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CS 499: Computer Graphics

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## **Assignment 2: Synthesis**

The world of image editing has seen countless advancements, empowering individuals to manipulate and create visual content with ever-increasing ease and sophistication. One such innovation is PatchMatch, a groundbreaking algorithm introduced in the 2009 SIGGRAPH paper "PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing." This technique, developed by Connelly Barnes, Eli Shechtman, Adam Finkelstein, and David B. Goldman, revolutionized the way we approach image editing by offering a fast and versatile method for tasks like inpainting, content transfer, and image reshuffling.

At the heart of PatchMatch lies the concept of patch correspondence. Imagine dividing an image into small, square patches. PatchMatch seeks to find corresponding patches within the same image or a different image that share similar visual characteristics. Traditionally, finding the best match involved an exhaustive search, which could be computationally expensive and time-consuming. PatchMatch, however, breaks free from this limitation by introducing a randomized approach.

The algorithm starts with random guesses for patch correspondences. It then iteratively refines these guesses by considering the local structure of the image. This means that PatchMatch not only looks for patches with similar colors and intensities but also takes into account the surrounding pixels and their relationships. Through several iterations, the algorithm progressively improves the accuracy of its initial guesses, ultimately converging upon a set of approximate nearest-neighbor correspondences between patches.

The brilliance of PatchMatch lies in its computational efficiency. By leveraging randomization, it avoids the need for a comprehensive search, making it significantly faster than traditional techniques. This speed allows for interactive editing, enabling users to see the results of their modifications in real-time. Additionally, PatchMatch's versatility extends beyond just speed. The algorithm can be adapted to various image editing tasks by incorporating user-specified constraints. For instance, while inpainting

missing regions, users can guide PatchMatch by providing information about the desired content or excluding specific areas from the search process.

One of the most widely known applications of PatchMatch is image completion, also known as inpainting. Imagine a photograph with an unwanted object obscuring a beautiful landscape. PatchMatch can effectively "fill in" the missing region by searching for similar patches from surrounding areas or a reference image. This process seamlessly blends the newly synthesized content with the existing image, resulting in a visually consistent and aesthetically pleasing outcome.

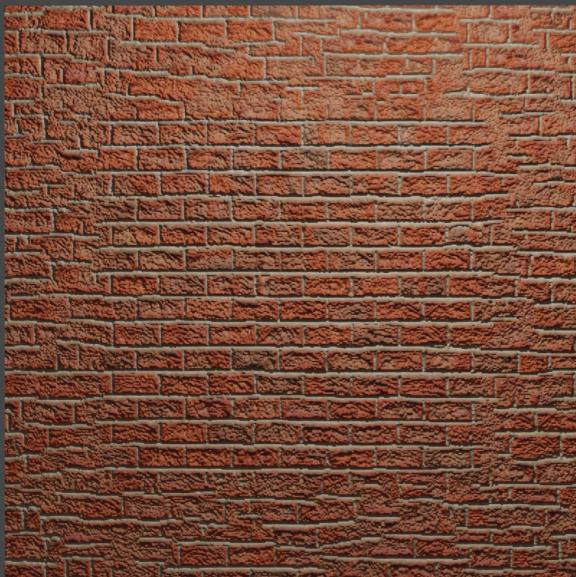
Another compelling application is image reshuffling. This technique allows users to manipulate the content of an image by rearranging or removing specific elements. PatchMatch plays a crucial role in this process by identifying corresponding patches and propagating the changes throughout the image while ensuring coherence and maintaining the overall structure. This capability empowers users to creatively experiment with image composition and achieve artistic effects.

PatchMatch's reach extends beyond simple image manipulation. It even finds applications in texture transfer, an exciting technique that allows users to transfer the texture from one image to another. Imagine taking the bark texture from a tree and seamlessly applying it to the surface of a building in your photograph. PatchMatch facilitates this process by finding corresponding patches between the two images and adjusting them to ensure a visually plausible transfer of texture information.

