

## Appendix of Intelligent Photo Retouching with Language Model-Based Artist Agents

### A. Related Work

**Photo Retouching** Automated photo retouching methods can be categorized into end-to-end image processing models and physically inspired models. End-to-end models learn mappings from original to retouched images [6, 11, 12, 24, 32, 33, 77]. They are often confined to patterns present in training datasets and lack interpretability [21, 22, 53]. Physically inspired models frame image enhancement as a parameter optimization/learning problem for physical models [43, 62, 76]. These approaches include methods based on 3D look-up tables [63, 68, 69, 74, 75], parameterized filters [25, 59], and curve-based image adjustments [5, 19, 37–39, 44, 45, 57]. Most relevant to our work are approaches based on reinforcement learning [25, 31, 36, 48, 59]. These methods also attempt to simulate human artists’ photo retouching interactions, decomposing photo retouching into a series of operations and estimating their parameters. Although these methods formally mimic human workflows and offer some transparency in tool usage, they fail to capture the artistic vision inherent in human creative processes and lack deeper user interaction capabilities.

**Language Models and Vision Language Models** Recent advances in Large Language Models (LLMs) have revolutionized natural language processing capabilities [1, 3, 16, 29, 47, 58]. These models, trained on vast text corpora, generate text through next-token prediction. The generated text exhibits knowledge and logical reasoning abilities learned from extensive corpora, demonstrating powerful potential in complex reasoning [35, 64], step-by-step planning [70, 71], and domain-specific knowledge application [23, 46]. Vision language models (VLMs) further connect language generation with multi-modal visual inputs, enabling models to understand images [51] and generate text based on image inputs [1, 13, 14, 34, 42, 72, 73]. LLMs and VLMs are crucial for implementing the system described in this paper for three main reasons. First, these advanced models can engage in intelligent interaction with users through text generation. They can explain current operations and accept user instructions through dialogue. Second, language model training data contain extensive material on photographic aesthetics appreciation, and LLMs excel at leveraging existing corpora for creative output based on input images. Third, LLM-based agents have opened new possibilities for executing complex tasks, which we detail in subsequent sections.

**LLM Agents** An agent is a program built to reach a goal by perceiving its surroundings and engaging with it through the tools at its disposal. These agents are autonomous and capable of operating independently without human intervention, while also adopting a proactive approach in pursuing their goals [18, 40, 67]. Early agent programs primarily relied on symbolic approaches [18] and reinforcement learning [25, 26, 56]. Recent years have witnessed transformative advances through LLM-based agent systems [7, 70]. Unlike traditional reinforcement learning agents, LLM-based agents can maintain explicit long-term plans and leverage extensive general knowledge for flexible problem-solving [1]. This capability has been likened to human cognitive processes, where LLMs’ basic responses parallel System 1 (automatic thinking), while compound agent systems emulate System 2 (deliberate thinking) [30, 41, 71]. Recent work has explored various agent architectures that enhance LLMs’ problem-solving capabilities through structured mechanisms [20, 52, 61]. Notable approaches include tree-based and graph-based search strategies [2, 71], external tool integration [54, 65], memory retrieval systems [49, 79], and error-based learning mechanisms [55, 70]. These agent systems demonstrate promising potential for complex task execution by combining LLMs’ reasoning capabilities with structured problem-solving frameworks [17]. There have also been some pioneering works that have tried to apply the capabilities of LLM agents to solve complex image processing problems [8, 78]. The agent paradigm offers unique advantages for photo retouching tasks.

### B. Additional Discussions

Due to space constraints in the main paper, we provide further discussion on several important aspects here.

#### B.1. Cost

Currently, PhotoArtAgent does not require any dedicated training. Its primary expense comes from calls to large-scale language models. For instance, in over 600 tests conducted using GPT-4o, the total API cost was about \$68.41 – an average of \$0.11 per image. While this is higher than purely end-to-end methods, it remains reasonable given the system’s large-model foundation, interactive features, and demonstrated performance. Moving forward, the cost can be reduced by streamlining the cognitive architecture—keeping only essential information—and by setting limits on the number of reflection steps. Conversely, one could invest in more detailed cognitive processes to achieve greater intelligence at a higher cost.

#### B.2. Run Time

Because our method interacts with Adobe Lightroom via a graphical user interface to perform image operations, a significant portion of the runtime is spent communicating with

Lightroom. A typical run of PhotoArtAgent takes around two minutes: roughly one minute waiting for responses from the language model API, and another minute spent on Lightroom operations. We plan to improve this by employing faster APIs and parallelization strategies.

### B.3. Consistency

Language models operate by predicting the probability of each possible next token in a sequence. When generating text, these probabilities can be used in different ways, resulting in varying degrees of creativity and consistency. A common method is temperature scaling, where a parameter  $\tau$  adjusts how “evenly” the model distributes probability among potential next tokens. A higher temperature makes the probability distribution flatter, increasing the likelihood of less probable tokens and thus introducing more variability. Conversely, a temperature of zero corresponds to greedy decoding, where at each step the model always selects the most probable next token. This results in deterministic, reproducible outputs for a given input. However, it also removes the serendipity that can be valuable in creative processes, where randomness can spark fresh ideas. Hence, the choice of temperature (and other sampling methods, like top-k or top-p sampling) offers a trade-off: reliability and reproducibility on one hand, and diversity and originality on the other. Figure 11 shows examples of this consistency issue.

### B.4. Scalability

Our approach is highly extensible. Although we only explored light adjustments, color adjustments, and Color Mixer HSL adjustments in this study, any tool that supports programmatic access could be integrated. For example, additional Lightroom features could be controlled via the API, or PhotoArtAgent could call upon other automated photo-enhancement models for inspiration. In the future, PhotoArtAgent may even leverage internet resources – for instance, web searches – to further enrich its artistic process. Our work merely serves as an innovative demonstration of how a language-model-based agent can be used for photo retouching and creative tasks. As with building blocks, different language model calls can be combined flexibly to construct increasingly complex and intelligent systems, guided by a thoughtfully designed cognitive architecture.

### B.5. Hallucination of the Language Model

PhotoArtAgent relies heavily on the reasoning and judgment capabilities of large language models. In most situations, the model provides convincing, coherent outputs. However, we have also observed cases of hallucination – instances in which the model generates inaccurate or misleading responses. Hallucination occurs when the model invents information lacking any factual basis or evidence.

Possible causes include flawed or insufficient training data and biases within the model itself.

For the majority of initial parameter selections, our reflection mechanism effectively identifies and corrects errors. Nevertheless, in certain uncommon scenarios, the model remains at risk of producing hallucinations. When this happens, its decisions regarding retouching parameters may become unreliable because it lacks the necessary experience or knowledge for that specific class of images. In such cases, the model might default to a familiar but suboptimal approach.

Figure 10 in our main text illustrates one way to mitigate these issues: by explicitly providing relevant experience and context within the prompt. Our experiments indicate that offering such focused guidance reduces the likelihood of hallucination, improving the reliability of PhotoArtAgent’s outputs.

### B.6. Future Directions

**More Tools** Although our current implementation of PhotoArtAgent primarily focuses on Lightroom’s light adjustments, color corrections, and Color Mixer HSL manipulations, future work can expand its capabilities to cover the full spectrum of photo-editing tools. For instance, more advanced local adjustments such as spot healing, gradient filters, and AI-based object removal could be integrated. Likewise, third-party applications offering specialized retouching or artistic effects (e.g., skin smoothing, background replacement, or style transfer) could be incorporated into PhotoArtAgent’s workflow. By broadening the range of tools accessible to the system, we can further approximate the versatility and creativity of human artists.

**Cooperation with Other Retouching Methods** Beyond incorporating additional tools, PhotoArtAgent can cooperate with other automated or semi-automated retouching methods to achieve a hybrid approach that combines rule-based strategies, deep learning models, and human-like reasoning. For instance, certain steps – such as noise reduction or super-resolution – could be offloaded to specialized neural networks, with PhotoArtAgent subsequently evaluating and refining the outcome based on its higher-level artistic judgment. Similarly, advanced face- or object-recognition algorithms might handle complex segmentation tasks, while PhotoArtAgent focuses on global or stylistic adjustments. This cooperative framework would not only enhance workflow efficiency but also enable a more holistic retouching pipeline where multiple methods dynamically support each other.

