Universal Color ↔ Black & White Image Converter

Project Title

Universal Color ↔ Black & White Image Converter using OpenCV

GITHUB LINK →B&W converter

WEBSITE LINK → B&W converter

Introduction

Images play a vital role in communication and documentation. Often, there is a need to convert images between **Color and Black & White** for artistic, printing, or analytical purposes. The **Universal Color ↔ Black & White Converter** is a **web-based application** that allows users to **capture webcam snapshots or upload images**, convert them between **Color and Black & White**, and **download the results instantly**. It is designed to be **simple, fast, and user-friendly**, with a professional and modern interface.

Objective

The objective of this project is to develop a **web-based interactive application** that allows users to:

1. Capture snapshots using their **webcam**.
2. Upload images in **JPG or PNG format**.
3. Convert images between **Color and Black & White (grayscale)**.
4. Download the converted images for personal use.

The application is designed to be **professional, user-friendly, and responsive**, providing a seamless user experience.

Tools and Technologies Used

Tool / Library	Purpose
Python 3.10+	Programming language for app development.
Streamlit	Web framework for building interactive apps easily.
OpenCV	Image processing and color/grayscale conversion.
Pillow (PIL)	Handling image reading, conversion, and saving.

NumPy	Array processing for image manipulation.
BytesIO	In-memory image storage for download functionality.

Environment Setup:

streamlit==1.28.0

numpy==1.25.2

opencv-python-headless==4.7.0.72

Pillow==9.5.0

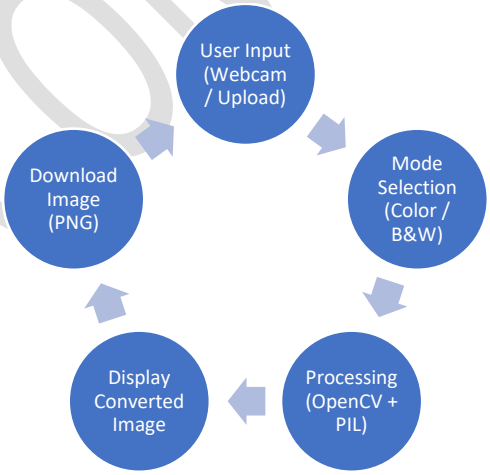
Application Architecture

The application is a **single-page web app** developed using Streamlit.

Components:

1. **Mode Selection:** User chooses between Color or Black & White conversion.
2. **Webcam Snapshot:**
    - The webcam activates only when the user clicks **"Activate Webcam"**.
    - Users can capture a snapshot, process it, and download the result.
3. **Image Upload:**
    - Users can upload JPG or PNG images.
    - The app converts the image based on the selected mode.
    - Users can download the converted image.

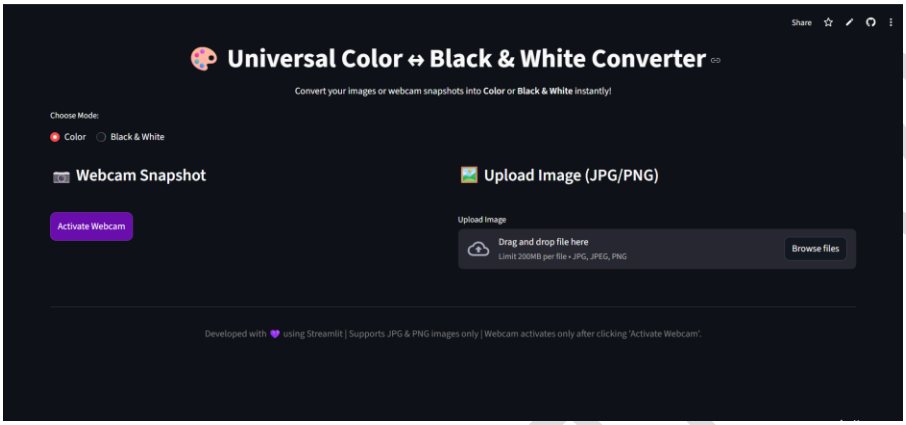
Data Flow:



User Interface Design

The UI is designed for a **professional and modern look**:

- **Two-column layout**:
    - Left: Webcam snapshot
    - Right: Image upload
- **Flat design**: No distracting boxes or cards.
- **Buttons**: Rounded and colored for better visual appeal.
- **Responsive download buttons** for easy saving of images.



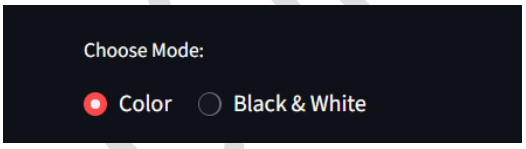
Implementation

Core Functionalities

Mode Selection

```
mode = st.radio("Choose Mode:", ("Color", "Black & White"), horizontal=True)
```

- Allows user to select the desired output format.



Webcam Snapshot

```
webcam_img = st.camera_input("Take Snapshot")

img = Image.open(webcam_img)

if mode == "Black & White":
```

download_img = convert_to_bw(img)

- Uses st.camera_input for webcam.
- Conversion uses **OpenCV** for robust grayscale processing.
- Snapshot is downloaded in PNG format.

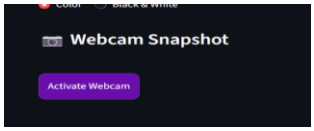


Image Upload

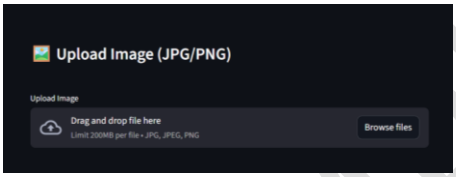
uploaded_file = st.file_uploader("Upload Image", type=["jpg", "jpeg", "png"])

img = Image.open(uploaded_file)

if mode == "Black & White":

download_img = convert_to_bw(img)

- Users can upload any supported image.
- Processed using **Pillow + OpenCV**.
- Download available in PNG format.



Color ↔ B&W Conversion Function

def convert_to_bw(pil_img):

if pil_img.mode != "RGB":

pil_img = pil_img.convert("RGB")

img_np = np.array(pil_img)

gray = cv2.cvtColor(img_np, cv2.COLOR_RGB2GRAY)

return Image.fromarray(gray)

- Converts any image to grayscale efficiently.
- Supports images of different color modes (RGB, RGBA, etc.).

Features

1. **Interactive Mode Toggle**: Color or Black & White conversion.
2. **Webcam Integration**: Activate on demand.
3. **Image Upload**: Supports multiple image formats (JPG, PNG).
4. **Professional UI**: Flat modern dashboard layout, responsive buttons.
5. **Download Feature**: Save converted images instantly.
6. **Efficient Image Processing**: Fast conversion using OpenCV and PIL.

Advantages

- Easy to use with **minimal clicks**.
- Professional **dashboard-like layout**.
- Lightweight and can run **locally or on Streamlit Cloud**.
- Supports **instant download** without saving images on server.
- Safe: **Webcam activates only on click**.

Limitations

- Only **supports JPG and PNG images**.
- Webcam snapshot requires **browser permission**.
- Live mode-switching (Color ↔ B&W) for webcam is **manual** (Process Snapshot button).

Conclusion

The **Universal Color ↔ Black & White Converter** is a **fully functional, professional web application**. It allows users to **capture, upload, and convert images** easily, while maintaining a **modern, interactive, and professional interface**.

The project demonstrates the **integration of Python, Streamlit, OpenCV, and PIL** for image processing in a real-world scenario.

COMPUTER VISION