Paper 1: "Parallel Style-Aware Image Cloning for Artworks"
Paper 2: "Coordinates for Instant Image Cloning"

The primary paper I chose is "Parallel Style-Aware Image Cloning for Artworks" it is published in "IEEE Transactions on Visualization and Computer Graphics" journal by Yandan Zhao and Xiaogang Jin and Yingqing Xu and Hanli Zhao and Meng Ai and Kun Zhou in February 2015.
The secondary paper I chose is "Coordinates for Instant Image Cloning" published in "ACM transactions on graphics" journal by Z. Farbman, G. Hoffer, Y. Lipman, D. Cohen-Or, and D. Lischinski in march 2009.

The abstract of the **secondary paper** states that Seamless cloning of a source image patch into a target image is an important and useful image editing operation, which has received considerable research attention in recent years. This operation is typically carried out by solving a Poisson equation with Dirichlet boundary conditions, which smoothly interpolates the discrepancies between the boundary of the source patch and the target across the entire cloned area. In this paper, we introduce an alternative, coordinate-based approach, where rather than solving a large linear system to perform the interpolation, the value of the interpolant at each interior pixel is given by a weighted combination of values along the boundary. More specifically, our approach is based on Mean-Value Coordinates (MVC). The use of coordinates is advantageous in terms of speed, ease of implementation, small memory footprint, and parallelizability, enabling real-time cloning of large regions, and interactive cloning of video streams. We demonstrate several applications and extensions of the coordinate-based framework.

In this paper, the authors introduce a new, coordinate-based approach that performs seamless cloning, as well as many other related operations in a direct manner, without ever having to form and solve systems of equations. Our approach is fast, straightforward to implement, and features a small memory footprint. The bulk of the computation may be performed completely in parallel, making it an ideal candidate for a GPU implementation. Recently, there has been significant interest in using generalized barycentric coordinates for solving transfinite interpolation problems. In his seminal paper, Floater [2003] introduced the Mean-Value Coordinates (MVC) which are motivated by the Mean-Value Theorem for harmonic functions. These coordinates approximate a harmonic-like solution to the boundary interpolation problem. They are well defined over the entire plane for arbitrary planar polygons without self-intersections, smooth (C^{∞}, except at the polygon vertices where they are C^0), and invariant under similarity transformations. MVC coordinates have also been extended to 3D polyhedral and used for space deformation. In this work, we explore the novel use of MVC as a computationally attractive alternative for solving the Poisson equation in certain image editing tasks.

Given the speed of MVC cloning, it is only natural to consider applying it to seamless cloning of video. Seamless video cloning has been attempted before by Wang et al. [2004], by forming and solving a 3D Poisson equation over the entire 3D space-time volume of the video. Since our goal is to clone interactively, while both the source clip and the target video are continuously playing, we opt instead for a frame-by-frame solution, with temporal smoothing between consecutive interpolating membranes to ensure temporal coherence. In this current implementation, the shape of the source video patch and its position in the source video frames are kept fixed. We store with each mesh vertex (in addition to its MVC coordinates) a set of its membrane values in the last k frames. To form a membrane for the current frame we compute a weighted average of these values, with the weights of older frames decaying with time: $\Delta t^{-0.75}$, where Δt is the distance in frames between the current frame and the older one. However, for seamless results the membrane must respond quickly to changing discrepancies between the source and the target along the boundary. Thus, the weight of older membranes in the temporal averaging is further reduce at vertices near the boundary (by a factor of 2^{-d}, where 'd' is the normalized distance of a vertex to the boundary).

One limitation of this approach is that it is not applicable to every scenario where the Poisson equation might be used, as it relies on the ability to decompose the solution into a sum of a smooth interpolating membrane and a known function. Thus, we do not currently see a way of applying it to tasks such as gradient domain HDR compression or Poisson cloning with mixed gradients, where the resulting guiding field is not conservative.

The primary paper presents a style-aware image cloning, a novel image editing approach for artworks, which allows users to seamlessly insert any photorealistic or artificial objects into an artwork to create a new image that shares the same artistic style with the original artwork. To this end, a real-time image transfer algorithm is developed to stylize the cloned object as per distance metric based on the artistic styles and semantic information. Several interactive functions, such as layering, shadowing, semantic labeling, and direction field editing, are provided to enhance the harmonization of the composite image. Extensive experimental results demonstrate the effectiveness of this method.