**Knowledge Injection** One promising direction for mitigating hallucinations and improving the model’s domain expertise is the injection of external knowledge. For instance,

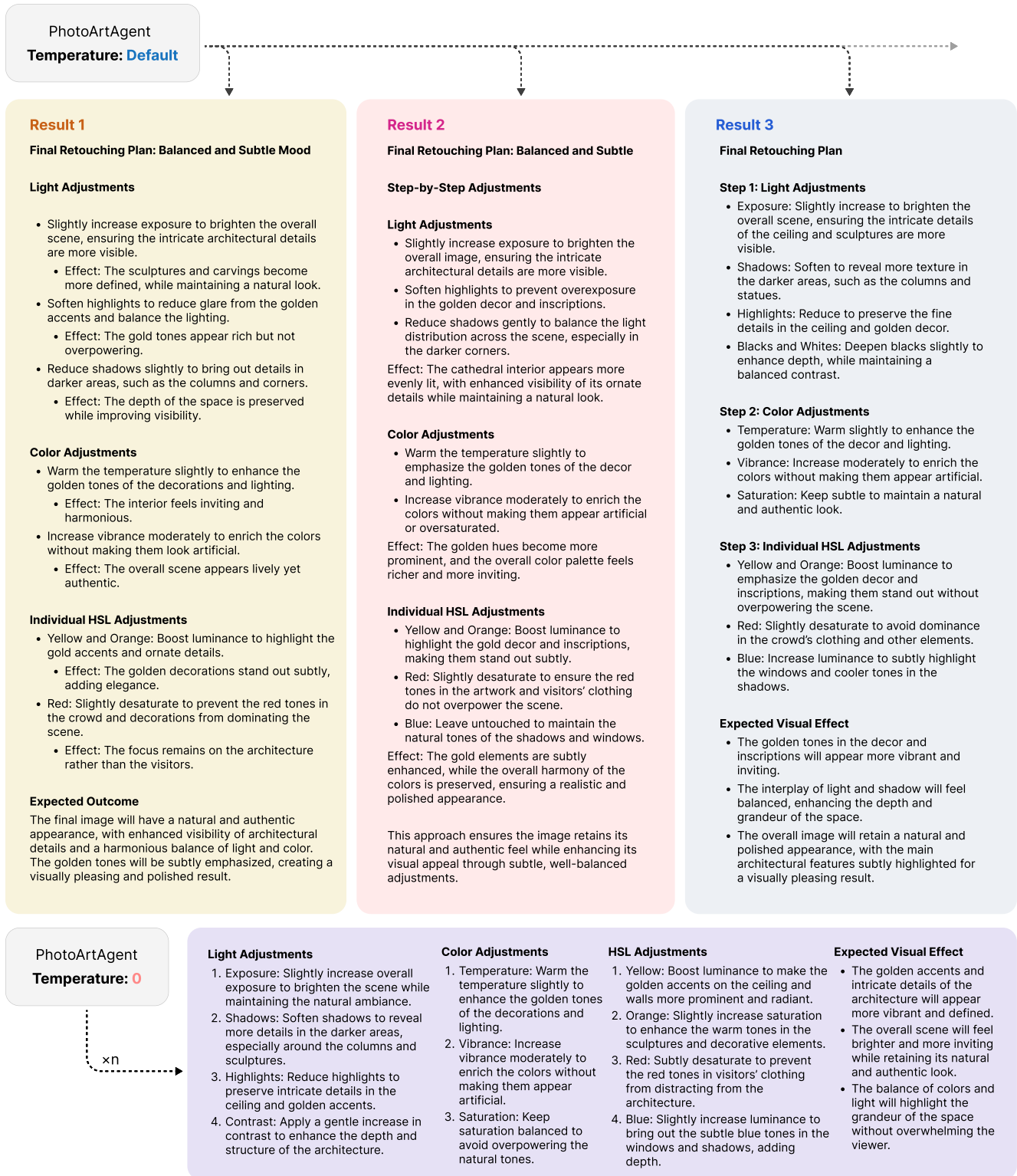


Figure 11. Examples illustrating the impact of temperature on language model outputs. Higher temperatures introduce greater variability and creativity by assigning higher probabilities to less likely tokens, while lower temperatures, such as greedy decoding (temperature = 0), produce deterministic and consistent results.

*Retrieval-Augmented Generation* (RAG) techniques could be employed to equip the language model with references to authoritative databases, user manuals, or style guides. When PhotoArtAgent encounters an unfamiliar scenario – say a specific photography genre or lighting condition – it could query these external sources to gather accurate, context-relevant information before deciding on a course of action. By grounding the model’s reasoning in verifiable facts, knowledge injection helps reduce the risk of fabricating parameters or recommendations. Moreover, domain-specific guidance (e.g., portrait retouching best practices, color-matching rules for specific industries, or even historical art references) can be introduced to further refine the creative process. This approach maintains the flexibility and open-endedness of large language models while improving reliability and depth of expertise.

**Assessment Module** Finally, the design of a dedicated *Assessment Module* could significantly improve the quality and coherence of PhotoArtAgent’s retouching outcomes. Such a module might function as an internal critic or feedback loop, evaluating the aesthetic and technical merits of the current edit. For instance, it could assess image sharpness, color balance, exposure consistency, or even subjective measures of visual appeal through learned aesthetic models. The output of this assessment would guide subsequent retouching iterations or even prompt the agent to explore alternative solutions. By formalizing an assessment stage—potentially powered by a second language-based agent, a classical computer vision algorithm, or a hybrid of both—PhotoArtAgent could not only enhance its self-correcting capabilities but also better adapt to different artistic or technical requirements.

## C. More Results

We provide additional qualitative comparisons in Figure 12 and Figure 13, and we include some complete outputs of our system:

### Example 1



User input image

### Image Content Description

The image portrays an impressive coastal rock formation, featuring beige and brown layered cliffs eroded by natural processes. The foreground showcases horizontal rock strata, and the background reveals more rugged cliffs under a clear blue sky with sparse clouds. The scene has a dry and arid feel, emphasizing the geological textures and colors of the natural terrain.

### Retouching Approaches

#### Approach 1: Balanced Natural Enhancement

- **Light Adjustments:** Slightly increase exposure and contrast for clarity, gently lift shadows, and reduce highlights to preserve sky details.
- **Color Adjustments:** Add subtle warmth to the temperature and slightly boost vibrance to enhance natural tones.
- **Individual Color Adjustments:** Slightly increase luminance for yellows and oranges to emphasize the rock textures and warmth. Minor desaturation of blues for a more neutral sky tone.

#### Approach 2: Cool and Muted Atmosphere

- **Light Adjustments:** Reduce exposure and deepen shadows for a moodier appearance. Lower whites and highlights to tone down brightness.
- **Color Adjustments:** Cool the temperature for a slightly bluish cast, reduce vibrance, and tone down saturation for a subdued aesthetic.
- **Individual Color Adjustments:** Desaturate yellows and oranges slightly for a less

warm look, and enhance cyan and blue luminance for a gentle atmospheric effect.

### Approach 3: Bold and Dramatic Effect

- **Light Adjustments:** Dramatically boost contrast, deepen shadows, and increase whites for a stark, high-contrast effect.
- **Color Adjustments:** Intensify warmth with stronger saturation of earthy tones while keeping the sky vibrantly blue.
- **Individual Color Adjustments:** Amplify saturation and luminance of yellows and oranges to make the cliffs stand out prominently. Slightly darken blues for a deep and striking sky.

Each approach provides a distinct interpretation of the scene, catering to different aesthetic and emotional preferences.

## Final Retouching Approach: Balanced Natural Enhancement

### Step 1: Light Adjustments

- **Exposure:** Slightly brighten the image to bring out details in the cliff and foreground.
- **Contrast:** Increase contrast to emphasize the rock layers and textures.
- **Shadows:** Gently lift shadows to reveal subtle details in the darker rock strata in the foreground.
- **Highlights:** Reduce highlights slightly to retain detail in the sky and softened cloud patterns.

### Step 2: Color Adjustments

- **Temperature:** Warm the scene minimally to enhance the earthy tones of the rock formation.
- **Vibrance:** Add a touch of vibrance to enrich the sandstone hues without overpowering the natural look.

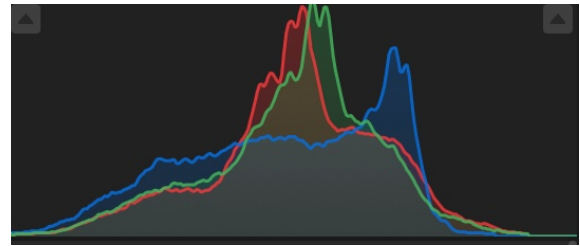
### Step 3: Individual Color Adjustments (HSL)

- **Yellow and Orange:** Slightly increase luminance to highlight the sandstone's layered texture, making it stand out more under soft lighting.
- **Blue:** Decrease saturation marginally to prevent the sky from appearing too saturated, ensuring it remains a supportive background.

### Expected Result

- The cliffs gain a warm and inviting glow, with details in the layered structure becoming more pronounced.
- The sky takes on a soft, subdued appearance, drawing focus to the natural textures of the rocky landscape.
- Overall, the image feels natural and authentic, creating a visually appealing and harmonious composition.

## Histogram Analysis (iteration 1)



Histogram of the input image

The provided histogram indicates a well-distributed tonal range primarily centered in the midtones, with balanced representation of shadow, midtone, and highlight information. The overall tonal range does not suggest significant underexposure or overexposure, as there are no prominent spikes at either extreme of the histogram. The image appears to have a good black point, with the left edge of the histogram tapering off, implying the presence of true blacks but no heavy clipping in the shadows. Likewise, the white point on the far right edge is similarly defined, suggesting that the image avoids highlight clipping and retains detail in bright areas, though increasing brightness might be an option without risking detail loss.