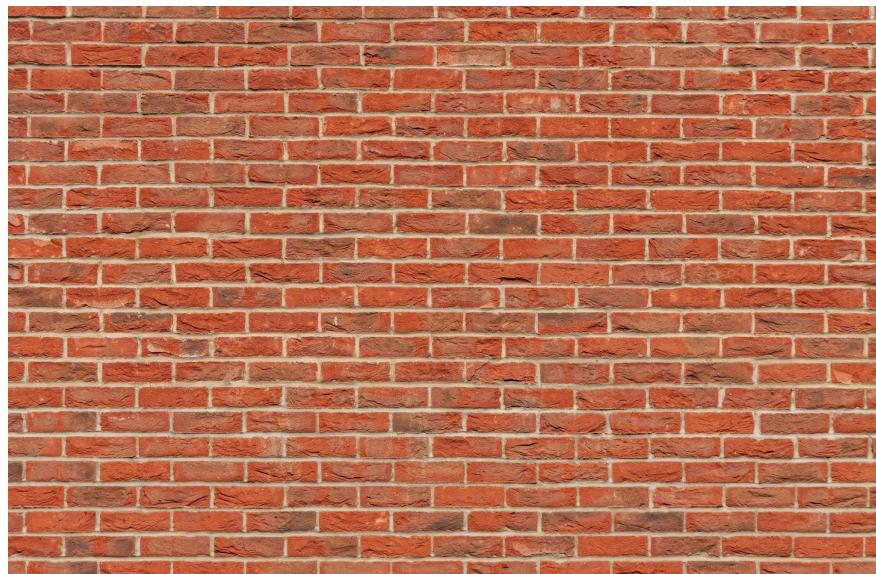
While PatchMatch offers remarkable capabilities, it is essential to acknowledge that it is not without limitations. The algorithm relies on finding good enough, not necessarily perfect, matches. This can lead to imperfections in the final edited image, particularly in scenarios with complex details or drastic content changes.

Despite these limitations, PatchMatch remains a transformative contribution to the field of image editing. Its innovative approach to finding patch correspondences, coupled with its efficiency and versatility, has opened up new possibilities for image manipulation and creative expression. As research continues to explore and refine algorithms like PatchMatch, we can expect even more exciting advancements in the way we interact with and modify visual content in the future.

