Exploring Digital Graffiti: A Real-Time Painting System in Unreal Engine 5

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Abstract

The Unreal Engine 5 (UE5) is one of the most important tools in the creation of digital art with the advancement of virtual reality (VR) technology, which allows for the investigation of new modalities of artistic expression. This system aims to develop a UE5 real-time painting tool that emulates the aesthetics and techniques of graffiti and street art that I have long appreciated. This environment will provide viewers with an interactive framework in which they are able to paint and hang their graffiti artwork while socializing with others. The technology capabilities include the Blueprint scripts, material editor, as well as ray tracing, all of which work together to enable the re-modelling of actual surfaces in real time. The project delivers brush behavior, adjustable color palette choice, along with optimizing painting mechanics in a blank canvas model context that lets players undergo fully immersive and intuitive creative experiences firsthand. While the project had some challenges for the perfection of the realism of the visuals, there was also a demonstration of the potential of UE5 as the tool for the artistic expression and the interactive systems for the future development of interactive digital art.

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1. Introduction

Virtual reality (VR) technology with the fast evolution of digital arts increasingly employs Unreal Engine 5 (UE5) as the tool in creating digital art. The appeal of virtual environments for painting and graffiti art lies in who they not only give artists the space and freedom required to express their creativity but also give players a unique experience by allowing them to create and interact with each other. Such an idea is an outcome of my love for graffiti and wall art, thus a UE5 real-time painting system is proposed for players to freely paint graffiti or spray tag in the virtual setting. Arguably, this system combines aesthetic expression with sociability, hence an engaging and unique environment is created.

Recently digital art has gained more popularity which is necessitates intuitive tools specialized for real-time painting and street painting. Internet counterparts of street art, which is traditionally a form of graffiti, emerged, yet still many artists feel that street art is spontaneous and free, providing more than can be achieved with digital tools. This venture intends to incorporate the elements of traditional techniques of graffiti with modern mechanisms of digital platforms by exploiting the power of Unreal Engine 5 to expand the domain of creative virtual arts.

2. Related Works

Graffiti has immensely become associated with various urban subcultures over the years, which makes it appear a whole lot more as a freestanding and independent form of street art. Earlier, digitized graffiti art focused mainly on two-dimensional pixelation, however, 3D gaming engine technology and real-time rendering have been embraced by graffiti artists to use in three-dimensional space. For instance, Minecraft uses block-placing mechanics for their freeform creative style, that essentially resembles the action of a graffiti artist who uses a spray can to express themselves artistically, as both create or modify a virtual world around them.

Numerous inquiries have looked into integrating traditionally artistic concepts into technologically advanced 3D recreational painting apparatuses and they have obtained promising findings.As Akleman, E., Mullins, C., Morrison, C., and Oh, D. (2023). The paper “Recursive Camera Painting: A Method for Real-Time Painterly Rendering of 3D Scenes” introduces a linear camera painting method for achieving painterly blur effects in real-time rendering applications. The method has been implemented in GPU-based ray tracing and VR gaming environments to achieve dynamic effects in real-time 3D painting.

Furthermore, graffiti may be out in video games, as seen in the development in the last few years. Some games such as *Splatoon* and *Passpartout: The Starving Artist* contain real-time painting techniques whereby players can grasp hold of the game by painting or making their graffiti. *Splatoon* rely on ink-based weapons that players regularly fill with the ink as they spray. Players do this to take over territory. In this kind of environment, creation of art is coupled with competition among players. In the *Passpartout: The Starving Artist*, players have the ability for art creation on virtual canvases and upon appraisal of created artworks by non-playable characters (NPCs)

based on aesthetic criteria.