The midtones exhibit a concentrated and broad peak, particularly in the green and red channels, indicating sufficient contrast and depth in this tonal range. However, the blue channel shows a slightly wider distribution across the tonal range, which may result in cooler tones in parts of the image. This variation among RGB channels implies a slight imbalance in white balance, with the potential for the image to lean towards cooler or greenish hues. Red and green peaks dominate, suggesting warmer areas within the image,

while the blue's spread could lead to subtler, cooler elements, affecting overall harmony.

No Sharp or abnormal spikes were observed, meaning the image likely lacks major processing artifacts or harsh transitions. Overall, the histogram shows an image with a naturally balanced tonal range, offering room for slight fine-tuning in both light and color adjustments to achieve the intended aesthetic effect.

## Image Adjustment Parameters (iteration 1)

### Basic Adjustments

Parameter	Value
Exposure	+0.5
Contrast	+20
Highlights	-20
Shadows	+20
Whites	+10
Blacks	-10
Temp (Temperature)	5800
Tint	+5
Vibrance	+25
Saturation	+15

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Orange	0	+10	+10
Yellow	0	+10	+15
Cyan	0	-10	+5
Blue	0	-10	-10

The adjustments aim to bring out the rock formation's warm tones while maintaining the natural blue of the sky. Brightness and contrast adjustments enhance detail and depth, and selective color adjustments improve structure in key elements without over-modifying the scene's natural look.

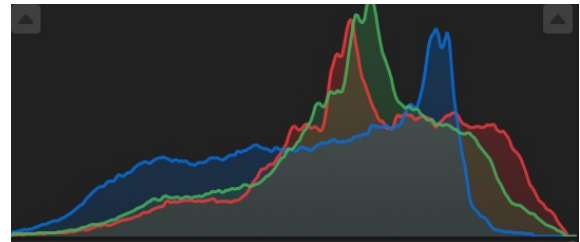


Retouched image (iteration 1)

### Reflection (iteration 1)

**The adjustment is NOT satisfactory.** The adjustments did not fully align with the global style requirements. The highlights remain slightly too strong, causing minor distraction in the rock details. Shadows could be further lifted to clarify darker parts of the image, and white balance adjustment is required to reduce the cooler undertones in select areas of the rocks.

### Histogram Analysis (iteration 2)



Histogram of the retouched image (iteration 1)

The histogram represents a well-balanced tonal range, with a smooth distribution of shadows, midtones, and highlights. There is no significant concentration at either end, suggesting that the image avoids both underexposure and overexposure. The black point on the far-left edge is defined without clipping, implying the presence of natural shadows without losing detail in the darkest areas. Similarly, the white point on the far-right edge is adequately represented, avoiding any extreme high-light clipping and maintaining detail in bright parts of the image. The central

peaks in the red and green channels indicate warm midtones typical of earthy or organic tones, while the wider distribution of the blue channel suggests cooler elements in some parts of the image, potentially lending subtle complexity to the overall color tone. However, the imbalance among channels, with red and green dominating over blue, could slightly shift the white balance towards a warmer or greenish tint. No unusual spikes or gaps are notable, indicating the image's tonal transitions are smooth and free from artifacts. Overall, the histogram suggests an image with a natural tonal range, ready for minor refinements in color balance and contrast to enhance harmony and clarity.

## Image Adjustment Parameters (iteration 2)

### Basic Adjustments

Parameter	Value
Exposure	+0.5 → +0.3
Contrast	+20 → +25
Highlights	-20 → -30
Shadows	+20 → +25
Whites	+10 → +15
Blacks	-10
Temp (Temperature)	5800
Tint	+5 → +8
Vibrance	+25 → +20
Saturation	+15 → +10

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Orange	0	+10 → +15	+10
Yellow	0	+10 → +15	+15 → +20
Cyan	0	-10	+5
Blue	0	-10 → -15	-10

The adjustments aim to emphasize the warmth and intricacy of the rock formation while preserving the natural tone of the sky. Shadows and whites are adjusted to reveal details in darker and brighter areas, and color calibrations enhance the rock and sky contrast harmoniously.



Retouched image (iteration 2)

## Reflection (iteration 2)

**The adjustment is satisfactory.** The adjustments successfully align with the user's requirements, enhancing the warmth and intricate details of the rock formation while maintaining a natural and harmonious look across the entire image. Balance between the tones and colors was achieved, especially in the shadow and sky context.

## Example 2



User input image

### Image Content Description

The image showcases a serene outdoor landscape at dawn or dusk. A prominent tree dominates the right foreground, with its dark silhouette contrasting against a subtle gradient of a pastel-colored sky. The background features scattered smaller trees and bushes, with soft clouds illuminated by warm sunlight. The foreground contains a grassy field in shadow, while the horizon line fades gently into the scene.

### Retouching Approaches

#### Approach 1: Balanced and Natural Mood

- **Light:** Slightly brighten the shadows while maintaining the highlights for a balanced dynamic range. Deepen blacks slightly to preserve the tree silhouette.
- **Color:** Increase vibrance subtly to enhance sky tones without oversaturation. Maintain a neutral-to-warm white balance.
- **Individual Colors:** Enhance Yellow and Orange luminance to emphasize the clouds and the sunlit area. Slightly boost the Blue saturation to enrich the sky.

#### Approach 2: Warm and Inviting Mood

- **Light:** Brighten exposure and soften shadows to evoke a softer, golden-hour effect. Reduce highlights slightly to avoid glare.
- **Color:** Warm the temperature by increasing yellow and red tones. Slightly boost saturation for richer, warm hues.
- **Individual Colors:** Increase Orange and Red saturation and luminance for a glow-

ing sunset effect. Soften Blue tones by reducing their saturation.

#### Approach 3: Bold and Dramatic Mood

- **Light:** Intensify contrast by deepening shadows and brightening highlights. Slightly underexpose the image to accentuate the silhouette effect.
- **Color:** Cool the temperature moderately to create a stark contrast between the sky and tree. Increase vibrance dramatically.
- **Individual Colors:** Boost Blue and Cyan luminance for a vivid sky. Deepen Orange and Yellow tones to create a strong focal point on the clouds. Shift Hue of Blue slightly towards Cyan for an ethereal feel.

### Final Retouching Approach

The image will benefit from a retouching approach combining subtle mood enhancement from approaches 1 and 2. Minor adjustments to light and color will be implemented to balance natural authenticity and visual appeal effectively.

#### Light Adjustments

- **Increase overall exposure moderately** (e.g., +1.5 or more) to enhance visibility in the dark foreground, drawing out subtle details in the grass.
- **Decrease highlights and whites significantly** to balance bright areas and eliminate glare in the sky.
- **Boost shadows and blacks slightly** to reveal texture in darker areas while maintaining the silhouette of the tree.
- **Enhance contrast** to deepen the visual separation of foreground and background elements.

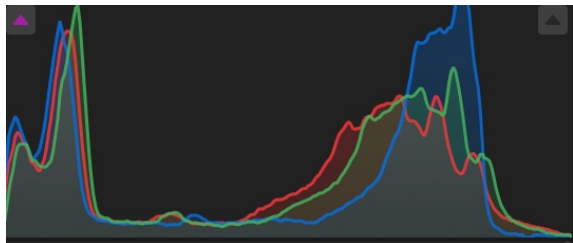
#### Color Adjustments

- **Warm the temperature marginally** to emphasize a golden, soft atmospheric tone without drifting into artificial warmth.
- **Increase vibrance slightly** to enrich the pastel hues of the sky while avoiding dramatic oversaturation.
- **Target Orange and Yellow luminance enhancements** to highlight the glowing edges of the clouds, providing a striking focal point.
- **Boost Blue saturation gently** to accentuate the depth of the sky.

#### Expected Visual Outcome

- The tree silhouette will retain its dramatic and natural look.
- The sky will become more visually appealing with interplay between warm and cool tones.
- The grassy foreground will gain subtle detail and texture, unifying the composition while keeping it understated.

## Histogram Analysis (iteration 1)



Histogram of the input image

The histogram displays a dual-peak distribution with distinct data clustering at both shadows (left side) and highlights (right side), suggesting a contrast-heavy image. There is a strong concentration of blue in the highlights, as indicated by the high peak of the blue channel on the far right, likely contributing a cool tone to the brighter areas. Conversely, the red and green channels demonstrate a relatively balanced distribution, albeit with lower peaks, which may temper the overall vibrancy. The black point appears well-defined with the RGB channels extending fully to the far-left edge, though the elevated peaks in shadows indicate the image may contain crushed blacks, losing some shadow details. Regarding the white point, the histogram reveals a slight dominance of blue in the brightest areas, and little to no clipping is evident, maintaining detail in highlights. This creates a clean tonal range but with a potential cool color cast. Midtones are underrepresented, suggesting reduced tonal depth overall, resulting in a potentially high-contrast image with limited gradation between shadow and highlight areas. For white balance, the dominance of blue, particularly in highlights, signals a cooler image that may lack warmth. Overall, the histogram suggests that contrast adjustments to balance shadow and highlight

details and fine-tuning of color temperature to neutralize the cool cast would improve tonal and color harmony.