**Patterned Input: Bricks**



Synthesized Render

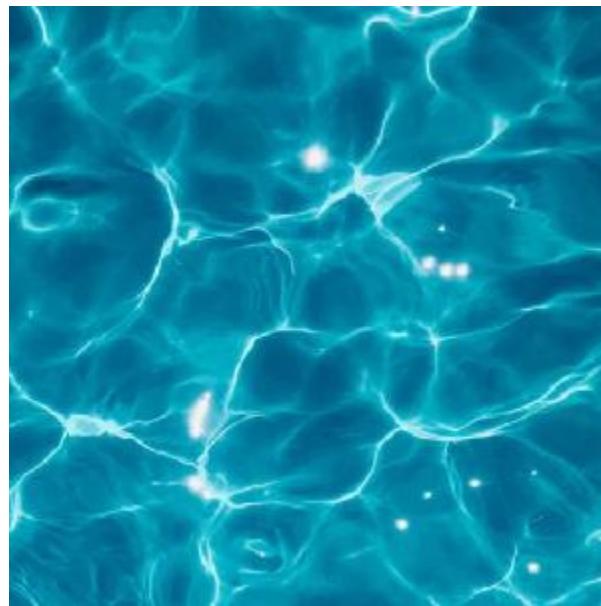


Original Image

**No-Pattern Input: Water**

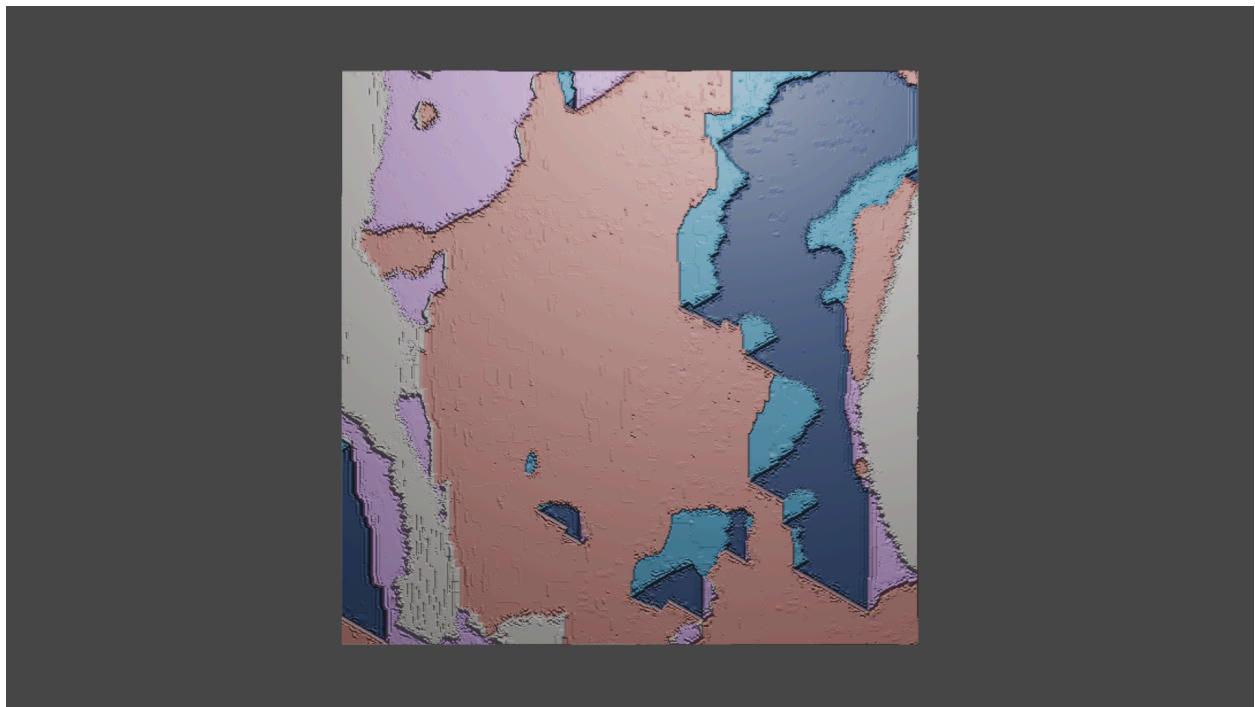


Synthesized Render

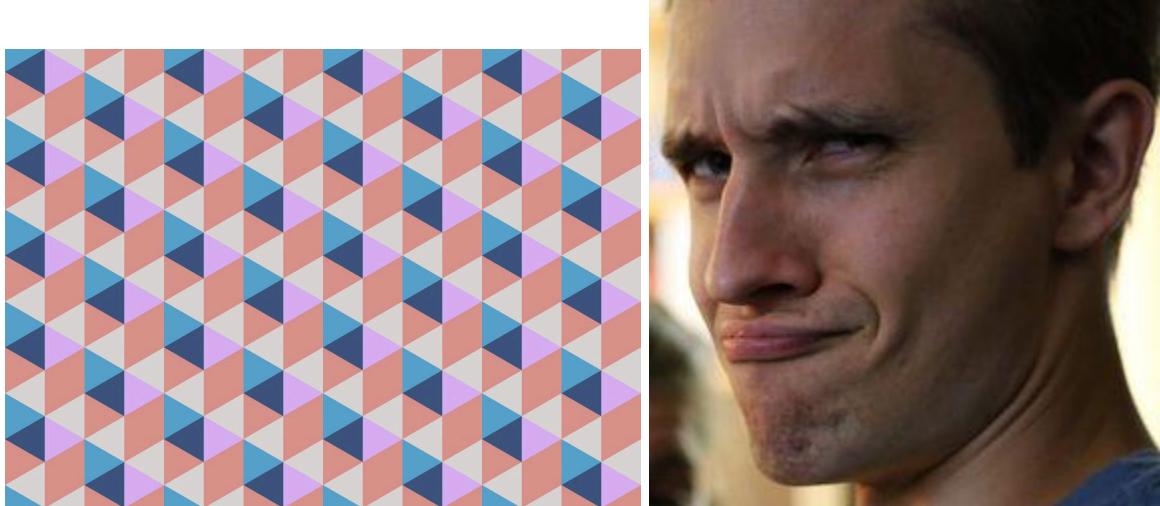


Original Image

**Research Input: Hatching Pattern & Male Face**

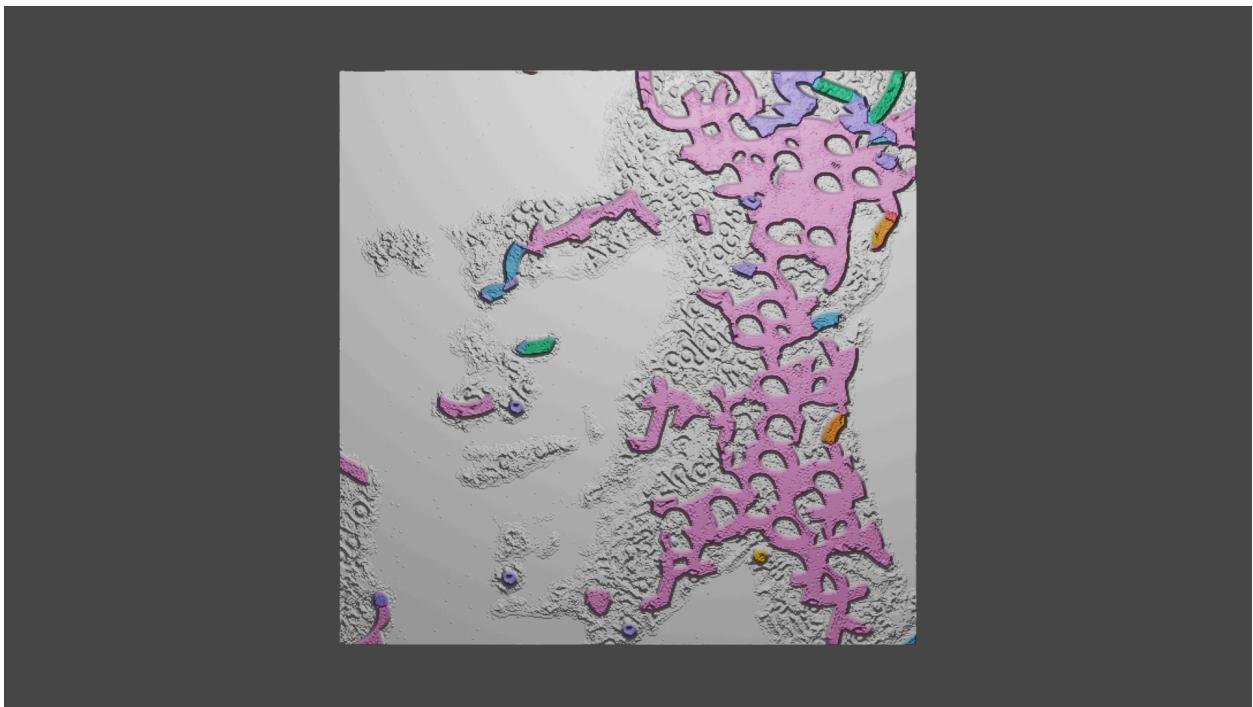


