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Calligraphic Brushwork for 3D Space

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Abstract **-** This paper will address the current possibilities of replicating 2D Chinese ink strokes in a digital 3D form, specifically through the 3D software Maya, and the Python programming language. The visual qualities of ink strokes will be analyzed, such as how the speed, pressure and deformation of a brush influence the qualities of the resulting mark. Attempts to replicate such qualities will then be demonstrated in Maya, and a comparison of the results with the initial 2D references. I will then discuss the way in which Python helps optimize the work of generating brushstrokes, and how the process I have developed might fit into a 3D or 2D animation workflow. Such practical exploration of adapting a traditional art form for contemporary digital art and animation will also demonstrate the possibilities of the role of technical artists in developing tools for specific use cases, as well as increasing experimentation with art making in digital software.

Keywords – 3D Software**,** Python, Chinese Ink

INTRODUCTION

The tradition of Chinese painting is an ancient and respected practice, from which many artists draw upon to develop their work. In particular, Chinese brushwork comprises a simplification of image representation based on qualities of line, shape and value which is known as its delusive quality[1]. Form ('xing' 形) is used to depict the Spirit ('shen' 神) of subject matter, while Vitality('qi' 气) and Rhythm('yun'韵) are essential for the overall composition of an image. This is influenced by techniques of writing characters in Chinese Calligraphy, which results in brushwork techniques that focus less on tediously precise duplications of nature, opting instead for summarising the characteristics of the subject.[2] The question arose of why techniques of Chinese Calligraphy are not more often applied in contemporary digital artwork, as they can provide artists with the delusive qualities of brushwork to design in both 2D and 3D formats. The answer is that in the dominant 3D software for artists, Autodesk's Maya, there are no available tools that allow easy implementation and experimentation with the possibilities of brush and ink. Much development has been made with 2D brush work in digital painting software, but none for the 3D. If brushwork can be faithfully represented in 3D, the artist has more options for using a single brushstroke as the angle of view can be adjusted and is not locked in a single perspective. When most digital artists today work heavily with 3D software, this is a gap we seek to fill, as well as discover its potential for ourselves. This is not primarily a historical or theoretical approach, but a practical one coming from a gap in the availability of tools for producing brushwork in 3D software. This project thus involves a look at the properties of the brushwork in 2D, followed by attempts to translate their effects into 3D space and creating a plugin that allows them to be reproduced more efficiently.

DESIGNING THE STROKE

Chinese ink brushwork is composed of several design principles that trace back to the initial Six

[1] (Ng and Lee 2014)

[2] (Hua, Wu, and Zhang 1989)

Principles by Xie He.[3] For the project, the second principle on bone manner is our focus. In contemporary understanding that has hybridized with western techniques, the aspects to be explored can be summarized as the Visual Rhythm[4] of the brushstroke. In the context of brushwork, this breaks down into the shape, size, curvature, speed of application, tonal change, and arrangement in an image space. In digital brushwork, there is also the added complexity of digital layers, which possess different optical effects to its real-world material counterpart. Such qualities in a brush work also manifest in different proportions in different types of brushwork, giving us an infinite number variation in the kind of brushwork that can be produced for any application. In Fig.1, we can observe a type of stroke produced with the wet on wet technique, with a broad brush. The stroke is applied continuously, with heavier to lighter pressure in a wave-like motion. The resulting effect is a stroke that changes in size, and the wet on wet effect produces a spreading along its edges which results in soft smokiness to its texture, implying volume and lightness despite being made on a flat 2D surface with ink. In Fig 2, a more rhythmic variation of this type of stroke is produced by lifting the brush off the surface at various stages. The edge softness, speed and rhythm of these marks unifies them despite white space between them, which can be evocative of foggy mountainous forms. This type of stroke exemplifies the delusiveness in terms of edge softness due to the interaction of solid pigment and the wet and rough surface of the paper. In Fig. 3, I have attempted to reproduce its effects in a brush stroke made in 3D space. Another type of stroke can be seen in Fig. 4, which exemplifies a dryer and harder edged brushstroke. My attempt to recreate this can be seen in Fig 5. These variations of edge hardness and roughness are the major textures used in drybrush to wet ink techniques, due to the importance of the textural methods('cun' 皴) in landscape painting.[5] Based on sampling textures from the referenced brushstroke, a particle emitter in Maya is used to generate thousands of instances of a texture. By changing the speed of the animation, the shape of the emitting mesh, and the life span of the particles, it is possible to generate effects that are very similar to these traditional methods. There are, however, some differences and weaknesses in the effects produced. While the effect of speed, line weight and edge hardness have been replicated, there is a difficulty in producing an organic looking overall shape due to the mathematical accuracy of the simulation. Variations produced from the artist's hand are not as easily recaptured. To produce a version truer to life, successive passes must be made to refine the variations throughout the stroke. Such requirements are managed on a project to project basis, hence the results I have achieve suffice as a proof of concept for what this project will achieve in the long run.

