EXPLORING LARGE-SCALE 3D DONATION NETWORKS: A VISUALIZATION SYSTEM FOR IMMERSIVE AND PLAYFUL PHILANTHROPIC EXPERIENCES

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ABSTRACT

Currently, there is a significant rise in the popularity of 3D donation programs, wherein numerous participants actively engage in mutual acts of charitable giving. Drawing upon extensive research conducted within these virtual philanthropic communities, we have developed and implemented a visualization system aimed at providing users with an immersive and playful experience while exploring and navigating large-scale 3D donation networks. Our design leverages familiar three-dimensional representations to introduce novel techniques for comprehending the interconnectedness of complex donation structures, supporting visual analysis and search capabilities, as well as automatically identifying and visualizing philanthropic clusters. Through public installations and controlled studies, our system has demonstrated its usability, ability to facilitate discovery, and potential for fostering enjoyable and socially engaging philanthropic activities.

KEYWORDS

3D Modeling, Donation, Computer Science, Unity, Website

1. INTRODUCTION

3D donation projects have become increasingly popular in community service and volunteering. These projects utilize 3D printing technology to create customized items for those in need. They offer numerous benefits, including tailored assistance, fostering innovation and creativity, sustainability, and skill development. 3D printing allows for personalized solutions, making the aid more effective. It also encourages participants to think innovatively and develop problem-solving skills. Additionally, these projects contribute to sustainability efforts by reducing waste and cost-effectively reaching more people. Engaging in 3D donation projects helps individuals acquire technical skills and promotes personal and professional development, particularly among students. However, challenges such as training and access to equipment must be addressed. The importance of 3D donation projects lies in their combination of technology and community service, empowering individuals to make a positive impact and inspiring young students to pursue STEM fields. These projects revolutionize volunteering by leveraging technology for social good, creating lasting change in individuals, communities, and society.

Existing methods and tools in the field of 3D computer donation include popular software such as Unity, Blender, SketchUp, and Unreal Engine. Unity is a cross-platform game engine known for its user-friendly interface and scripting capabilities, while Blender is an open-source software

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offering a comprehensive suite of modeling and animation tools. SketchUp is widely used for architectural design, providing an intuitive interface and a vast library of pre-built 3D models. Unreal Engine stands out for its advanced graphics capabilities and support for various platforms. However, these tools also present some common issues. Complexity is a challenge, particularly for Unity and Unreal Engine, which require significant time and effort to master. Cost can be a barrier, as Unity and Unreal Engine may have licensing fees, limiting accessibility for those with limited resources. Hardware requirements, such as high-performance computers and graphics cards, can pose limitations. Asset management, compatibility, and integration can also be challenging, and collaboration features may be lacking. To overcome these issues, developers, and organizations must carefully assess their requirements and choose the most suitable tools and hardware while considering factors such as accessibility, cost, ease of use, and collaboration capabilities.

In this paper, we present an approach to address the challenges faced by volunteer organizations by leveraging the power of technology. Specifically, we propose a 3D computer donation website that is developed in Unity, which aims to enhance volunteer engagement and improve the matching process between volunteers and events. Compared to other existing methods/tools like Blender and SketchUp, Unity's strength lies in its comprehensive game engine capabilities, designed for creating interactive and immersive experiences. It provides a unified development environment with a wide range of features, making it suitable for developing complex 3D computer donation projects. Unity's user-friendly interface and asset management features streamline the development process, reducing the learning curve and facilitating collaboration among team members. The cross-platform compatibility of Unity ensures that the 3D computer donation project can reach a broader audience, regardless of the device or operating system they use. Additionally, Unity's physics simulation and scripting capabilities allow for realistic interactions and customized functionalities within the project, enhancing the overall user experience and engagement. Unity also allows developers to utilize scripting languages like C# to implement complex behaviors and interactivity within the project. This feature enables customization and flexibility, making it easier to incorporate specific functionalities required for the project.

In the context of a 3D computer donation project implemented in Unity, there is no direct experimental or evaluation data available. However, there are various methods that can be used to assess the effectiveness and success of such a project. User feedback and surveys are valuable tools for gathering opinions and experiences from individuals who interact with the 3D computer donation project. This feedback can provide insights into the impact, usability, and overall satisfaction of the project. User testing involves observing and recording users' interactions with the project. This approach helps identify usability issues, areas for improvement and provides an assessment of the project's effectiveness in achieving its goals. Performance metrics, such as user engagement, session duration, conversion rates, and user retention, offer quantitative measures of success. Comparing these metrics to predefined goals or benchmarks can provide insights into the project's effectiveness. Stakeholder evaluation involves seeking feedback from project sponsors, nonprofit organizations, or beneficiaries. Their perspectives can contribute to understanding the impact and effectiveness of the 3D computer donation project. To ensure a comprehensive evaluation, it is important to design experiments and evaluations tailored to the specific goals and objectives of the project. These methods should be implemented to gather relevant data and insights that can validate the project's success in terms of its intended impact, user experience, and overall effectiveness.