Figure 1:Screenshot of *Splatoon*



Figure 2: Screenshot of *Passpartout: The Starving Artist*

The combination of graffiti with virtual reality technology has been proven scientifically in recent studies. A study exploring Roblox Graffiti Art Using Virtual Reality Devices: Reality and Spatial Presence in a Virtual Space stressed the magnificence of VR in generating Graffiti. The invention suggested that VR technology provides a more all-encompassing and intimate space by which graffiti artists can portray or annotate their artworks in virtual environments without worrying about legal and ethical consequences attached to traditional street art. It was also discussed the involvement of graffiti adaptations in cultural heritage. It perforates into a different angle of art, culture, and technology intersection. The research showed that the volume of spatial presence within the virtual world is what made users feel like they had more determinant of the outcome of the graffiti experience. That gave these the complement for adjusting and extending similar systems using virtual spaces.

These instances demonstrate how virtual graffiti technologies and real-time painting algorithms are applied in games giving players the opportunity to create and experience art in an interactive setting with a game.

3. Production Process

Compared to its predecessor, UE5 offers a much in-depth set of tools performing functions such as graphics rendering, interactions, and enhanced experience in 3D. 3D graffiti in UE5, is spread widely through the use of its blueprint system, material editor, and ray tracing. The real-time rendering technologies from UE5 allow developers either to generate textures dynamically or to do canvas effects, ensuring realistic representation of every individual pixel in a virtual world in the real-time. This mining enables the creation of highly interactive and interesting art objects. However, there are still some difficulties in allowing the artists to paint on a lot of complex 3D environment.

I established a basic game project in UE5, incorporating basic elements such as lighting, camera control, and essential scene components. This served as the foundation for the project, ensuring that all fundamental elements were functioning correctly and that the environment was set up for later painting functions.

I downloaded a simple easel model and used Substance Painter to modify the canvas material, transforming it into a blank canvas. This ensured that the canvas could be used as a mesh surface for painting.

Moreover, I created a Pawn class blueprint to handle player inputs and control the camera. To implement both camera rotation and painting functionalities, I set a boolean variable bLockRotate to control camera behavior. When the Alt key is pressed, bLockRotate is set to false, allowing the player to freely rotate the camera using the left mouse button. When the Alt key is released, bLockRotate is set to true, and pressing the left mouse button triggers the painting system.

