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**FACULTY OF SCIENCE AND NATURAL RESOURCES**

**SV30703 DIGITAL IMAGE PROCESSING**

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**ASSIGNMENT 1**

**TOPIC: DRAW AND ENHANCE IMAGES**

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## 1.0 INTRODUCTION

Sparky Edits is an innovative and feature-rich photo editing application designed to empower users with advanced image manipulation capabilities while maintaining ease of use. Developed with the robust PyQt5 framework for its graphical user interface and the powerful OpenCV library for image processing, Sparky Edits is tailored to meet the diverse needs of students, designers, and creative enthusiasts. Whether you're looking to make simple adjustments or explore detailed customizations, Sparky Edits offers a comprehensive suite of tools to enhance your images.

The application enables users to perform a variety of editing functions, such as zooming, rotating, and cropping images with precision. Unique to Sparky Edits are features like drawing primitives (circles, lines), pixel-level color editing, and adding text directly to images with customizable fonts and colors. Users can also combine multiple images either horizontally or vertically, a function ideal for creating collages or comparative layouts. Additionally, Sparky Edits allows for color space conversions, supporting transformations like grayscale, HSV, and CIE Lab to enable users to experiment with different visual effects.

Sparky Edits is designed with real-time interaction in mind. Features like crop previews, shape drawing previews, and live zooming and rotation adjustments ensure that users have full control over their edits before finalizing them. The application also supports the creation of blank canvases, allowing users to start from scratch and unleash their creativity.

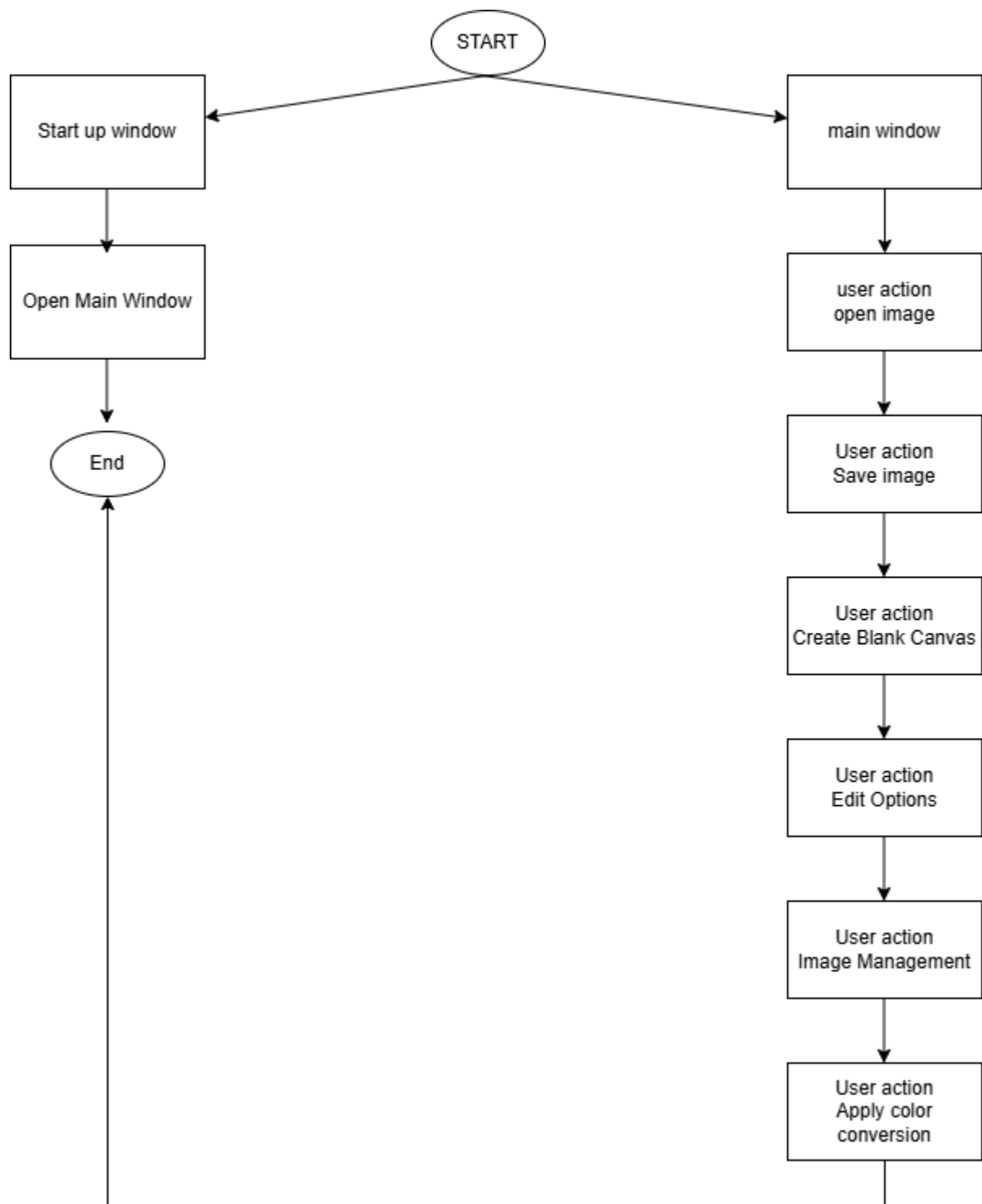
An integrated thumbnail generator simplifies managing large numbers of images, while the ability to open and edit images in multiple formats like PNG, JPEG, and BMP adds flexibility. To enhance productivity further, Sparky Edits provides tools for creating secondary windows, where users can explore different edits or perform specific manipulations without affecting the original image.