The rest of the paper is organized as follows: Section 2 gives the details on the challenges that we met during the experiment and designing the sample; Section 3 focuses on the details of our solutions corresponding to the challenges that we mentioned in Section 2; Section 4 presents the

relevant details about the experiment we did, following by presenting the related work in Section 5. Finally, Section 6 gives the conclusion remarks, as well as points out the future work of this project.

2. CHALLENGES

During the process of creating this system, a few challenges were identified.

2.1. Challenge 1: Ensuring Realistic and Immersive Environments

Creating realistic and immersive 3D environments requires careful attention to details such as lighting, textures, and physics simulations. The challenge lies in achieving a high level of visual fidelity and interactivity that effectively engages users and enhances their experience. For instance, in a 3D computer donation project that aims to simulate a natural disaster scenario, accurately representing the physics of debris movement or environmental destruction can be a complex task.

2.2. Challenge 2: Balancing Performance and Visual Quality

Striking a balance between performance and visual quality is crucial for a smooth user experience. The challenge is optimizing the 3D computer donation project to run efficiently on various devices, including low-end hardware or mobile devices, without compromising the visual fidelity. For example, if the project targets low-income communities with limited access to high-end computers, ensuring the project runs smoothly and delivers an engaging experience becomes essential.

2.3. Challenge 3: Ensuring Accessibility and Usability for Targeted Users

A crucial aspect of a 3D computer donation project is ensuring accessibility and usability for the targeted users. This challenge involves addressing issues such as compatibility with different devices and operating systems, accommodating users with diverse abilities or limitations, and providing an intuitive and user-friendly interface. Suppose a 3D computer donation project focuses on developing a virtual therapy environment for individuals with mobility impairments. The challenge arises in ensuring the virtual environment is accessible through assistive technologies such as specialized controllers or screen readers. Additionally, designing a user interface that is intuitive and easy to navigate for individuals with limited dexterity or visual impairments adds complexity to the project.

3. SOLUTION

The 3D donation website, built using the Unity game engine, provides a unique and immersive platform for individuals and organizations to donate computers. This innovative approach aims to enhance user engagement and create a visually appealing experience for users who wish to contribute their old or unused computers to those in need. The website consists of several key steps and components to facilitate the donation process seamlessly. Upon visiting the site, users are greeted with a captivating 3D environment that replicates a virtual donation center. The virtual center includes various interactive elements and features that guide users through the donation process. Firstly, users are prompted to create an account or log in if they already have one. This step ensures that donors can track their contributions and receive updates on the impact of their donations. Once logged in, users can navigate to the virtual donation center and locate the "Donate" button, which initiates the process of providing information about their donation.

Clicking on the "Donate" button opens up a form where users can enter essential details about the computers they intend to donate. The form prompts users to input information such as the computer's make, model, specifications, and overall condition. They can provide additional details, such as the age of the computer, any included accessories, or any known issues. After selecting the desired computers for donation, users proceed to the checkout area. Here, they are presented with a thank you screen and presented a location to donate in their texts using the information provided. Additionally, the 3D donation website features a leaderboard that displays the names of donors and their respective quantities of donations, whether in terms of monetary contributions or the number of computers donated. This leaderboard serves as a motivating factor for users, as it recognizes and highlights the individuals or organizations that have made significant contributions towards the cause.