## Image Adjustment Parameters (Iteration 1)

### Basic Adjustments

Parameter	Value
Exposure	+1.5
Contrast	+20
Highlights	-60
Shadows	+30
Whites	-35
Blacks	+15
Temp (Temperature)	5500
Tint	0
Vibrance	+15
Saturation	+10

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Orange	0	10	15
Yellow	0	10	20
Blue	0	15	10

These adjustments brighten the image while preserving contrast and detail. Warming the tones slightly enhances the golden-hour effect, and individual color tweaks improve the clouds' glow and sky depth.

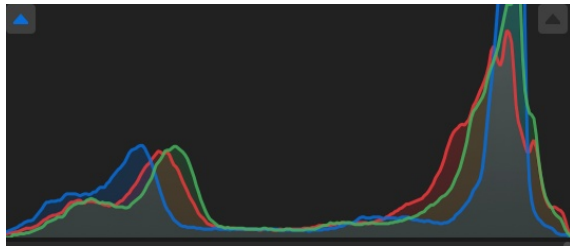


Retouched image (iteration 1)

## Reflection (iteration 1)

**The adjustment is NOT satisfactory.** The current adjustments do not fully satisfy the user's requirements. The image retains a cool tone that conflicts with the warm, visually appealing look intended by the user. Highlights are not sufficiently reduced, which risks minor overexposure in the brightest areas of the sky. Additionally, shadow details remain underrepresented due to crushed blacks shown in the histogram. Midtone adjustments are also insufficient, causing limited tonal depth and overall balance. Suggest warming the temperature further, enhancing vibrance, reducing the highlights by -85, and brightening shadows more to unlock details.

### Histogram Analysis (iteration 2)



Histogram of the retouched image (iteration 1)

The histogram reveals a heavy concentration of tones at both ends of the spectrum, indicating a high-contrast image with a potential lack of midtone details. The black point on the far-left edge is well-defined, showing all three RGB channels reaching the axis, but the elevated clustering in the shadows may suggest crushed blacks, leading to a loss of shadow detail. On the right side, the histogram highlights a strong presence of highlights without evident clipping, signifying intact bright details, though the dominance of the blue channel in this region creates a noticeable cool tone. The underrepresentation of midtones results in an image with stark dynamics but insufficient tonal gradation. The red and green channels are comparably balanced across the tonal range, preventing dramatic color imbalances, but the blue channel's prominence, particularly in highlights, yields a cooler overall hue. For optimal improvements, the tonal range should be broadened

with greater emphasis on midtones, shadows can be lifted to recover texture, and color temperature adjustments can balance the cool tone for a more natural or visually coherent effect.

### Image Adjustment Parameters (Iteration 2)

#### Basic Adjustments

Parameter	Value
Exposure	+1.5
Contrast	+20
Highlights	-60 → -75
Shadows	+30 → +50
Whites	-35 → -40
Blacks	+15 → +10
Temp (Temperature)	5500 → 6500
Tint	0
Vibrance	+15 → +20
Saturation	+10

#### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Orange	0	+10 → +15	+15 → +20
Yellow	0	+10	+20 → +25
Blue	0	+15 → +10	+10 → +15

The parameters are chosen to balance the visible tones while softening the current harsh contrasts. Light adjustments recover shadow detail, minimize highlights, and preserve the silhouetted tree while improving tonal depth. Color modifications enhance sky vibrancy and warmth while retaining its natural appearance and emphasizing subtle orange and yellow cloud details.

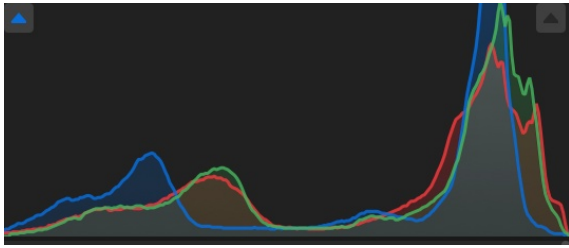


Retouched image (iteration 2)

## Reflection (iteration 2)

**The adjustment is NOT satisfactory.** The current adjustment does not meet the user requirements for a natural-looking and balanced outcome. The overall exposure remains somewhat low, shadow details are still obscured, and tonal balance lacks smooth gradation, as evidenced by the histogram's steep contrast profile. Additionally, the cool tone from blue-dominant highlights conflicts with the user's request for a subtle, natural, and slightly warmer appearance.

## Histogram Analysis (iteration 3)



Histogram of the retouched image (iteration 2)

The histogram illustrates a dual-peak tonal distribution with clusters in both shadow and highlight regions. Shadows are well-defined at the far left, with some risk of crushed blacks due to sharp peaks. Highlights dominate on the far right, especially in the blue channel, which indicates a cool bias in brighter image areas. The midtones appear underrepresented, suggesting reduced tonal depth and a heavy contrast profile. The RGB dominance of blue in the highlights suggests a cool temperature, with red and green balancing the lower tonal areas. Adjustments should focus on recovering midtones, reducing shadow crushing, and mitigating the dominance of cool highlights by slightly warming the color balance for tonal and color harmony.

## Image Adjustment Parameters (Iteration 3)

### Basic Adjustments

Parameter	Value
Exposure	+1.5
Contrast	+20
Highlights	-75 → -70
Shadows	+50 → +30
Whites	-40 → -50
Blacks	+10 → +20
Temp (Temperature)	6500 → 5500
Tint	0 → +10
Vibrance	+20 → +15
Saturation	+10

## Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Orange	0	+15 → +10	+20 → +15
Yellow	0	+10	+25 → +20
Blue	0	+10	+15

The adjustments focus on balancing shadows and highlights to improve visibility while retaining tonal depth, slightly warming the temperature for natural appeal, and enriching the vibrance of the sky to emphasize the interplay of warm and cool tones. The specific orange, yellow, and blue adjustments highlight the luminous clouds and sky depth.



Retouched image (iteration 3)

## Reflection (iteration 3)

**The adjustment is satisfactory.** The adjustments successfully balanced shadows and highlights, maintaining the natural silhouette effect while emphasizing subtle

details in the brighter areas. The color temperature was correctly warmed moderately, blending harmoniously with the sky's gradients and enhancing visual appeal while preserving authenticity.

### Example 3



User input image

### Image Content Description

This image shows a woman with back-facing posture, standing in shallow, greenish-blue water. She is wearing a white tank top and denim shorts, with her hands resting on her lower back and hip. The water surface is filled with floating leaves. The scene is outdoors in natural light, with a tranquil and casual atmosphere.

### Retouching Approaches

#### Approach 1: Subtle and Natural Look

- **Light Adjustments:** Slightly increase exposure and reduce highlights for a softer look. Boost shadows to enhance details in the darker areas of her clothing. Balance whites while increasing contrast moderately.
- **Color Adjustments:** Adjust temperature to retain a neutral tone, slightly enhancing

vibrance for natural hues. Keep saturation balanced.

- **Individual Color Adjustments:** Enhance Green's saturation and luminance to make the water more vibrant. Slightly increase Blue luminance for clarity.

#### Approach 2: Warm and Dreamy Tone

- **Light Adjustments:** Increase exposure for a warmer, airy scene. Reduce contrast and deepen blacks for a softer focus.
- **Color Adjustments:** Warm up the temperature and increase vibrance to make the colors pop. Slightly enhance overall saturation.
- **Individual Color Adjustments:** Shift Green hue towards Yellow for a golden effect. Boost Orange and Yellow luminance for a sunny ambiance.

#### Approach 3: Bold and Dramatic Impact

- **Light Adjustments:** Increase contrast heavily and reduce shadows for high drama. Focus on brightening highlights for sharp contrasts.
- **Color Adjustments:** Cool down the temperature for a surreal feel, significantly increasing vibrance and saturation.
- **Individual Color Adjustments:** Shift Green hue towards Cyan and boost its saturation dramatically. Deepen the blues in shadows and increase Blue saturation and luminance for a vivid, otherworldly effect.

## Final Retouching Plan

### Light Adjustments

- **Exposure:** Slightly lower the exposure overall to maintain a slightly darker and subtler tone while preserving highlights for a natural glow. The white tank top and edges of the subject become more defined without overpowering the environment.
- **Contrast:** Increase slightly to add depth, especially enhancing the separation between the subject and the water backdrop. The denim shorts appear more textured, and water ripples gain definition.
- **Shadows:** Lift the shadows modestly in the subject's hair and darker regions of the clothing. Provides slight detail visibility in shadow areas, ensuring realism.

### Color Adjustments

- **Temperature & Tint:** Keep the color temperature neutral to maintain authenticity while slightly enhancing the vibrance. Increase the vibrance slightly to ensure

the water and leaves look more striking yet natural. Overall colors stay understated, with just enough enhancement to highlight textures.