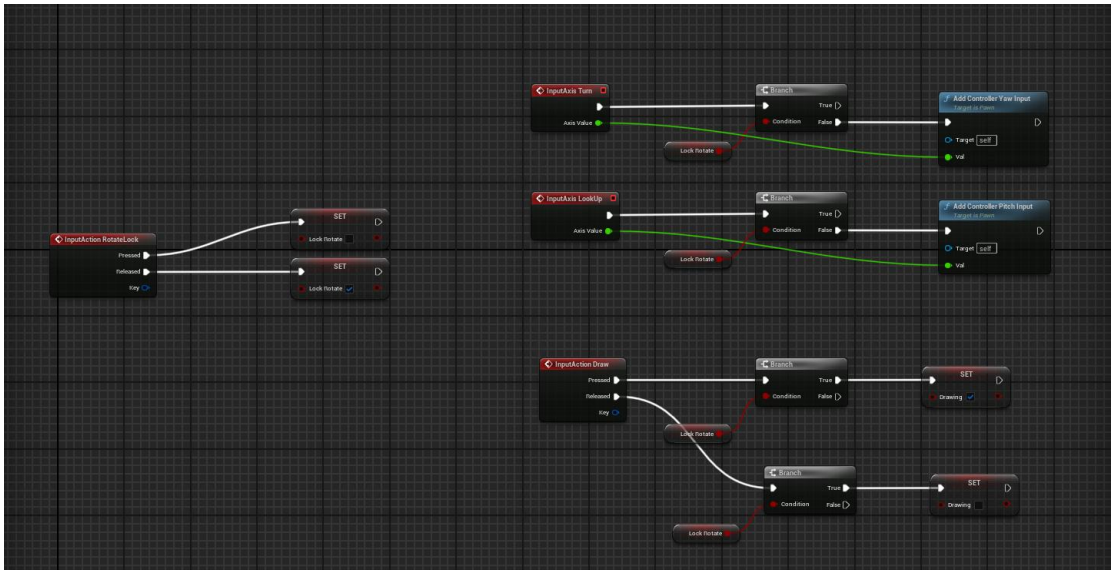


Figure 3: Blueprint of camera control

The painting system uses ray tracing to detect the location of the player' s mouse on the canvas. I employed the "Line Trace by Channel" node, with the start point of the trace being the camera' s position and the endpoint being the world coordinates derived from the mouse' s screen position. When the ray intersects with the canvas, the system returns the hit point' s world coordinates and corresponding UV coordinates, which map the hit location on the canvas.

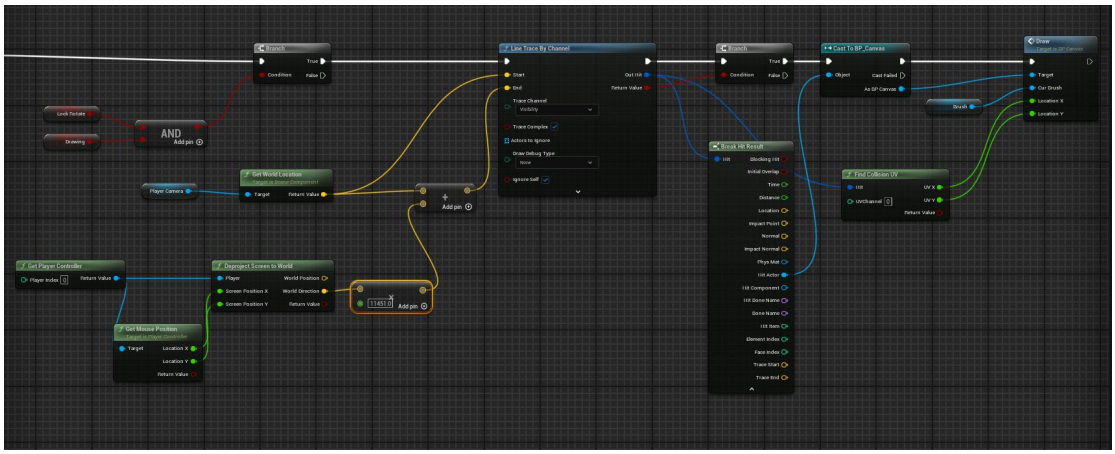


Figure 4: Blueprint of UV Collision

To simulate painting, I created a brush material with an alpha texture representing the shape of the brush. The center of the brush was dynamically updated based on the UV coordinates of the hit point, allowing the brush to align with the canvas surface and

create the desired painting effect. This material was drawn onto a 2D render target using the "Draw Material to Render Target" node, blending the brush texture with the original canvas material.