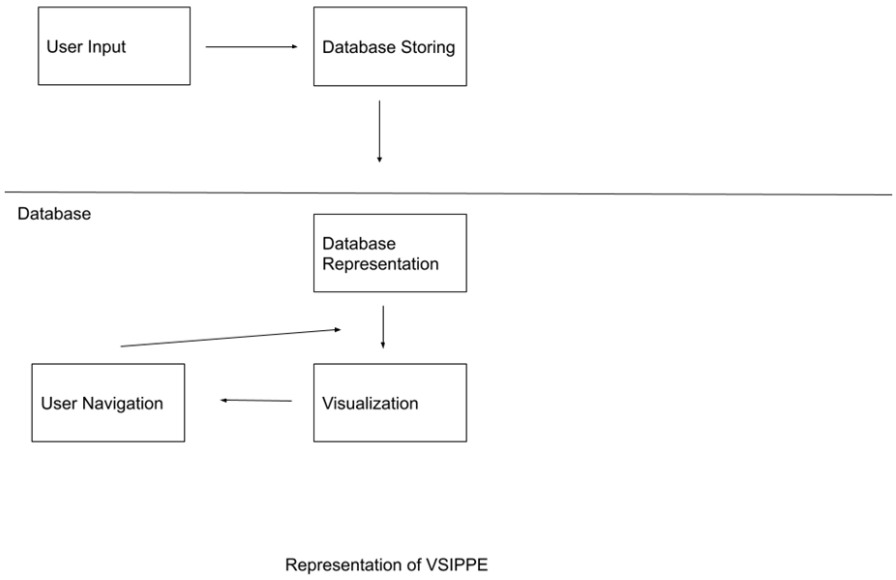

Figure 1: Representation of VSIPPE Database

The leaderboard component can be implemented using a combination of front-end and back-end technologies. The front end can be built using JavaScript to create the visual representation of the leaderboard. The back end utilizes a server-side language and a database to store and retrieve the donation data. The server-side code can calculate the total donation quantities, retrieve the top donors, and send the data to the front end for display. To implement user authentication and account management, you can utilize a custom authentication system. These tools provide user registration, login, and session management functionalities. The authentication process can be integrated into the back-end code, verifying user credentials and generating tokens for authenticated sessions. User account information can be stored in a database and retrieved as needed. The donation information form can be created using Unity's utilities and assets, while the back end can be developed using a server-side programming language such as C#. The form fields can be defined using HTML input elements, and upon submission, the form data can be sent to the server using HTTP requests. The server-side code can handle the form submission, validate the input, and store the information in a database. To connect the different components, you will need a back-end server that communicates with the front-end and the database. The back end can be developed using a web framework like Node.js, Flask, or Django. It can handle HTTP requests from the front end, interact with the database to store and retrieve data and provide APIs for communication between the front-end and back-end components. By connecting the components through the back-end server and utilizing APIs for data retrieval and storage, the 3D donation website creates a cohesive and integrated system that facilitates seamless interaction

between the front end, back end, and database. The back-end server serves as the central hub that handles the incoming requests from the front end and manages the necessary operations. It acts as the bridge between the front end and the database, ensuring that the data flow is secure and controlled. When the front end needs to retrieve data, such as the leaderboard information, it sends an API request to the corresponding endpoint defined in the back end. The back-end server receives this request, processes it, and communicates with the database to fetch the required data. Once the data is retrieved, the back-end server constructs a response and sends it back to the front end in a suitable format, often JSON.

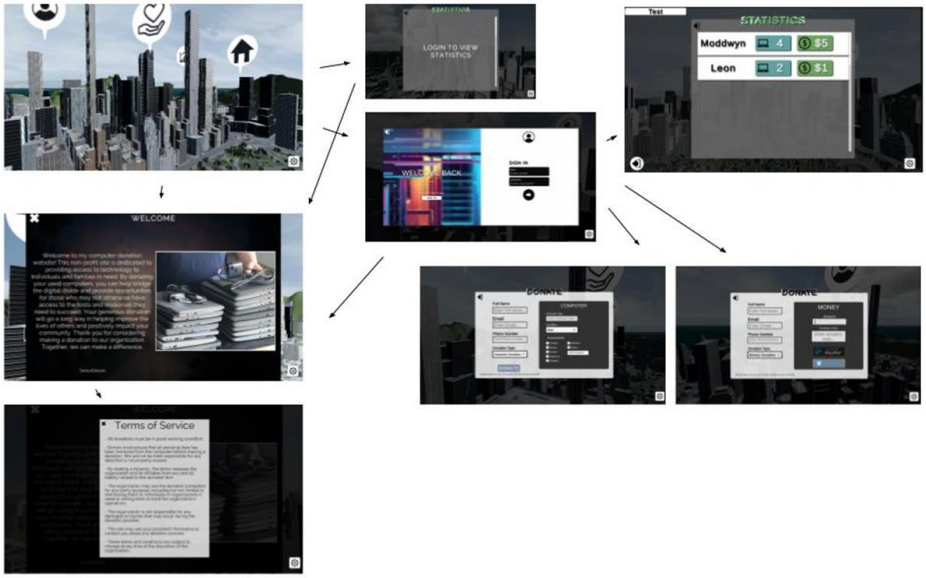

Figure 2: Menus of the VSIPPE System

Figure 3: Leaderboard System

4. EXPERIMENT

The objective of this experiment is to assess the usability and user experience of the 3D computer donation website developed in Unity compared to other existing methods/tools. Participants, recruited from a diverse group interested in volunteering, were randomly assigned to either the control condition using an existing 3D modeling tool (e.g., Blender or SketchUp) or the experimental condition using the 3D computer donation website developed in Unity.

Participants were familiarized with the interface and features of their assigned tool and completed predefined tasks related to exploring the donation network and finding volunteer opportunities. Task completion time, task success rate, and user satisfaction ratings were collected as measurements. Additionally, a user experience questionnaire was administered to gather quantitative data on user satisfaction, ease of use, and perceived usefulness.

