Computational Flow Dynamics Analysis of Pelvic and Abdominal Veins Using CT, Venography, and Duplex Imaging

(Technical Paper)

Animation in Media: How technological context constructs cultural meaning

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Katherine Dunn

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Technical Project Team Members

Katherine Byrd

Jessica Cornthwaite

Katherine Dunn

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature _____ Date _____

Katherine Dunn

Approved _____ Date _____

John Fritz Angle, M.D., Division of Interventional Radiology

Approved _____ Date _____

Bryn E. Seabrook, Department of Engineering and Society

Prospectus

Introduction

The global three-dimensional animation market was valued at 259 billion USD in 2018 and has been projected to grow steadily over the next decade (Clare, 2021). Despite the US being the largest contributor to the 3D animation industry, various Asian countries' animation markets are projected to increase more rapidly. 3D animation is only a facet of the massive animation industry, and is a tool used in both education and entertainment. The computer graphics field has rapidly developed as well, leading to the creation of new medias which fall under the umbrella-term "animation" (Morie, 1998). Modern animation, though widely encompassing many fields, is a critical cultural and intellectual artifact of any society. Through examining how the development of animation impacts its cultural meaning, characteristics of media and technological values can be identified. In the proposed research project, the content of animated media will be examined to evaluate its cultural significance.

Software used by animators for 3D volume rendering and object rigging is also used for educational and research purposes. Computer animation is used as a tool to present visual information in 2D and 3D spaces (Musa, 2013). 3D modeling is crucial to clinicians developing minimally invasive strategies to improve patient prognosis. The improvement of modeling has improved the ability to research internal phenomenon in a controlled, reproducible virtual environment. The University of Virginia Division of Interventional Radiology is using CT and Ultrasound imaging to construct 3D models of patient veins in order to improve the ability to predict the formation of life-threatening blood clots. In the proposed technical project, clinical imaging data will be used to construct a 3D model of blood vessels. Through refinement and verification of the reliability of the model, the physiological factors contributing to blood-clot

formation can be assessed and a proper treatment course can be developed. Clinical applications of modeling will potentially allow patient treatment to become more individualized and lower risk. Modeling improves both the academic and medical field by providing a virtual environment to examine physio-pathological phenomenon.

Computational Fluid Dynamic Analysis of Pelvic and Abdominal Veins Using CT, Venography and Duplex Ultrasound Imaging

Lower deep vein thrombosis (DVT) is a clinically challenging condition where a blood clot, known as a thrombus, forms in the lower extremities, typically in the common and iliac veins found within the abdominal and pelvic regions. (Definition of Thrombus - NCI Dictionary of Cancer Terms - National Cancer Institute, 2011) The blood clot formation causes blood flow irregularities as well as partial or complete blood flow blockages, which can be very problematic for patients. These abnormalities in blood flow patterns cause many patients to experience leg pain and swelling; however up to 50% of patients with a DVT are asymptomatic (Bruni-Fitzgerald, 2015). In order to diagnose a patient with a DVT, clinicians utilize computerized tomography (CT) scans, venography, and ultrasound imaging to confirm thrombus formation. The current treatment for DVT is a procedure utilizing balloon angioplasty, in which a balloon is used to open the vein around the blockage to then precisely place the stent into the occluded vein, which is intended to improve blood flow through the body. However, in one study performed, the stenting procedure was successful in the first 6 month following the procedure in 80-90% of patients (Razavi et al., 2015). The exact mechanism for formation of venous stent stenosis is still unclear. In many patients who received stenting treatments develop stenosis, even after the occlusion was originally cleared out.

Using imaging techniques to then build computational models of venous flow may provide insights into why stenosis is more likely to occur in specific regions of the iliac vein. By modeling the iliac vein, clinicians can potentially predict where stenosis may occur. Specific patient models may be used in the future to improve prognosis for DVT patients. Insights on flow after venous stenting may provide insights towards optimizations for stent placement and size. Modeling also provides a non-invasive method to predict the patency of the stent post-insertion. Modeling blood flow in DVT patients is significant for improving surgical outcomes and improved patient care.

