where both the input and output are images, but with improved visual quality. In general, digital image processing involves processing two-dimensional images using computer devices [14]. Image processing plays a crucial role because both the system input and output are digital images, with the primary difference being the enhanced visual quality of the processed output. Digital image processing generally includes operations such as pixel value transformation, image filtering, and spatial domain manipulation .

The image processing procedures implemented in this application focus on spatial domain techniques, in which pixel values are directly modified based on specific mathematical formulas. These techniques are chosen due to their high computational efficiency and suitability for mobile devices such as smartphones. By applying spatial domain approaches, the application can provide immediate visual feedback to users, which is essential for enhancing usability and user experience [15].

Furthermore, the image processing pipeline is designed by balancing visual quality and computational complexity. This consideration is important in Android-based application development due to limited device resources such as processor power and memory. Therefore, the selected image processing techniques are capable of producing optimal visual enhancement without excessively burdening system performance [16].

Greyscale

Grayscale is the process of converting an RGB image into a grayscale image by simplifying three color components into a single grayscale intensity matrix [6]. Grayscale conversion is a fundamental technique in digital image processing that aims to simplify color images by reducing the three primary color components red, green, and blue into a single intensity value. This process reduces image data complexity while preserving important visual information such as object shape, texture, and contrast. In grayscale images, each pixel is represented by a single gray level ranging from black to white [17].

The grayscale method implemented in this application uses a weighted conversion formula that considers the sensitivity of the human visual system to each color component. Typically, the green component contributes most to perceived brightness, followed by red and blue. This approach ensures that the resulting grayscale image appears natural and visually informative. Grayscale images play an important role in various image analysis processes because they reduce computational requirements and eliminate unnecessary color variations. In this application, grayscale conversion functions not only as a visual effect but also as a foundation for advanced image processing techniques such as sharpening and edge enhancement [18].

Sharpening

Sharpening aims to enhance image sharpness by emphasizing object edges and details. This technique works by increasing brightness differences between neighboring pixels, making object boundaries clearer [8]. Sharpening is an image enhancement technique designed to improve sharpness by highlighting fine details and edges. It operates by amplifying high-frequency components in an image, which are associated with rapid intensity changes between pixels. As a result, object boundaries become more distinct and image textures appear more defined [19].

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In this application, sharpening is implemented using a convolution-based approach, where a sharpening kernel is applied to each pixel along with its neighboring pixels. The kernel increases the difference in values between the center pixel and surrounding pixels, thereby enhancing contrast in edge regions. This approach has proven effective in improving image sharpness without significantly altering the main image structure. Sharpening is particularly beneficial for images that suffer from slight blurring due to camera movement or focus limitations during image capture. However, excessive sharpening may introduce noise and visual artifacts. Therefore, this application applies controlled sharpening intensity to ensure optimal sharpness enhancement without degrading image quality. This balanced approach enables users to obtain clearer and more detailed images for both visual presentation and documentation purposes [20].

3. Results and Discussions

Image Acquisition Results

The images used in this study were color digital images obtained through an Android smartphone. These images were captured directly using the phone's camera or selected from the device's internal storage gallery. The chosen images contained various objects, colors, and varying lighting conditions to represent different visual scenarios for testing the image processing application. The image acquisition process was carried out through the Select Image button available on the application interface. After the image was successfully loaded, it was immediately displayed in the Original Image section as the initial image before any processing was performed. This step is crucial because the original image serves as the main reference for evaluating the visual changes that occur after the application of the sharpening filter, conversion to grayscale, and various additional effects such as sepia, brightness, contrast, and other artistic effects. The comparison between the initial image and the final image was used as the basis for evaluating the quality improvement and image modifications produced by the application.

Figure 2. Application Interface

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The image above shows the interface design of an Android application called Image Filter App, which is intended for digital image processing. At the top, the application name is displayed, and below it there are two blank areas that function to display the original image as input and the processed image as output. At the bottom of the screen, there are three main buttons: Select Image to choose a photo from the gallery or camera, HD & Grayscale to improve image quality and convert it into a black-and-white image, and Image Effects to add various visual effects such as color changes, lighting adjustments, and other artistic effects. The design is kept simple and user-friendly, allowing users to easily select, process, and view the modified image results directly within a single interface.

Figure 3. Original Image

A. Grayscale Process

After the user selects an image through the Select Image button, the color image, which originally has three main color components, namely Red (R), Green (G), and Blue (B), is processed using the grayscale method. At this stage, each pixel in the image is converted into a single grayscale intensity value by combining the R, G, and B values. The result of this calculation produces one level of gray for each pixel, so the entire image becomes a black-and-white image without eliminating the main shape and details of the objects.

Figure 4. Display of the Results after the Grayscale Process

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B. Sharpening Process

The sharpening process is a stage aimed at improving image clarity by emphasizing the contours and details of objects in the image. This stage is performed using a convolution kernel (sharpening matrix) applied to each pixel in the image, which functions to enhance the difference in values between the center pixel and its surrounding pixels. As a result, edges appear sharper, textures become more distinct, and the image looks clearer and less blurry, thereby improving the visual quality of the image compared to the original.