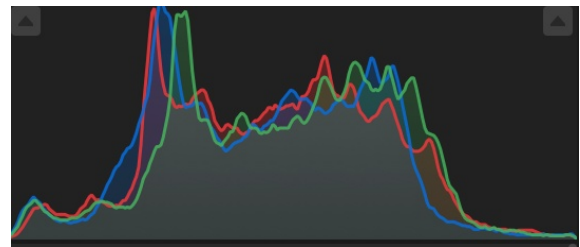
### Individual HSL Adjustments

- **Green:** Boost saturation and luminance. Makes the water appear fresh and subtly vibrant without feeling artificial.
- **Blue:** Slightly increase luminance for gentler tones in water reflections. Smoothens and highlights water surfaces.
- **Yellow/Orange:** Subtly enhance luminance to brighten leaves floating on the surface. Creates more dimensionality and clarity for the foliage.

### Final Visual Outcome

The image retains its authentic, natural allure with slightly more vivid water and enhanced subject detail. The balance of warmer tones in the leaves and cooler water creates a visually harmonious and understated effect.

## Histogram Analysis (iteration 1)



Histogram of the input image

The provided histogram signifies a generally balanced distribution of tonal values, though a few key characteristics emerge. The tonal range stretches across most of the histogram but lacks pronounced extremities. Data clustering on the left edge shows a defined black point with limited shadow clipping, indicating that shadow detail is still preserved. Conversely, the right side of the histogram lacks significant data, revealing an insufficient white point and brightness levels, making the image potentially dull or lacking highlight detail. Midtone data is moderately distributed, with some peaks signifying areas of focused tonal compression, potentially contributing to a perception of limited contrast or tonal depth.

In terms of color balance, the histogram shows discrepancies among the RGB channels. The green channel is more pronounced in the mid-to-shadow range, suggesting a greenish tint overall. The red channel, peaking slightly more in the midtones, hints at a subtle warm hue, while the blue channel remains lower, likely causing a cooler shadow tone. These deviations imply a color imbalance, leading to an image skewed towards cooler greens with reduced warmth or vibrancy in highlights.

Lastly, the histogram lacks extreme spikes or abrupt gaps, showing an overall smooth distribution. The absence of these features suggests minimal processing artifacts but also indicates that the image may lack dynamic tonal variation. Taken together, the histogram reflects subdued contrast and color imbalances that could affect the image's depth and overall harmony.

## Image Adjustment Parameters (Iteration 1)

### Basic Adjustments

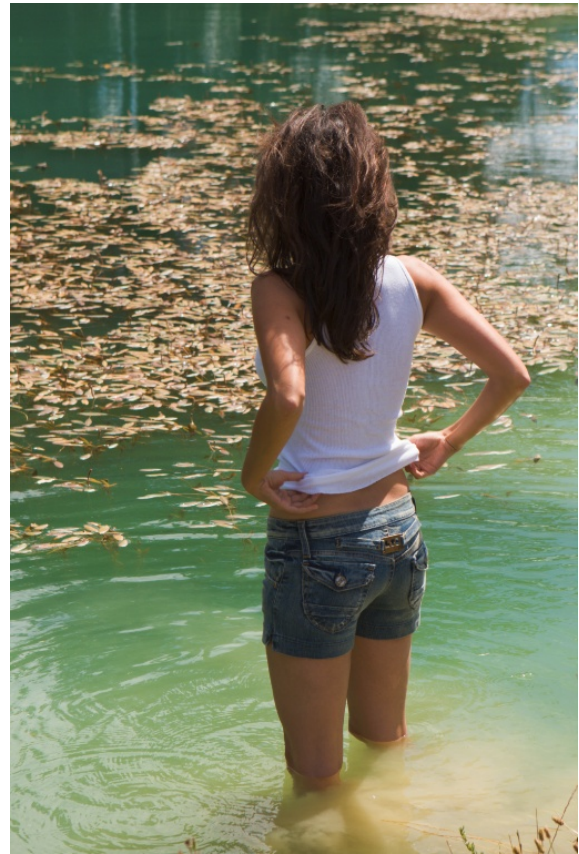
Parameter	Value
Exposure	+0.2
Contrast	+15
Highlights	-20
Shadows	+15
Whites	-10
Blacks	+10
Temp (Temperature)	5700
Tint	+5
Vibrance	+20
Saturation	+10

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Orange	0	+10	+5
Yellow	0	+10	+10
Green	0	+20	+15
Blue	0	+10	+10

This adjustment enhances the overall mood by subtly enriching the natural colors, minimizing harsh highlights, and balancing shadows for detail. The slightly warmer

temperature and vibrance emphasize the greenery and water tones while retaining a calm, authentic look.

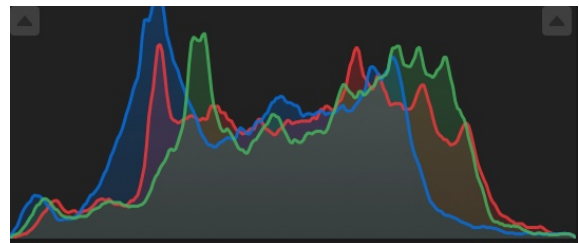


Retouched image (iteration 1)

### Reflection (iteration 1)

**The adjustment is NOT satisfactory.** The current retouching needs improvement due to imbalanced whites and highlights, which cause a slight lack of visual clarity. Adjust whites and increase contrast slightly for improved subject focus and depth, while ensuring natural color harmony is retained.

### Histogram Analysis (iteration 2)



## Histogram of the retouched image (iteration 2)

The histogram shows a generally balanced tonal range, with a few areas requiring attention. The exposure is neither overly high nor low but is moderately placed, suggesting the image has more of a standard lighting balance. The black point is well-defined on the far-left edge, with some data presence, meaning that the shadows are preserved without significant clipping. However, the white point on the far-right edge lacks substantial data, indicating the image could benefit from improved brightness or enhanced highlights to add some vibrancy and depth.

In the midtones, significant clustering is observed, pointing to a compressed tonal range that might contribute to a slightly flat appearance. This indicates insufficient tonal separation and limited contrast, reducing the image's sense of depth and liveliness. As for color balance, the green channel dominates in certain regions, particularly in the midtones, which can give the image a cooler or greenish cast. The red channel offers some warmth but appears less pronounced, whereas the blue channel has moderate peaks and remains neutral in most tonal regions. The color imbalance, with the green channel leading, could affect the overall harmony and visual appeal of the image by leaning it towards cooler tones.

Lastly, the lack of extreme spikes or hard gaps suggests that the tonal range transitions smoothly, indicating no significant processing artifacts. Overall, the histogram hints at a need to brighten the highlights, increase contrast in the midtones, and carefully adjust the color balance to infuse energy and correct tonal flatness for enhanced depth and harmony.

## Image Adjustment Parameters (Iteration 2)

### Basic Adjustments

Parameter	Value
Exposure	+0.2 → +0.3
Contrast	+15 → +25
Highlights	-20 → -25
Shadows	+15 → +20
Whites	-10 → -5
Blacks	+10 → +15
Temp (Temperature)	5700 → 6000
Tint	+5 → +10
Vibrance	+20 → +30
Saturation	+10 → +15

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Orange	0	+10 → +15	+5 → +10
Yellow	0	+10 → +15	+10
Green	0	+20 → +25	+15 → +20
Blue	0	+10 → +20	+10 → +15

The adjustments aim to energize the image by enhancing depth and bringing out vibrant tones in the water and greenery. Increasing brightness, contrast, and shadows adds dimensionality, while the warmer temperature improves harmony and sunlight-like warmth. This provides a natural yet striking outcome suitable for professional quality.



Retouched image (iteration 2)

### Reflection (iteration 2)

**The adjustment is satisfactory.** The left image has been effectively enhanced in the right image by improving contrast, vibrancy, and natural exposure levels. The adjustments achieve user requirements by maintaining realism while enhancing fine details, creating a balanced natural yet pleasing rendering.

### Example 4



User input image

### Image Content Description

This image depicts a sunny, serene scene featuring a charming house with soft yellow walls and pastel blue shutters. It is surrounded by lush greenery, including a tall cypress tree and colorful flowering bushes. In the background, large, dense trees border the property, while the bright blue sky with wispy clouds enhances the tranquil atmosphere.

### Retouching Approaches

#### Approach 1: Balanced and Natural Mood

- **Light Adjustments:** Increase overall brightness slightly and enhance contrast for clarity, softening shadows slightly to retain texture in greenery.
- **Color Adjustments:** Slightly increase vibrance and warmth to emphasize the sunny environment while maintaining natural tones.
- **Individual Color Adjustments:** Boost yellows and greens in luminance and saturation for a lively feel without oversaturation. Bring out the light blue of the shutters gently.

#### Approach 2: Cool and Calm Mood

- **Light Adjustments:** Lower overall exposure slightly, decreasing highlights for a subdued feel, while deepening shadows for added depth.
- **Color Adjustments:** Cool the color temperature to evoke a relaxed ambiance and reduce vibrance for a slightly muted effect.