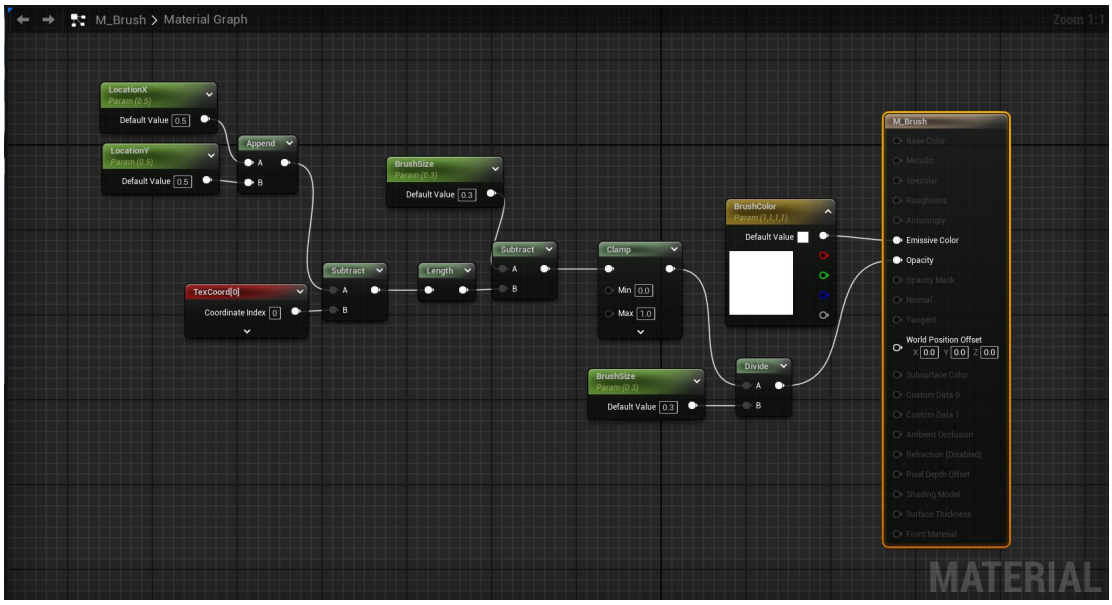


Figure 5: Blueprint of Brush Material

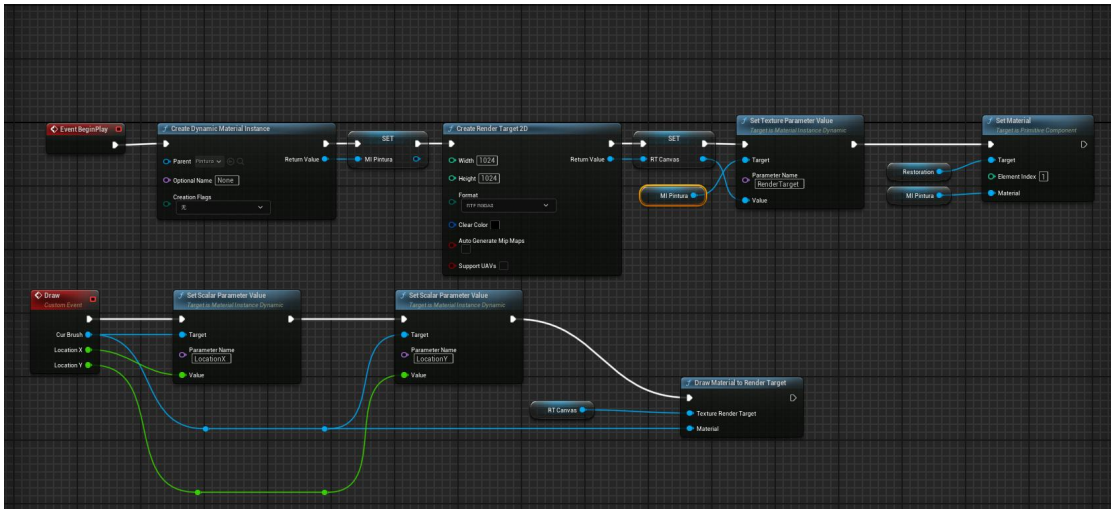


Figure 6: Blueprint of Canvas

To enable the player to adjust brush colors, I implemented a color picker in the UI. Using a radial slider, players could adjust the RGB channels in real time to change the color of the brush and apply it to their artwork.