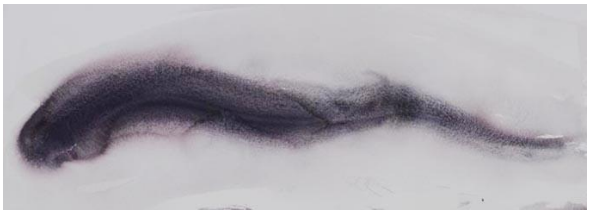

Fig 1 Brushwork on wet paper, Source: Ng 2019

Fig 2 Brushwork on wet paper, Source: Ng 2019

Fig 3 Brushwork generated in Maya, Source: Chia 2020

[3] (Lancaster 1952)

[4] (Ng 2016)

[5] (Huang 2003)

Fig 3.1 Generated brushstroke at a different angle in 3D space, Source: Chia 2020

Fig 4 Dry, harder edged brushwork, Source: Ng 2020

Fig 5 Generated drybrush stroke in 3D, Source: Chia 2020

Fig 5.1 Generated drybrush stroke from a different angle in 3D, Source: Chia 2020

IMPLEMENTATION

In this section, I will outline how I derived the 3D counterparts of the 2D figures used. Autodesk Maya is a professional 3D software with an extensive technical documentation[6] of its components that more advanced users may use to control its tools to a more precise degree and with greater efficiency. First, it is necessary to talk through the manual process of producing a particle emitter in Maya and then applying effects to it. First, a menu must be navigated to create an emitter that is centered in world space (Fig.4). A very useful menu system is available to adjust the initial attributes of the stroke, which is helpful for establishing a baseline of properties for a brushstroke (Fig.5). Next, if an animator wants the emitter to follow the speed and direction of an existing animation, the particle must be parented to the animation at the point from which is desired. This is a single loop of the steps necessary in Maya at the moment. For a single particle, this is not so tedious. However, if we wanted to produce a more dynamic scene with multiple brushstrokes with varying effects, it becomes exponential more time consuming and arduous to repeat. In my own estimates, adjusting the emitter for the desired brush like effects takes about 15 to 30 minutes depending on the complexity desired. Furthermore, there is a never-ending range of possible ways to experiment with it, thus it can take much longer to create one emitter effect. Thus, it is necessary to use Python scripting to capture the effects we want and to reproduce them with a single push of a button as many times as needed. Thus, with the help of programmer Fredy Tantri, a script was produced that would create particle emitters at any chosen vertex of an animated 3D object, which is able to drastically reduce the amount of time needed to create the brush effects in Maya (Fig.6). Maya has an inbuilt option to make all scripts run from an easily accessible button in its workspace, thus increasing efficiency even further. The importance of such technology in digital work cannot be understated, as it frees up much more time for the artist to focus on experimenting with visual effects and creative decision making, instead of tedious technical tasks. Hence the 3D digital brushwork also introduces a much faster workflow in generating animated brushwork for artists digitally.

[6] (Autodesk Knowledge Network n.d.)