A 3D computational model of the iliac vein will be created by our technical team using imaging data provided by our technical advisor to gain insight on blood flow in the pelvic and abdominal region. Modeling then will be conducted with ANSYS simulation software in conjunction with blood velocity data from patient sonography to determine flow properties. Flow analysis will be conducted to compare flow patterns and properties in both normal and pathophysiological states. Parameters for proper modeling will be selected based on significance to the flow and physiology of the iliac vein. Clinical data from dynamic CT, venography, and duplex ultrasound imaging modalities will then be used to construct an individualized CFD model of the pelvic and abdominal veins. The outputs of such models can be used to analyze flow in the context of stent stenosis and DVT formation, aiding clinicians in determining if patients are at high risk for stenosis. The proposed technical project will deliver a computational model of venous anatomy and fluid flow as well as an analysis of the flow properties contributing to DVT.

Animation in Media: How technological context constructs cultural meaning

"Animation" is a single term that is often colloquially used to describe a number of very different media forms. In his 1989 book, *Glossary of Filmographic Terms*, Jon Gartenberg describes animation as, "the arts, techniques and processes involved in giving apparent movement and life to inanimate objects by means of cinematography". Animation can also be separated into 2D and 3D animation. 2D animation involves the construction of objects in a 2D environment while 3D animation is constructed in a 3D environment (Au, 2014). 3D animation is often conflated with CGI, but CGI refers to any visual element created with software assistance, while 3D animation must include 3D models and graphics (Jordan, 2020). 3D animation has a wide range of applications outside of the entertainment and film industry, including architecture, commercials, and educational tools. Interactive 3D spaces and virtual reality are being developed for both entertainment and education (Lee, 2019). Aside from the technical distinctions between animation categories, there are also less apparent cultural definitions that distinguish different forms of animated media.

2D animation is used differently in the US compared to non-western cultures. The most prevalent example of different uses of 2D animation is seen in American cartoons and Japanese anime. Both involve the same technical processes, yet are viewed as two different forms of media. American cartoons are generally associated with content aimed towards children whereas Japanese anime is marketed towards a wide range of age demographics (Sage, 2019). The difference in interpretation of these two mediums can only be attributed to cultural understanding of animated media, considering there are few differences in the technology itself. Additionally, the use of 3D animation in media appears to be favored in some American media over 2D animation, and the opposite holds true in most Japanese media. To understand how a particular technology comes to hold a specific meaning in a cultural context, the formation and usage of

that technology must be examined. Animation has developed through various technical advancements to encompass 3D rendering and modeling with distinct characteristics from different time periods. Analyzing how the different animation techniques have been formed and are currently used in media can inform how the associated meaning of animation has come to be.

One STS theory which will be used to examine the topic in question is the social construction of technology. A social construct in the context of technology refers to the acquired meaning associated with a technology that is determined by the society in which it is created. This theory, commonly referred to as SCOT, was coined by Trevor Pinch and Wiebe Bijker in a 1987 article concerning the relationship between science and technology. They argue that relevant social groups impart meaning to technology or "artifacts" through their actions (Klein, H. K., & Kleinman, D. L., 2002). Though this scholarship has limitations in its scope, it is a relevant framework for the analysis of the acquired meaning of animation. Animation in the US often reflects a desire to represent reality by creating images indistinguishable from film. Value is placed on improving animation technology to create detailed and realistic images. In Japanese animation, value is placed on stylization as well as the scope of the characters and environments portrayed (Shen, 2007). Though there is some overlap between the aesthetics of both medias, there are distinguishable differences in the cultural ideologies surrounding animation.

In order to analyze the ideologies that influence the cultural meaning of animation, a number of animated mediums produced in the last two decades will be examined. Additionally, the globalization of animation will also be examined through global production networks, GPNs, focusing on the evolution of the animation industry in different regions (Yoon, 2008). To determine how animation has been socially constructed in both the US and Japan, the development of production networks alongside the content of animated media in the last decade

will be compared. When determining the content of animated media, the frequency of 2D and 3D animation techniques will be counted, and the intended age group and genre will be assessed. To limit the scope of media being analyzed, only high-grossing media franchises will be viewed. Previous research has assessed how animation techniques have contributed to perception of animated media (Dahle, 2019), but this research will attempt to correlate the content of the animated media itself with the cultural understanding of animation and how it was formed.