- **Individual Color Adjustments:** Desaturate greens and yellows lightly to balance the temperature, while enhancing the blue shutters' saturation and luminance for contrast.

### Approach 3: Dramatic and Surreal Effect

- **Light Adjustments:** Increase contrast dramatically, deepen blacks, and brighten whites for a bold composition. Slightly add vignetting.
- **Color Adjustments:** Intensify vibrance and saturation across warm tones (yellows, oranges) for a striking, surreal summer aesthetic.
- **Individual Color Adjustments:** Shift yellow hues slightly toward orange, increase saturation of greens for an almost otherworldly lushness, and emphasize the blues in the sky and shutters for a dreamlike clarity.

## Final Retouching Plan

### Light Adjustments

- Slightly boost overall exposure, maintaining a touch of darkness for understated appeal.
- Increase contrast moderately to bring out details in the house facade and greenery.
- Adjust shadows and highlights to preserve textures in the trees and structure, ensuring the scene remains realistic.

### Color Adjustments

- Warm up the color temperature slightly to emphasize the sunny setting.
- Increase vibrance gently, just enough to make colors pop without feeling artificial.

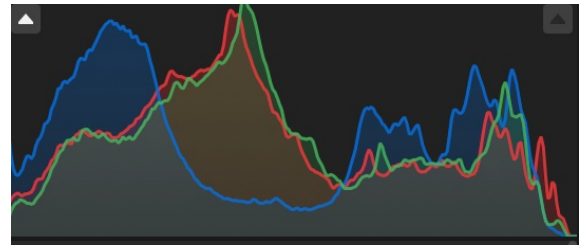
### HSL Adjustments

- **Yellow:** Enhance saturation and luminance to make the house's walls appear slightly more vibrant.
- **Blue:** Brighten and enhance the shutters and sky for a cheerful yet soft appearance.
- **Green:** Boost saturation slightly, emphasizing the lush greenery without oversaturating it.

### Expected Outcome

The image will maintain its authentic and polished look, with slightly enriched colors and refined contrasts that subtly highlight the harmony between the house and its natural surroundings.

## Histogram Analysis (iteration 1)



Histogram of the input image

The histogram presents a relatively even tonal range, slightly favoring midtones and highlights. The distribution shows some peaking toward the brighter and midtone areas (center-right), while shadows (far-left) and blacks are represented lightly, suggesting that the image may lack strong dark tones. This absence of a prominent black point could result in a subdued sense of depth. Conversely, the white point appears mostly intact but without significant data clustering at the far-right edge, indicating that the image isn't overexposed but might benefit from slightly enhanced brightness in highlights. The color balance across the RGB channels suggests a mild imbalance, with the green and red channels somewhat pronounced in the mid-tones and highlights. This could imply a slightly warm and yellowish cast in the image. The blue channel is well-represented but less prominent compared to the green and red, which aligns with a warmer tone overall. Other notable features include some uneven peaks toward the mid and brighter tones in the green and red channels, which might indicate an overemphasis on certain hues of greens and yellows. These could benefit from subtle adjustments to restore harmonious saturation and to prevent saturation clumping. Overall, the histogram reveals an image that leans slightly toward a soft, warm aesthetic but lacks strong tonal depth in the shadows and blacks, limiting dynamic range and contrast.

## Image Adjustment Parameters (Iteration 1)

### Basic Adjustments

Parameter	Value
Exposure	+0.3
Contrast	+15
Highlights	-10
Shadows	+10
Whites	+20
Blacks	-10
Temp (Temperature)	5500
Tint	0
Vibrance	+10
Saturation	+5

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Yellow	0	+10	+15
Green	0	+5	+5
Blue	0	+10	+15

The adjustments aim to maintain the natural and polished look of the image while slightly enriching its vibrancy and depth. The exposure and contrast adjustments enhance clarity, while color temperature helps emphasize the sunny ambiance. Individual color tuning highlights the yellow house walls, lush greenery, and blue sky and shutters without oversaturating.



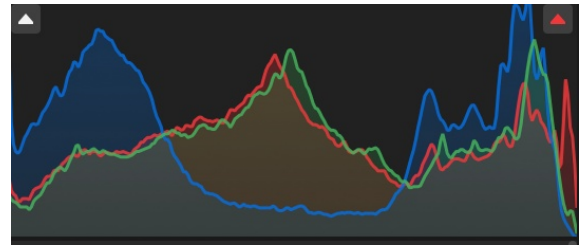
Retouched image (iteration 1)

### Reflection (iteration 1)

**The adjustment is NOT satisfactory.** The original adjustment plan exhibits a warm and pleasant mood; however, the current implementation does not align fully with user requirements. The image lacks sufficient shadow depth as indicated by the histogram,

resulting in reduced overall contrast and a flat appearance. The blue channel is subdued compared to the reds and greens, leaving the image slightly warmer than intended without achieving harmony. Further balancing of colors, an emphasis on enhancing tonal depth, and counterbalancing the yellowish cast in some hues are needed to better meet user expectations. Exposure can remain stable, but highlights could use a slight boost for brilliance.

### Histogram Analysis (iteration 2)



Histogram of the retouched image (iteration 1)

The histogram reveals several key aspects of this image's tonal and color balance. First, there is a moderate-to-high clustering of data in the midtones and highlights, with distinct peaks in the red and green channels, indicating a warm-toned image. The image likely reflects a sunny, well-lit scene dominated by yellows, greens, and possibly muted reds, as these are suggested by the dominant RGB data. However, the blue channel appears underrepresented in both the shadows and highlights, skewing the temperature toward warmth and possibly creating a yellowish cast.

The far-left region of the histogram, representing shadows and blacks, shows a limited presence of deep tones, suggesting the black point is not well-defined. This indicates a lack of rich, deep shadows and could cause the image to feel flat or lack contrast in darker regions. On the other hand, the far-right edge displays adequate data, with no significant highlight clipping, meaning that while highlights are accounted for, they are just at the threshold of sufficient brightness.

Overall, the histogram highlights the following issues: a warm bias in color

temperature caused primarily by stronger red and green channels with diminished blue presence, and a constrained tonal range in the shadows. These factors result in an image that could benefit from enhanced shadow depth and possible cooling of the overall tone for better tonal balance and warmth control. This would lead to improved overall contrast, depth, and color harmony in the scene.

## Image Adjustment Parameters (Iteration 2)

### Basic Adjustments

Parameter	Value
Exposure	+0.3
Contrast	+15 → +25
Highlights	-10
Shadows	+10 → +15
Whites	+20 → +10
Blacks	-10 → -20
Temp (Temperature)	5500 → 5000
Tint	0
Vibrance	+10 → +15
Saturation	+5

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Orange	0	0 → +10	0 → +5
Yellow	0	+10 → +20	+15
Green	0	+5 → +10	+5 → +10
Blue	0	+10 → +15	+15

The adjustments aim to enhance the natural beauty of the image by slightly increasing exposure and contrast to add depth. Shadows and blacks deepen for more contrast, while highlights reduce slight brightness peaking. Warmth and vibrance highlight the sunny look, and specific color adjustments improve the house's walls, greenery, and sky without oversaturation.



Retouched image (iteration 2)

## Reflection (iteration 2)

**The adjustment is satisfactory.** The adjustments successfully enhance the natural appeal of the image, maintaining a realistic tonal balance with a warm yet not overpowering temperature. Shadows are deepened for better dimension, while specific color adjustments bring out the house, greenery, and sky without feeling artificial.

## Example 5



User input image

### Image Content Description

The image showcases a rugged desert landscape featuring a prominent rock formation resembling a solitary spire or pillar on the right. The terrain consists of reddish-brown sand and sparse vegetation, with a backdrop of expansive sky filled with thick clouds. The dark and moody lighting creates a calm yet dramatic atmosphere.

### Retouching Approaches

#### Approach 1: Balanced and Subtle Mood

- **Light Adjustments:** Slightly brighten the image by increasing exposure and highlights while softening shadows to reveal more detail. Add a moderate contrast boost for balance.
- **Color Adjustments:** Warm the temperature slightly to bring out earthy tones. Enhance vibrance gently while keeping saturation natural.
- **Individual Color Adjustments:** Increase the luminance of reds and yellows slightly to emphasize the rock formations. Subtly boost the saturation of blues to enhance the sky.

#### Approach 2: Cool and Serene Desert Scene

- **Light Adjustments:** Focus on a cooler, softer scene by lowering highlights and increasing exposure slightly. Retain some shadow depth for texture.
- **Color Adjustments:** Shift the temperature cooler and lower vibrance slightly for a subdued aesthetic.

- **Individual Color Adjustments:** Muted reds and yellows for less stark rock colors, while blues and cyans are brightened to create an airy, serene look in the sky.

#### Approach 3: Bold and Dramatic Effect

- **Light Adjustments:** Deepen shadows and increase contrast heavily while slightly brightening highlights for an intense, dramatic feel.
- **Color Adjustments:** Intensify warmth for a fiery desert effect by significantly enhancing vibrance and saturation.
- **Individual Color Adjustments:** Amplify reds and yellows for a glowing rock formation. Boost the luminance and saturation of blues to create a vibrant, high-contrast sky against the landscape.