Designed with both beginners and professionals in mind, Sparky Edits combines ease of use, speed, and precision. Its lightweight yet powerful architecture ensures seamless performance,

making it an indispensable tool for anyone looking to edit, enhance, or create stunning images. Whether you're crafting a social media post or refining professional visuals, Sparky Edits sparks creativity and brings your ideas to life.

## 2.0 APPLICATION OVERVIEW

### 2.1 System Flowchart



## 2.2 System Architecture

The architecture of Sparky Edits is structured to deliver a seamless and interactive photo editing experience while ensuring efficient performance and maintainability. The system is divided into three primary layers: **User Interface Layer**, **Processing Layer**, and **File Management Layer**. Each layer plays a crucial role in ensuring the application's functionality, responsiveness, and extensibility.

### 1. User Interface Layer

The **User Interface Layer** forms the backbone of user interaction in Sparky Edits. It is implemented using PyQt5 and designed to be intuitive and user-friendly, catering to both beginners and professionals. Key components of this layer include:

- **Main Window:**  
The main window acts as the central workspace for users. It features a dynamic QLabel for displaying images and an interactive toolbar offering access to core functionalities like zoom, rotate, crop, and more. Users can easily navigate through operations without needing extensive training or tutorials.
- **Dock Widgets:**  
Dock panels are used to enhance accessibility and organization. The left dock displays a list of loaded images along with their thumbnails, enabling users to switch between images quickly. The right dock displays detailed information about the currently active image, such as file name, resolution, and dimensions.
- **Toolbars and Input Dialogs:**  
The toolbar is equipped with shortcuts for commonly used features, such as opening and saving images, drawing shapes, and combining images. Additional user inputs, like text for annotations or dimensions for a blank canvas, are handled through input dialogs and color/font pickers.
- **Real-Time Previews:**  
Users receive immediate feedback for their actions, such as a dashed rectangle for cropping or a transparent preview of shapes and text before finalizing edits. This ensures precision and reduces errors during the editing process.

- **Interactive Mouse Controls:**

The UI captures mouse events for intuitive features like dragging to crop, clicking to edit pixels, or dragging to draw circles and lines. The cursor dynamically updates to reflect the current mode, providing visual cues to the user.