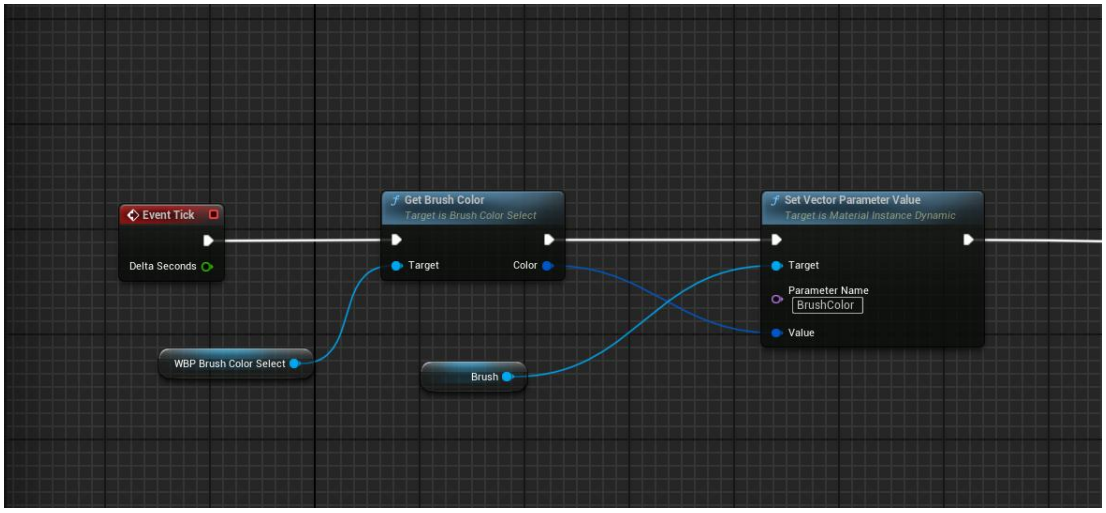


Figure 7: Blueprint of Brush Color

4. Challenges and Solutions

1. Precision and Fluidity in Real-Time Painting

One of the initial challenges I encountered was achieving precision in the painting process. When performing ray tracing in UE5, the brush sometimes did not align perfectly with the detected point on the canvas. This misalignment led to inaccuracies in the painting process. To resolve this issue, I optimized the ray tracing algorithm and adjusted the UV mapping on the canvas mesh. This improved the accuracy of the hit point detection, ensuring that each brushstroke was properly placed on the canvas.

2. Implementing the Color Picker

Another challenge arose when trying to implement the color picker. Initially, I attempted to modify the Emissive Color directly in the material to change the brush color, but this approach proved to be too inflexible and did not allow for real-time adjustments. After experimenting with different solutions, I created a Widget Blueprint and used a radial slider to provide an intuitive, dynamic color picker. This allowed players to adjust RGB values and apply the changes to the brush in real time, greatly enhancing user interaction.