### Final Retouching Plan

#### Step 1: Light Adjustments

- Significantly increase **exposure** (+1.5 or more) to illuminate the overall image, countering the dark surroundings.
- Drastically reduce **highlights** and **whites** to recover sky details and prevent overexposure.
- Enhance **shadows** and **blacks** to bring out rich details in the foreground and rock formations.
- Increase **contrast** moderately to highlight the textures in the rock and terrain.

**Visual Effect:** The sky becomes more defined with visible cloud textures, and the landscape appears brighter and more detailed without losing depth.

#### Step 2: Color Adjustments

- Slightly warm the temperature to enhance earthy tones while ensuring the sky remains natural and inviting.
- Increase vibrance to bring out the richness of the desert colors, while keeping saturation subtle for authenticity.

**Visual Effect:** The reddish hues of the rock formations are more vibrant, complementing the blue tones in the sky for a balanced result.

#### Step 3: Individual HSL Adjustments

- **Reds and Oranges:** Enhance saturation and luminance slightly to make the rock formations stand out with more depth and texture.
- **Yellows:** Boost luminance to highlight the sunlit portions of the landscape.

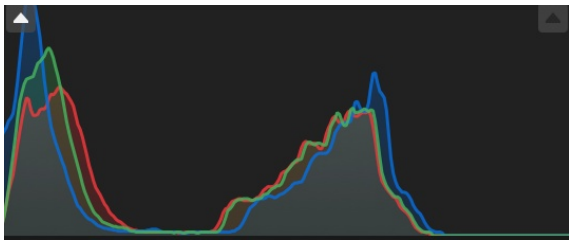
- **Blues:** Brighten and slightly boost saturation to bring out the sky's clarity and create a subtle contrast with the rocks.
- **Greens:** Slightly increase luminance to emphasize vegetation details without overpowering the composition.

**Visual Effect:** The rocks take on a lively, warm tone while the sky and scattered vegetation add harmony without overpowering the natural feel.

### Summary

This approach balances the exposure changes, recovers sky details, and subtly enhances colors to achieve a natural, polished appearance. Each adjustment enhances the scene's realism while maintaining its authenticity.

## Histogram Analysis (iteration 1)



Histogram of the input image

The histogram shows a well-distributed tonal range but with potential areas for improvement. There is a moderate clustering on the far-left indicating adequately defined blacks, although a slight amount of clipping in the shadows is visible, which might cause some loss of detail in the darkest areas. The highlights and whites, represented by the far-right side, appear to be moderately pronounced but not excessively clipped, suggesting that the image retains most highlight details with slight room for brightening in the whites.

The midtones occupy the central portion of the histogram and represent a significant portion of the tonal range, showing a balanced exposure overall. The image likely has a mix of bright and dark elements with a mild leaning towards a low-key aesthetic, which may enhance mood but could also benefit from a slight lightening overall.

Color channels (red, green, and blue) exhibit alignment in mid and highlight regions, indicating good overall white balance and no significant color cast. However, the peaks in the red channel, particularly in shadow areas, may indicate a slightly warm tone in darker regions. The blue channel has a more distinct peak in highlights, suggesting cooler tones dominate in brighter areas of the image. Balancing these variations could bring a more harmonious and natural feel.

Overall, the histogram suggests a balanced image; however, minor adjustments such as reducing shadow clipping, enhancing midtone brightness, and ensuring harmony across color channels would elevate its visual appeal while retaining detail.

## Image Adjustment Parameters (Iteration 1)

### Basic Adjustments

Parameter	Value
Exposure	+1.5
Contrast	+20
Highlights	-60
Shadows	+50
Whites	-20
Blacks	+30
Temp (Temperature)	7000
Tint	+10
Vibrance	+30
Saturation	+10

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Red	0	+15	+10
Orange	0	+20	+10
Yellow	0	+10	+10
Green	0	0	+5
Blue	0	+10	+15

The image needs significant brightening and saturation to bring out warm, earthy tones of the desert and details in the cloudy sky. Adjustments aim to balance light and color while ensuring the image maintains natural aesthetics.



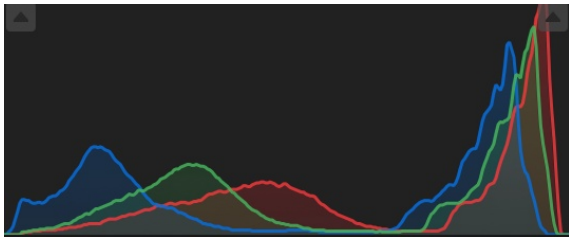
Retouched image (iteration 1)

## Reflection (iteration 1)

**The adjustment is NOT satisfactory.**

The current adjustment needs improvement. While the image appears brighter and highlights the landscape, shadow clipping occurs in darker areas, reducing detail as seen on the histogram's left side. Whites and the warm tones are overemphasized, leading to color imbalances and deviating from the natural aesthetic user preference. Suggest reducing reds and yellows, improving blue tones, softening blacks, and increasing midtone illumination.

## Histogram Analysis (iteration 2)



Histogram of the retouched image (iteration 1)

The histogram reveals a distinct tonal distribution, crucial for adjusting the image's light and color. Starting with **exposure and tonal range**, there is substantial data concentrated on the brighter end, particularly in the highlights and whites, as evident from the right-edge clustering. This prominence suggests an overall bright image with minimal under-exposure issues. However, slight upward

clipping in the bright areas points to a potential loss of detail in highlights, which, if unmanaged, could diminish subtle textures. At the opposite end, the shadows and blacks show a controlled presence, indicating no black clipping and a preserved shadow detail, underpinning the image's overall depth.

In terms of **white balance** (temperature and tint), clear channel imbalances are visible: the red and green channels peak more substantially than the blue channel, particularly in the midtone and highlight ranges. This dominance implies a warmer tone within the image, likely skewing toward yellows or earthy reds. The blue channel, comparatively subdued, highlights a deficiency in cooler tones, which could disturb color harmony if not intended.

Other noteworthy features include the lack of sharp spikes or erratic gaps, pointing to a naturally graduated tonal distribution. Still, the histogram demonstrates inefficiencies in balancing cool and warm tones, which could be remedied while preserving overall depth and tonal structure. Overall, the image stands well in brightness and dynamic range but could benefit from rebalancing for color neutrality and slightly adjusting highlight preservation for improved clarity and texture retention.

## Image Adjustment Parameters (Iteration 2)

### Basic Adjustments

Parameter	Value
Exposure	+1.5
Contrast	+20 → +25
Highlights	-60 → -50
Shadows	+50 → +40
Whites	-20
Blacks	+30 → +20
Temp (Temperature)	7000 → 5500
Tint	+10
Vibrance	+30
Saturation	+10

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Red	0	+15	+10
Orange	0	+20	+10 → +15
Yellow	0	+10	+10 → +20
Green	0	0 → +5	+5 → +15
Blue	0	+10	+15 → +20

This approach aligns with the strategy to brighten the image, recover detail in the sky, and enrich the natural tones of the desert scene. Adjustments maintain the earthy warmth while enhancing vibrance and clarity, carefully balancing the dominant reds and yellows with cooler blues for cohesion.

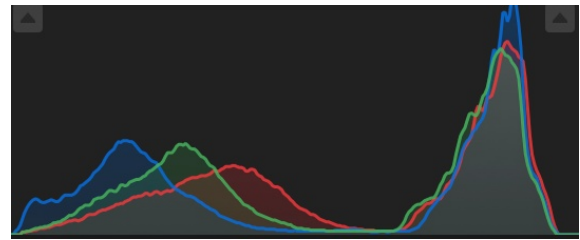


Retouched image (iteration 2)

## Reflection (iteration 2)

**The adjustment is NOT satisfactory.** The adjustments need improvement. The histogram reveals that highlight clipping persists, leading to loss of detail in the brightest areas, particularly in the sky. Additionally, the warmed tone dominates too strongly due to the subdued blue channel, disrupting color harmony. Recommend further reducing highlights, increasing black depth for contrast, and correcting the blue channel balance to better align with the intent.

## Histogram Analysis (iteration 3)



Histogram of the retouched image (iteration 2)

The histogram reveals a tonal distribution significantly skewed toward the highlights, indicating an image with a high-key leaning and prominent bright tones. There is an evident clustering toward the far-right edge in the histogram, particularly in the blue channel, suggesting possible highlight clipping, which risks losing detail in the bright areas. The left section shows no significant data clipping, meaning the shadows and true blacks are preserved, but there might be an opportunity to deepen blacks slightly for enhanced depth and contrast.

The RGB channels reveal imbalances, with the red channel peaking more prominently across the midtones and highlights, followed by green, while the blue channel is slightly subdued. This results in an overall warmer tonal bias, leaning toward yellows and diminishing the balance with cooler tones. The overlapping spikes in the highlights for all RGB channels indicate contributions to brightness and a clustered tonal range but may need further refinement to prevent oversaturation or excessive warmth.