Most of recent works (e.g., Poisson image editing and seamless image cloning) have focused on solving the color discrepancies between the source object and target background along the cloning region boundary. While these algorithms can generate good results for real world images, they may create undesirable results for artworks, especially if the source and target regions are of inconsistent visual styles. Some methods can be used to correct the texture inconsistency between the source and target using multi-scale techniques and patch-based synthesis. However, when inserting an object into an artwork, these methods may still suffer from artifacts because objects and textures in the source and target are too different. To solve the above problem, texture transfer techniques can be used to stylize the photo to match the artistic style of the artwork. However, discoloration artifacts may exist by using these methods because the semantic information of the cloned object is not explored. Moreover, when editing an artwork, system responsiveness is essential. It is noticed that the above-mentioned methods use a scan-line order to perform texture transfer, and are not suitable for a fast-parallel implementation.

The main contributions of this paper are twofold. First, it introduces a novel image editing framework for seamlessly cloning an object from a source image into a target artwork so that the composite looks harmonious with consistent color, luminance, and internal texture. Second, it develops a new distance metric function which takes into consideration the luminance, texture, direction, local coherence, and semantic information of images, and solve it via a new parallel algorithm on the GPU to achieve real-time performance.

The framework in this paper takes an artistic image A and the objects O to be cloned as input, and generates a resultant image R with the user-desired objects cloned. The approach begins with a preprocessing step which tries to match the hue and the lightness of the photographic objects to the artwork. We decrease the ambient difference between O and A by histogram matching and reduce the number of O's distinct colors by bilateral filtering and luminance quantization. Because the colors of O and A can be quite different, A may not always contain enough data to match O using RGB channels. Hence, we convert A and O from the RGB color space to the YIQ color space and use the Y channel as luminance for the following similarity analysis. Then, we formulate a novel distance metric with style features and semantic information in the similarity analysis step. Some user interactions are optionally needed to get the sematic information when dealing with occlusions, shadow casting, semantic labeling, and direction field editing. Before the interaction, the artwork A is segmented into several parts which represent different layers. After that, a stylization step is performed to harmonize the cloned objects with the artistic image. A new parallel stylization technique is developed to achieve real-time feedback. Finally, in the post processing step we convert O (with updated Y channel) from YIQ color space to RGB color space. This framework provides two ways to create the colored result. One way is to use the original color of O. The other way is to use the color of to guarantee seamless boundaries between O and A the object mask is employed. The mask is blurred with a Gaussian filter and then used for a-blending.

In conclusion, the paper has presented a novel interactive rendering framework for cloning photo-realistic or artificial objects into real-world artworks seamlessly. The harmonization between the cloned objects and the artwork is achieved by transferring the style features encoding luminance, texture, direction, local coherence, and semantic information in the artistic images. Extensive experiments have been conducted to demonstrate the effectiveness of the proposed method. Our new image cloning approach can facilitate designers to create new artworks by utilizing existing images with a high fidelity. Even amateurs can also enjoy themselves through creating various non-photorealistic images with our method. To reduce the illumination difference between the cloned object and the artwork, our approach adjusts the color of the cloned image by histogram matching. However, such an adjustment cannot simulate the light interactions between the cloned object and the artwork. Thus, the lights in the artwork cannot illuminate the cloned object. Although we have simulated shadow casting by projecting the contours of cloned objects through some user interactions, a better solution which can realistically insert cloned objects into existing artworks accounting for their lighting interactions should be developed.

When we compare **both the papers**, there has been an improvement on the image cloning method, which allows users to seamlessly insert any photorealistic or artificial objects into an artwork to create a new image that shares the same artistic style with the original artwork. The secondary paper concentrated more on the Seamless cloning of a source image patch into a target image is an important and useful image editing operation where as the primary paper concentrated more on the style-aware image cloning, a novel image editing approach for artworks. Both of the papers have focused on solving the color discrepancies between the source object and target background along the cloning region boundary. And many other algorithms have been used in the primary paper. After comparing both the papers we can say that new image cloning approach can facilitate designers to create new artworks by utilizing existing images with a high fidelity.

Reference for paper 1:
Y. Zhao, X. Jin, Y. Xu, H. Zhao, M. Ai and K. Zhou, "Parallel Style-Aware Image Cloning for Artworks," in *IEEE Transactions on Visualization and Computer Graphics*, vol. 21, no. 2, pp. 229-240, Feb. 1 2015.
doi: 10.1109/TVCG.2014.2355221

Reference for paper 2:
Z. Farbman, G. Hoffer, Y. Lipman, D. Cohen-Or, and D. Lischinski, “Coordinates for instant image cloning,” ACM Trans. Graph., vol. 28, no. 3, pp. 67:1–67:9, 2009.