## **2. Processing Layer**

The **Processing Layer** is the core of Sparky Edits, handling all the computational tasks for image manipulation. It integrates PyQt5's QPixmap functionality with OpenCV to deliver a powerful and versatile set of editing tools. Key functionalities in this layer include:

- **Image Transformations:**

Transformations like zooming, rotating, and translating images are handled using PyQt5's QPixmap and QTransform. Zooming is achieved by dynamically scaling the image, while rotation is performed in 90-degree increments for simplicity and efficiency.

- **Drawing Primitives:**

The application supports drawing basic shapes, such as circles and lines. These are implemented by capturing mouse events and calculating parameters like radius (for circles) or start and end points (for lines). Shapes are drawn onto temporary layers before being finalized.

- **Text Addition:**

Users can annotate images with text, choosing from a variety of fonts and colors. Text placement is calculated relative to the user's click position, and QPainter is used to render the text directly onto the image.

- **Color Space Conversions:**

Sparky Edits supports converting images between different color spaces (e.g., grayscale, HSV, LAB) using OpenCV's cvtColor function. This feature allows users to experiment with different visual effects and adjust images for various applications.

- **Pixel-Level Editing:**

The application allows users to modify individual pixels, enabling precise adjustments. For instance, users can click on a pixel and change its color using the QColorDialog picker.

- **Cropping and Combining Images:**

Cropping is implemented by defining a QRect based on user input and extracting the specified region from the active image. For combining images, Sparky Edits stitches multiple images together either horizontally or vertically by calculating their dimensions and aligning them appropriately.

### 3. File Management Layer

The **File Management Layer** ensures robust handling of image files, allowing users to load, save, and manage images effectively. Key functionalities include:

- **File Loading:**

The application supports importing images in various formats, such as PNG, JPEG, BMP, and GIF. Loaded images are stored as QPixmap objects, enabling efficient rendering and manipulation.

- **File Saving:**

Users can save their edits to a location of their choice. The application ensures compatibility with multiple formats and creates thumbnails automatically for quick previews.

- **Thumbnail Generator:**

Sparky Edits generates and stores 128x128 thumbnails for every loaded image. These thumbnails are displayed in the dock widget, providing users with an overview of their image library.

- **Blank Canvas Creation:**

Users can start from scratch by creating a blank canvas of custom dimensions and color. This feature is particularly useful for designers and artists looking to create unique visuals.

### Layer Interactions

The architecture promotes modularity and seamless interaction between the layers. For example:

- When a user performs a crop operation, the **User Interface Layer** captures the cropping rectangle, the **Processing Layer** extracts the cropped region, and the **File Management Layer** saves the updated image.



- Real-time updates and previews are achieved through continuous communication between the **User Interface Layer** and the **Processing Layer**, ensuring a smooth user experience.

### **Benefits of the Architecture**

- **Modularity:** Each layer is independent, making the application easy to maintain and extend with new features.
- **Efficiency:** The use of QPixmap and OpenCV ensures high performance, even for computationally intensive operations like color conversion and large image processing.
- **User-Focused Design:** The architecture prioritizes usability, with real-time feedback and intuitive controls to simplify complex tasks.

Sparky Edits' architecture demonstrates a thoughtful integration of advanced processing techniques with an accessible and responsive user interface, ensuring a powerful yet enjoyable photo editing experience for all users.

## 2.3 Algorithm Used

The functionality of Sparky Edits relies on various algorithms for image manipulation, interaction, and processing. Below is an explanation of the key algorithms used in the application:

### 1. Zooming Algorithm

The zooming functionality scales the image based on a zoom factor:

- **Input:** Zoom level (greater than 1 for zoom in, between 0 and 1 for zoom out).
- **Process:**
  1. Retrieve the current image as a QPixmap.
  2. Apply scaling using QPixmap.scaled(), maintaining the aspect ratio.
  3. Update the display to show the scaled image.
- **Output:** An updated zoomed image.