Figure 5. Display of the Results after the Sharpening Process

C. Negative Process

After the image is selected, the negative process is performed by inverting the intensity value of each pixel in the image. At this stage, the Red (R), Green (G), and Blue (B) values of each pixel are subtracted from the maximum value (usually 255), so that light colors become dark and dark colors become light. The result is an image with inverted colors, where the structure and shape of objects remain visible but are displayed with contrast opposite to the original image.

Fiigure 6. Display of the Results after the Negative Process

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D. Sepia Process

After the image is selected, the sepia process is applied by modifying the Red (R), Green (G), and Blue (B) values of each pixel using a specific combination that produces the characteristic brownish tone of old photographs. This calculation makes the bright areas of the image appear warmer and the dark areas look deeper, resulting in an overall image with a classic, antique, and artistic feel without removing the main shapes and details of the objects in the image.

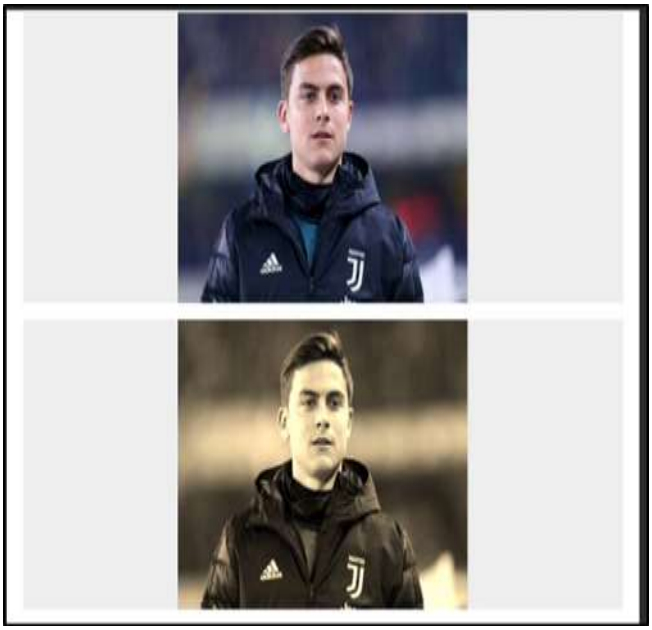

Figure 7. Display of the Results after the Sepia Process

E. Blur Process

After the image is selected, the blur process is then performed by smoothing the pixel values using a convolution technique with a smoothing kernel (such as Gaussian blur or an average filter). At this stage, each pixel is calculated based on the average value of the surrounding pixels, thereby reducing sharp differences between pixels. As a result, fine details and object edges become softer, producing an image that appears smoother and slightly blurred without significantly changing the basic shape of the objects.

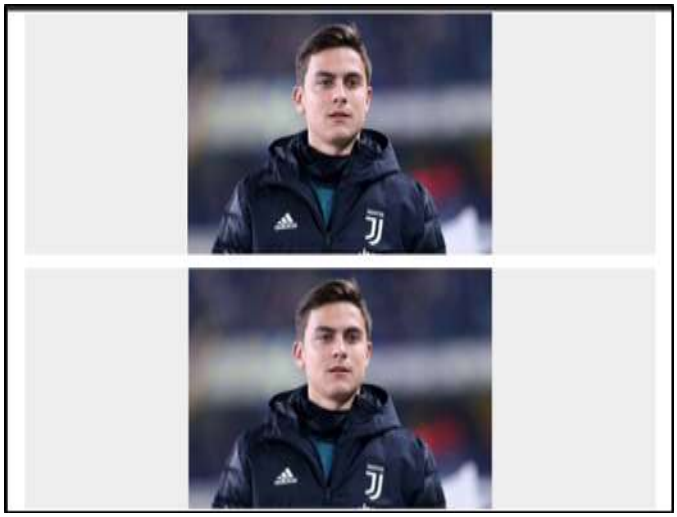

Figure 8. Display of the Results after the Blur Process

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Discussion

The image processing results of the developed application show that the sharpening filter clearly enhances edge sharpness and object details, while the grayscale filter successfully simplifies colors without eliminating the main structure. Additional effects such as sepia provide a classic tone, blur creates a soft appearance, negative inverts color contrast, and brightness and contrast adjustments give users full visual control. Subjective evaluation through visual observation and objective comparison with the original image demonstrate that the application is capable of applying various filters and effects in real-time with an intuitive interface, confirming its effectiveness in improving image quality, aesthetics, and the interactive user experience

.4. Conclusion

The developed image processing application has been proven effective in enhancing image quality and aesthetics; the sharpening filter significantly sharpens edges and object details, grayscale simplifies colors without removing the main structure, while additional effects such as sepia, blur, negative, brightness, and contrast provide visual variety and full user control. Subjective and objective evaluations show that all filters and effects can be applied in real-time through an intuitive interface, making the application not only improve visual quality but also provide a practical and enjoyable interactive experience for users.

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