Overall, the histogram suggests a bright and warm image, albeit with limited tonal depth and potential oversaturation in highlights. Enhancing shadow depth, balancing midtones, and adjusting the blue channel to cool down the warmth slightly could ensure a visually cohesive and balanced outcome.

## Image Adjustment Parameters (Iteration 3)

### Basic Adjustments

Parameter	Value
Exposure	+1.5 → +1.2
Contrast	+25 → +20
Highlights	-50 → -60
Shadows	+40
Whites	-20 → -30
Blacks	+20 → -20
Temp (Temperature)	5500 → 5700
Tint	+10 → 0
Vibrance	+30
Saturation	+10 → +15

the foreground. Shadows and blacks have added depth without overpowering vibrancy, while the enhancements to the blue channel resolved the slight tonal imbalance, creating a harmonious and realistic desert aesthetic.

### Color Adjustments (HSL)

Color	Hue	Saturation	Luminance
Red	0	+15	+10
Orange	0	+20 → +10	+15
Yellow	0	+10	+20
Green	0	+5	+15 → +10
Blue	0	+10	+20

The adjustments aim to brighten the foreground, recover sky details, and slightly warm the image while retaining natural vibrancy. Individual hues and luminance are refined to emphasize the rocks, deepen sky tones, and subtly enhance vegetation to align with the original desert mood.



Retouched image (iteration 3)

### Reflection (iteration 3)

**The adjustment is satisfactory.** The adjustments have enhanced the image significantly by balancing the tonal range, recovering sky details, and brightening

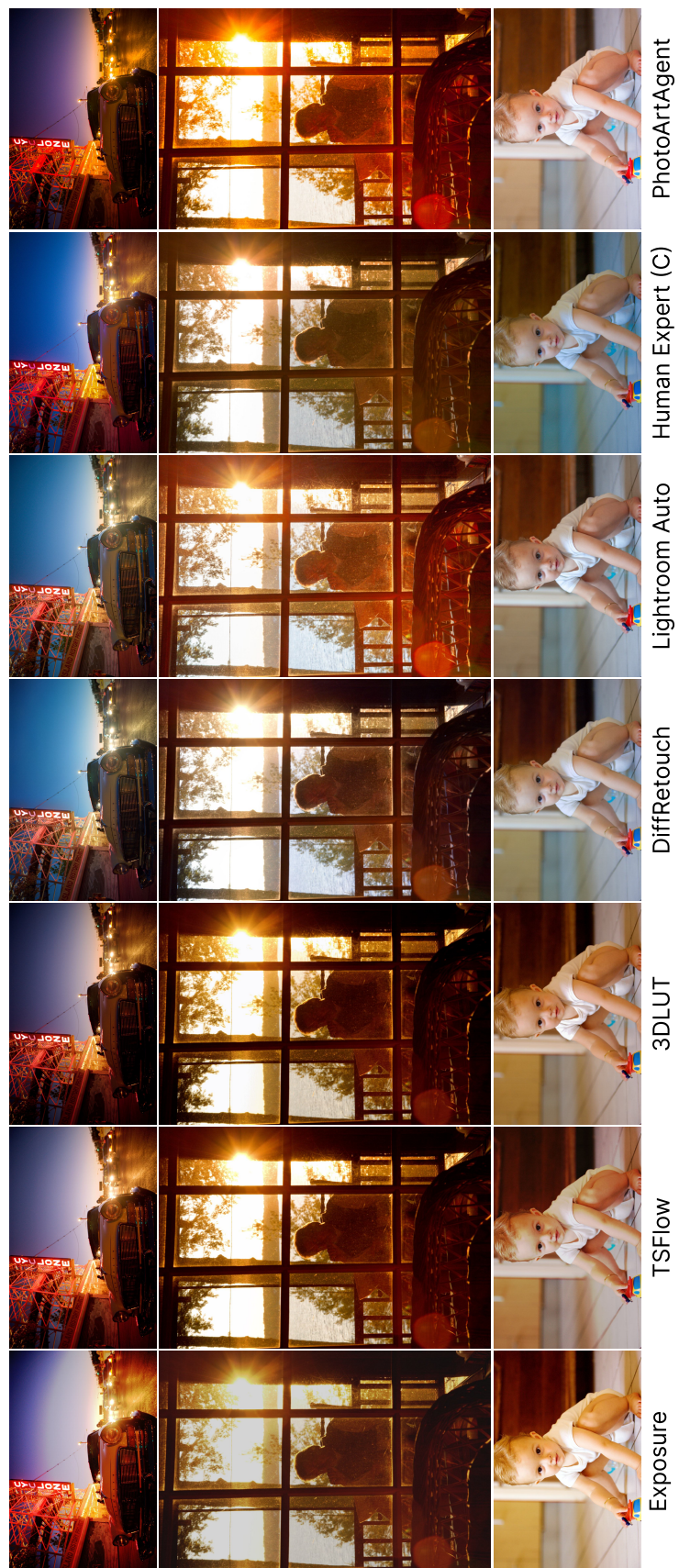


Figure 12. Visual comparison of retouching results across different methods.

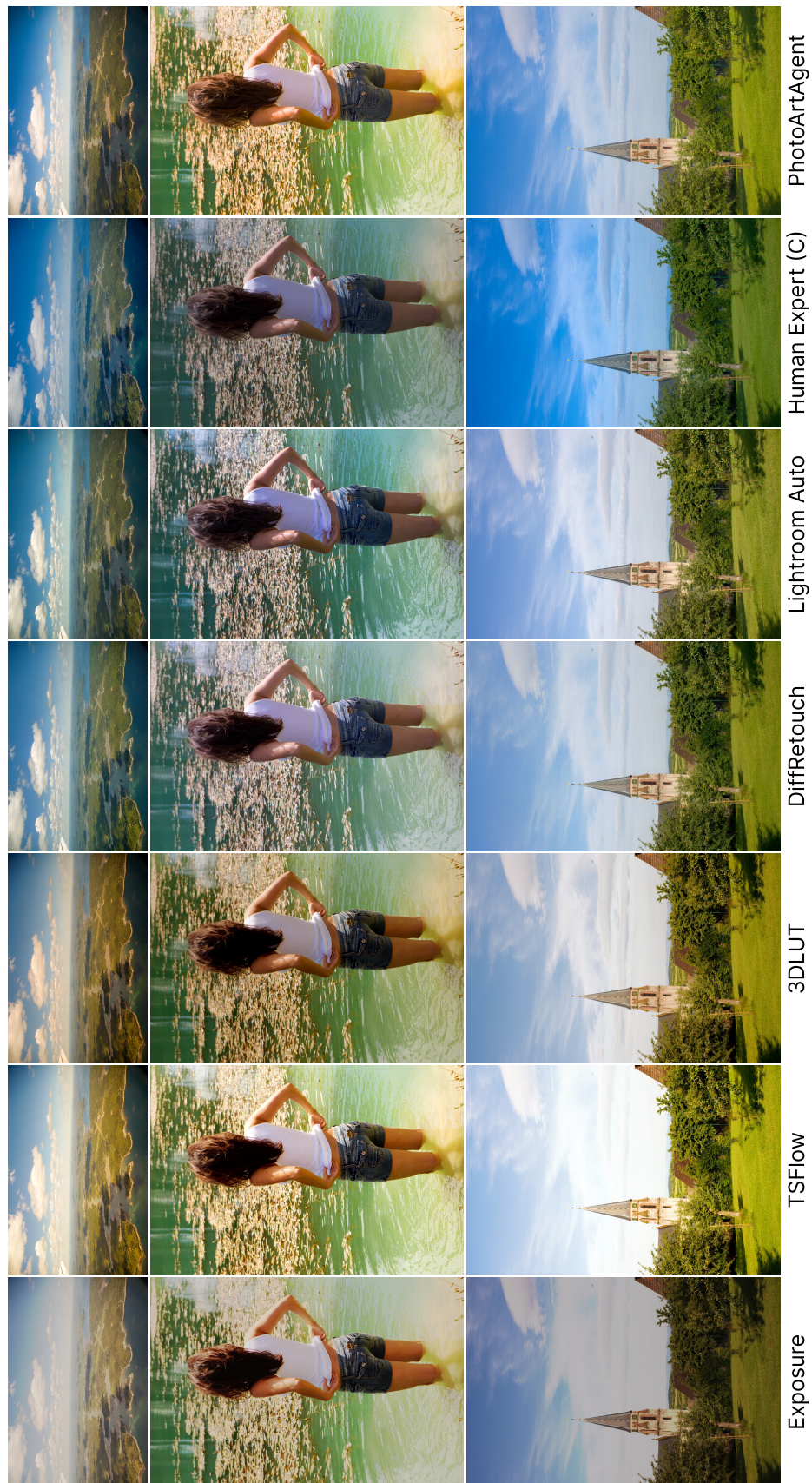


Figure 13. Visual comparison of retouching results across different methods.