### 2. Rotation Algorithm

The rotation algorithm rotates the image by 90-degree increments:

- **Input:** Current rotation angle and image.
- **Process:**
  1. Increment the rotation angle by 90 degrees.
  2. Use QTransform.rotate() to rotate the image.
  3. Recalculate the bounding box to fit the rotated image.
  4. Update the image display.
- **Output:** A rotated image with the updated angle.

### 3. Cropping Algorithm

The cropping functionality allows users to extract a specific rectangular region from an image:

- **Input:** Crop rectangle defined by the user (start and end points).
- **Process:**
  1. Map the mouse drag coordinates to the image's pixel coordinates.
  2. Create a QRect object using the start and end points.
  3. Intersect the crop rectangle with the image bounds to ensure validity.
  4. Use QPixmap.copy() to extract the defined region.
  5. Replace the original image with the cropped version.
- **Output:** Cropped region of the image.

#### 4. Drawing Primitives Algorithm

Primitives like circles and lines are drawn based on mouse interactions:

- **Input:** Start and end points of the drawing operation.
- **Circle Drawing:**
  1. Calculate the radius using the Euclidean distance between the start and end points.
  2. Use QPainter.drawEllipse() to draw the circle.
- **Line Drawing:**
  1. Connect the start and end points with a straight line.
  2. Use QPainter.drawLine() for rendering.
- **Output:** Updated image with the drawn primitive.

#### 5. Text Addition Algorithm

Users can add text annotations to images:

- **Input:** Text content, font, color, and position.
- **Process:**
  1. Prompt the user to input text using `QInputDialog`.
  2. Allow the user to choose font and color via dialogs.
  3. Map the click position to the image's pixel coordinates.
  4. Render the text onto the image using `QPainter.drawText()`.
- **Output:** Image with the added text annotation.

## 6. Color Space Conversion Algorithm

This algorithm converts the image into different color spaces:

- **Input:** Selected color space (e.g., grayscale, HSV).
- **Process:**
  1. Load the image using OpenCV (`cv2.imread()`).
  2. Apply the appropriate conversion function, such as:
    - `cv2.COLOR_RGB2GRAY` for grayscale.
    - `cv2.COLOR_RGB2HSV` for HSV.
  3. Convert the processed array back to a format suitable for display (`QImage`).
- **Output:** Converted image in the selected color space.

## 7. Pixel Editing Algorithm

This feature enables pixel-level color changes:

- **Input:** Pixel coordinates and chosen color.
- **Process:**
  1. Map mouse click to image coordinates.

2. Use QImage.setPixel() to update the specific pixel with the chosen color.
  3. Update the QPixmap with the modified QImage.
- **Output:** Image with updated pixel color.

## 8. Image Combination Algorithm

Images can be combined horizontally or vertically:

- **Input:** List of images and direction (horizontal or vertical).
- **Process:**
  1. Determine the total width or height based on the selected direction.
  2. Create a new QImage object with the combined dimensions.
  3. Use a QPainter to draw each image in sequence:
    - For horizontal: Offset the x-coordinate by the width of each image.
    - For vertical: Offset the y-coordinate by the height of each image.
  4. Convert the combined QImage to QPixmap for display and saving.
- **Output:** Combined image.

## 9. Thumbnail Generation Algorithm

The application generates thumbnails for quick previews:

- **Input:** Image to be processed.
- **Process:**
  1. Resize the image to 128x128 pixels using QPixmap.scaled().
  2. Save the thumbnail in a predefined directory.
- **Output:** Scaled-down version of the image for preview purposes.

## 10. Blank Canvas Creation Algorithm

Allows users to create a blank canvas of custom size and color:

- **Input:** Canvas dimensions (width, height) and color.
- **Process:**
  1. Use QPixmap() to create a new canvas.
  2. Fill the canvas with the selected color using QPixmap.fill().
  3. Add the new canvas to the image list and display it.
- **Output:** Blank canvas ready for editing.