Synthesized Render

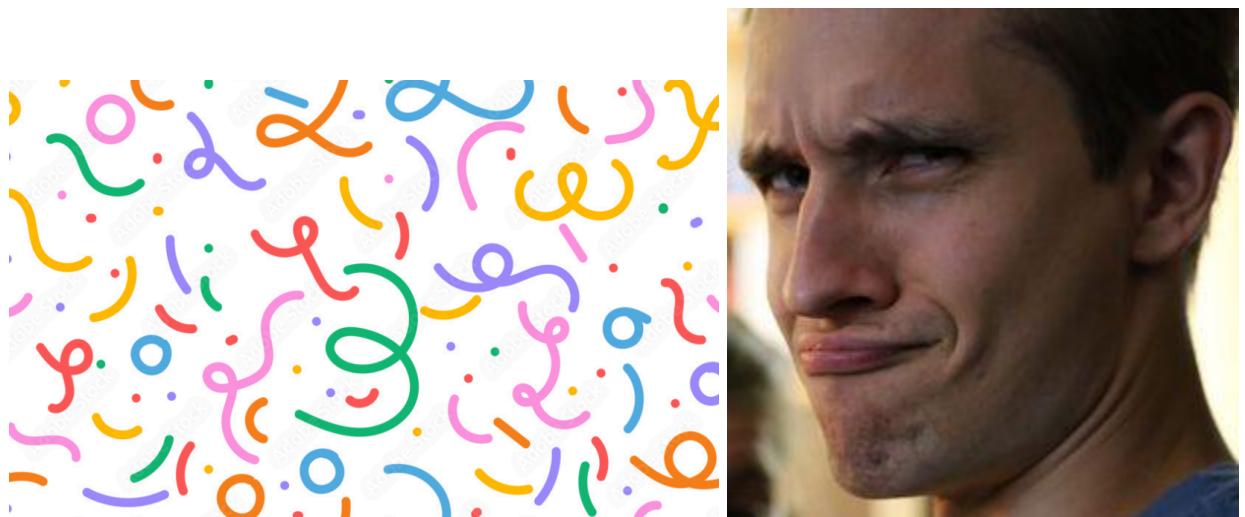


Original Images

**Research Input: Scribbling Pattern & Male Face**



Synthesized Render



Original Images

While I wanted to try and map the textures on more complex geometry, I ran out of time and thus had to use a plane.