Conclusion

The first proposed project in this paper will focus on the methodology used to model fluid flow in a 3D model of the iliac vein. This model will be constructed from clinical data of patients with and without DVT. The computational flow model of the iliac vein will be created to analysis the factors which could contribute to DVT. This model is intended to supplement current academic and medical research and potentially be used in a clinical setting. Beyond the scope of this project alone, advanced applications of computational modeling in the medical field will impact the effectiveness of patient care. The second proposed project in this paper will analyze how animation has been used in entertainment and education across different cultures. Drawing on prior STS theories, this section will address how the formation of animation tools and practices has come to shape the cultural understanding of what animation is. This section will analyze various forms of animated media and animation tools to examine the cultural significance of animation. A greater understanding of how culture impacts technology is valuable to both those who consume animated media and those who create it.

References

Au, K. (2014). *Animation: 2D Versus 3D and Their Combined Effect* [Undergraduate Thesis].

Bruni-Fitzgerald, K. R. (2015). Venous thromboembolism: An overview. *Journal of Vascular Nursing*, *33*(3), 95–99. https://doi.org/10.1016/j.jvn.2015.02.001

Dahle, T. (2019). *Culture and 3D Animation* [Undergraduate Dissertation]. http://www.diva-portal.org/smash/get/diva2:1328360/FULLTEXT01.pdf

Clare. (2021, October 20). *3D Animation Market Research Report by Animation Technique, by Component, by Deployment, by End-User, by Region - Global Forecast to 2026 - Cumulative Impact of COVID-19*. ReportLinker. https://www.globenewswire.com/en/news-release/2021/10/20/2317394/0/en/3D-Animation-Market-Research-Report-by-Animation-Technique-by-Component-by-Deployment-by-End-User-by-Region-Global-Forecast-to-2026-Cumulative-Impact-of-COVID-19.html

Gartenberg, J. (1989). Glossary of filmographic terms, 1989. Fiaf.

Jordan, J. *What's The Difference Between CGI and 3D Animation?* (2020, November 19). NarraSoft. https://narrasoft.com/whats-the-difference-between-cgi-and-3d-animation/

Klein, H. K., & Kleinman, D. L. (2002). The Social Construction of Technology: Structural Considerations. *Science, Technology, & Human Values*, *27*(1), 28–52. https://doi.org/10.1177/016224390202700102

Lee, T. (2019, June 6). *Types of 3D Animation and 3D Animation Techniques*. Academy of Animated Art. https://academyofanimatedart.com/types-of-3d-animation-and-3d-animation-techniques/

Morie, J. F. (1998). CGI training for the entertainment film industry. *IEEE Computer Graphics and Applications*, *18*(1), 30–37. https://doi.org/10.1109/38.637268

Muir, D. W. (1985). Computer Animation in Engineering. *Computer Graphics*, 299–308. https://doi.org/10.1007/978-4-431-68030-7_20

Musa, S., Ziatdinov, R., & Griffiths, C. (2013). Introduction to computer animation and its possible educational applications. *ArXiv:1312.1824 [Cs]*. https://arxiv.org/abs/1312.1824

Razavi, M. K., Jaff, M. R., & Miller, L. E. (2015). Safety and Effectiveness of Stent Placement for Iliofemoral Venous Outflow Obstruction. *Circulation: Cardiovascular Interventions*, *8*(10). https://doi.org/10.1161/circinterventions.115.002772

Sage, I. (2019, June 11). *Duality of American and Japanese Animation.* The Artifice. https://the-artifice.com/american-japanese-animation/

Shen, L. F. (2007). What is "computer animation"?: examining technological advancements and cultural aesthetics of Japanese animation. *ACM SIGGRAPH 2007 Educators Program on - SIGGRAPH '07*. https://doi.org/10.1145/1282040.1282064

Yoon, H. (2008). *THE ANIMATION INDUSTRY: TECHNOLOGICAL CHANGES, PRODUCTION CHALLENGES, AND GLOBAL SHIFTS* [Dissertation].