Each algorithm in Sparky Edits is optimized for efficiency, ensuring that the application remains responsive while providing high-quality results. These algorithms form the foundation of the application's advanced features, making Sparky Edits a powerful tool for photo editing.

### 3.0 STRENGTH AND UNIQUENESS

**Sparky Edits** stands out as a versatile and innovative photo editing application, offering a range of features and capabilities that cater to both novice users and advanced professionals. Its strengths and uniqueness lie in its thoughtful design, advanced functionality, and user-focused approach.

#### 1. User-Friendly Interface

- **Intuitive Layout:** The graphical interface is designed to be clean and straightforward, ensuring users can access tools and features effortlessly.
- **Real-Time Feedback:** Features like previewing crop areas, drawing shapes, and zooming allow users to see their changes before finalizing them.
- **Dynamic Cursor Modes:** The cursor changes according to the active tool (e.g., cross for cropping, I-beam for text), providing clear visual guidance.

#### 2. Advanced Features

- **Comprehensive Editing Tools:** Users can perform essential operations like zooming, rotating, and cropping alongside advanced manipulations such as pixel editing, shape drawing, and text addition.
- **Color Space Conversion:** Sparky Edits supports a wide range of color models (e.g., grayscale, HSV, LAB), enabling users to explore and apply creative effects.
- **Image Combination:** The application allows horizontal or vertical merging of multiple images, making it ideal for creating collages and comparison layouts.
- **Blank Canvas Creation:** Users can start from scratch with a customizable canvas, choosing the dimensions and color to suit their needs.

#### 3. Versatility

- **Multi-Format Support:** The application supports various image formats, including PNG, JPEG, BMP, and GIF, ensuring compatibility with most user files.

- **Pixel-Level Editing:** Sparky Edits provides fine-grained control over individual pixels, enabling precise edits and color adjustments.
- **Secondary Windows:** Users can open images in new windows to explore edits without altering the original file, promoting experimentation and flexibility.

#### 4. Lightweight and Efficient

- **Optimized Performance:** The integration of PyQt5 and OpenCV ensures fast processing of images, even for computationally intensive tasks like rotations and color transformations.
- **Thumbnail Generator:** The automatic creation of thumbnails simplifies image management, allowing users to preview and select images quickly.

#### 5. Customization

- **Text Annotations:** Users can add custom text to images with full control over font, size, color, and position.
- **Shape Drawing:** The ability to draw circles and lines with customizable attributes allows users to highlight or decorate their images.
- **Interactive Cropping:** Cropping is not only precise but also visually guided, giving users control over the selected area.

#### 6. Scalability and Extensibility

- **Modular Design:** The application's layered architecture makes it easy to add new features or modify existing ones without disrupting other components.
- **Real-Time Interaction:** Sparky Edits' seamless integration of GUI and processing ensures a responsive experience, even with complex operations.

#### 7. Unique Selling Points



- **Pixel-Level Precision:** Few editors offer the ability to modify individual pixels, a feature especially valuable for designers and digital artists.
- **Secondary Window Functionality:** Sparky Edits allows users to edit the same image in different contexts, enhancing creative exploration.
- **Versatile Combination Options:** With its ability to merge images horizontally or vertically, Sparky Edits simplifies collage creation and enhances workflow efficiency.
- **Interactive Previews:** Users can visualize their edits, such as crop areas and drawn shapes, in real time before finalizing changes.

## 8. Accessibility

- **Beginner-Friendly:** The application is designed to be intuitive for new users, requiring no prior experience with photo editing tools.
- **Advanced Capabilities:** While accessible to beginners, it also caters to advanced users with features like color space transformations and detailed text customizations.

Sparky Edits is more than just a photo editor; it's a creative toolkit that balances simplicity and power. Its unique features and thoughtful design make it a standout application, offering users the freedom to enhance, personalize, and experiment with their images like never before.

## 4.0 SAMPLE OUTPUT