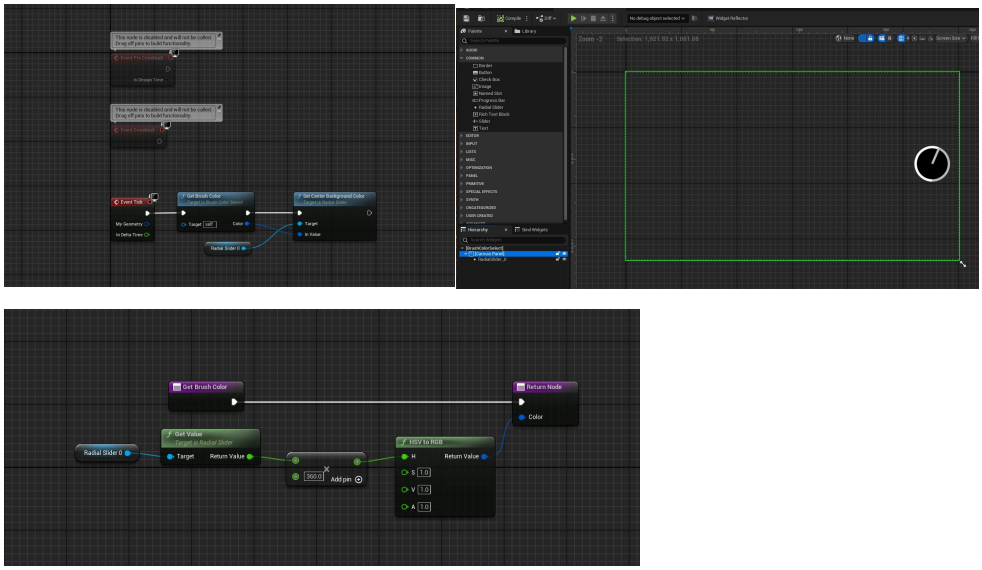


Figure 8,9,10: Widget Blueprint of Brush Color

5. Critical Analysis

This projects takes me have a deeper knowledge of real-time painting systems, as well as I acquired profound knowledge of UE5' s Blueprints. By trying out ray tracing, texture setting, and material rendering for the virtual environments. I learned the manner of real-time painting in virtual environments. However, the project was not without challenges. Due to my limited experience with UE5' s Blueprint system, I was unable to expand the system to allow painting on multiple objects, limiting the functionality to a single canvas model.

Additionally, I encountered difficulties with different special brush strokes and the representation of paint textures. Despite my efforts, the brush materials did not fully replicate the natural blending and texture effects of traditional paint. The unsuccessful encounter above proved to me that I need to broaden my horizon by learning more about UE5' s blueprint system, I gained a lot of knowledge in my studies. In the material writing of UE5, colors need to be converted into numbers for calculation. In the process of trying to link nodes, I also learned the functions of many nodes and the effects that several nodes can bring.

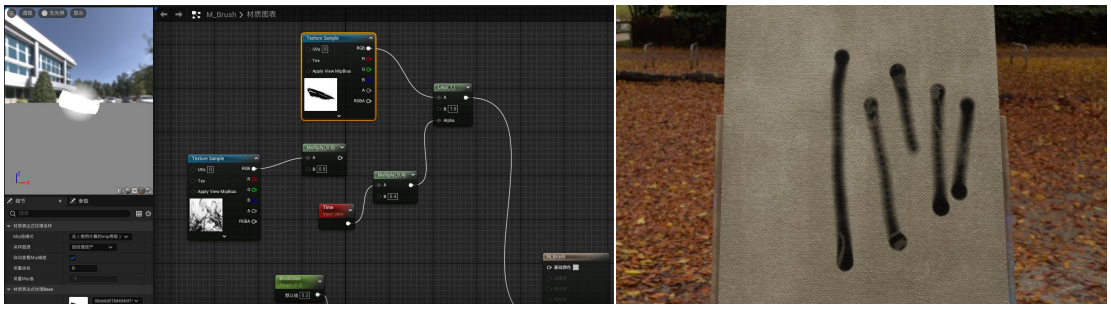


Figure 11,12: Unsuccessful blueprint of brush stroke

6. Conclusion

In conclusion, this article developed a blueprint with ray tracing, UV collision and dynamic materials in UE5 technology stack that let users create graffiti and other art in a virtual 3D environment. The system includes camera controls, passage of location track for painting and color customization to produce an engaging and easy-to-use process. It was through iterative testing and tweaking that this issue was resolved. Although challenges related to precision, material representation, and color selection were encountered, these issues were addressed through iterative testing and optimization. This enabled the system to perform better in its goal of providing the new medium for virtual art creations, making a significant contribution towards the advancement of the domain of 3D digital artwork

7. Bibliography

Akleman, E., Mullins, C., Morrison, C., & Oh, D. (2023) 'Recursive Camera Painting: A Method for Real-Time Painterly Renderings of 3D Scenes', *arXiv preprint*, arXiv:2312.12392. Available at: https://arxiv.org/abs/2312.12392 (Accessed: 3 March 2025).

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Easel Model: https://skfb.ly/6TBoJ

HDRI: https://polyhaven.com/a/autumn_hockey

Splatoon information: *https://en.wikipedia.org/wiki/Splatoon*

Passpartout: The Starving Artist information: *https://store.steampowered.com/app/582550/_/*

Figure 1: https://huaban.com/pins/998220987

Figure 2: https://www.bilibili.com/video/BV1pe411D7cF/