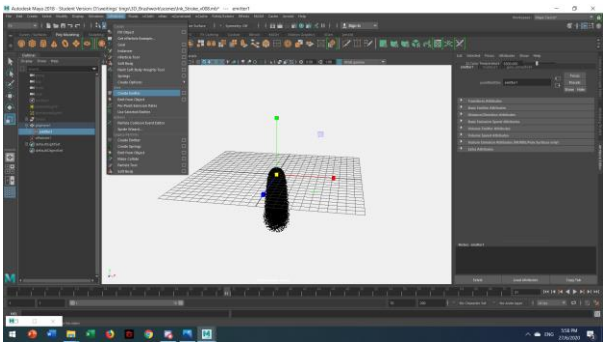

Fig 6 Maya particle emitter interface, Source: Chia 2020

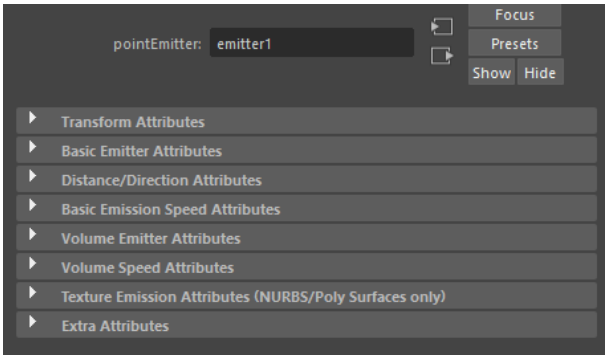

Fig 7 Emitter attribute editor, Source: Chia 2020

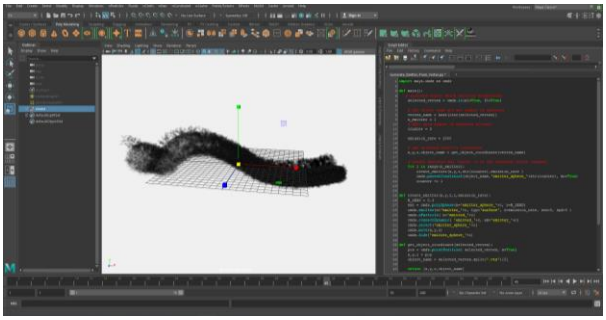

Fig 8 Maya Interface with scripts, Source: Chia 2020

Throughout this project, many iterations of the animated brushstroke have been documented in video form[7]. There is still much to be explored in terms of producing a more definitive set of brushwork that can be incorporated into a plugin. The hope is to also ensure that more customization by users is possible in terms of editing the brushwork and its colour as well. As mentioned earlier, there is also the issue of too much mathematical accuracy in the movement and quality of the lines produced by Maya. Thus, it is necessary to further understand the mathematical underpinnings of such digital representation, much of which has been documented extensively by software engineers[8], in order to be able to manipulate them in line with an artistic direction. Furthermore, additional variations in edge quality can be explored by employing more real-world textures in the image textures that are produced by the particle emitter. The project so far is thus a basic skeleton of the overall product, yet an insightful window into what can be achieved with extensive technical knowledge and an understanding of the visual theories behind Chinese brushwork.

CONCLUSION AND FUTURE WORK

In conclusion, this project is attempting to understand, from an artist's perspective, the dynamic nature of Chinese calligraphic brushwork due to its delusive qualities. In particular, the drybrush and wet ink effects that are emblematic of Chinese ink paintings. Capturing these variations in texture boil down to adjusting a few variables in 3D software to reproduce their physical counterparts. With further development, we may reduce the weaknesses of the simulated effect such that the textures are fully captured and expanded upon by manipulating them in 3D space. Potential possibilities include incorporation into Virtual Reality painting technologies, as well as visual effects in 3D films. In this approach, it is necessary to incorporate interdisciplinary work and be open to the cross-pollination of ideas from art to software engineering and vise-versa. This has been demonstrated in how brush strokes on paper have been analyzed for their visual qualities, and subsequently recreated in Maya. Furthermore, it is also demonstrated that such representations in 3D software are easily reproduced multiple times according to an artist's choice by way of Python scripting. This project thus demonstrates the overall ease of experimentation and iteration in 3D software, towards the expansion of traditional ways of painting in a digital age.

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[7] (Ang and Chia 2020)

[8] (Shi 2017)

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