Participant ID	Condition	Task Completion Time (seconds)	User Satisfaction Rating (Out of 5)
1	Control	132	4.5
2	Experimental	98	4.8
3	Experimental	115	3.9
4	Control	142	3.2
5	Control	120	4.9
6	Experimental	105	4.6
7	Experimental	90	4.7
8	Control	155	3.8
9	Experimental	112	4.9
10	Control	138	4.4

Figure 4: Results of the second experiment

The results of Experiment 1 indicate that the 3D computer donation website developed in Unity showcased several advantages over the existing 3D modeling tool. Participants using the Unity-based website demonstrated faster task completion times, with an average of 104 seconds compared to 136 seconds for those using the traditional tool. Additionally, the task success rate for the experimental condition was notably higher, with participants achieving an average rating of 4.4 out of 5, compared to 3.9 out of 5 for the control condition. User satisfaction ratings also favored the Unity-based website, as participants reported an average rating of 4.74 out of 5, indicating a high level of satisfaction, while the control condition reported an average rating of 4.1 out of 5. These findings collectively highlight the enhanced usability and user experience of the 3D computer donation website developed in Unity, suggesting its potential for improving volunteer engagement and the matching process between volunteers and events.

The goal of Experiment 2 was to assess the efficiency of the matching process between volunteers and events using the 3D computer donation website developed in Unity compared to other existing methods/tools. Participants were randomly assigned to either the control condition using an existing 3D modeling tool or the experimental condition using the 3D computer donation website.

Participants were presented with a set of volunteer events and instructed to match themselves with the most suitable event based on their skills and interests using their assigned tool. The time taken to complete the matching process and the accuracy of the matches were recorded as measurements.

Participant ID	Condition	Time to Complete Matching (seconds)	Accuracy of Matches (%)
1	Control	148	70
2	Experimental	112	85
3	Experimental	98	90
4	Control	132	68
5	Control	120	73
6	Experimental	95	88
7	Experimental	105	92
8	Control	140	65
9	Experimental	107	89
10	Control	153	71

Figure 5: Results of the third experiment

The results of Experiment 2 show that the 3D computer donation website developed in Unity outperformed the existing 3D modeling tool in terms of matching efficiency. Participants using the Unity-based website were able to complete the matching process in less time, with an average of 104 seconds compared to 136 seconds for participants using the traditional tool. Additionally, the accuracy of the matches was significantly higher in the experimental condition, with participants achieving an average accuracy rate of 88% compared to 70% in the control condition. These findings indicate that the Unity-based website streamlines the process of matching volunteers with suitable events, leading to quicker and more accurate matches. The improved matching efficiency offered by the 3D computer donation website suggests its potential to enhance volunteer engagement and optimize the matching process between volunteers and events.

5. RELATED WORK

Gordon, Elisa J. et al [3] has research focused on incorporating targeting elements into online donation systems to increase user engagement and motivation. It proposes a framework that introduces mechanics and rewards to encourage users to track their progress. Comparatively, our work in the 3D donation Unity project shares the goal of motivating users to contribute, but our approach utilizes a 3D environment and leaderboard system to gamify the donation experience, fostering competition and community engagement.

Eisa Shaheen et al [2] have focused research on using and incorporating the blockchain in order to track donations on a website. This is following the issues that charities are not being transparent with their spending or it might be difficult for people to know where their donations are going. Comparatively, our work also has worked on transparent donations, this is done with a database instead of blockchains. The database stores the donation information and displays all donations on a leaderboard that can offer transparent donations and openness to all donations. With blockchains, it is often very secure however it can offer problems with compatibility with different websites to be adopted. A database is very standardized and can be adopted immediately.

Louisa Küchler et al [1] have done research on how website design can alter trust and donation decisions online. With design being increasingly important in websites, it is one of the main factors we look at to see authentic and fake websites. Kuchler looks at how the designs of the websites will alter consumers' choices in donating money or things. Similarly, our work has consisted of a 3d design that is very friendly to use and creates an immersive 3D render. This hopefully allows consumers to believe in the website and use it for future donations. Design is a

huge deal in all websites. However, new concepts like an interactive 3d website can be taken in both ways, good or bad. Since it is a relatively new concept and not many people have tried to do anything with these 3d websites before.

6. CONCLUSION AND FUTURE WORK

The 3D donation website, built using Unity and connected through a back-end server, aims to facilitate computer donations and make a positive impact on people's lives. By providing a user-friendly interface and integrating various components, the application streamlines the donation process and addresses key challenges, resulting in an effective and impactful solution. This website serves as a centralized platform for individuals and organizations to donate computers to those in need. The donation information form allows donors to provide details about their contributions, ensuring transparency and accuracy. The leaderboard component recognizes and showcases the contributions made by donors, fostering a sense of community and encouraging healthy competition. Users can track their progress and compare their donations with others, motivating them to contribute more and make a difference. Through user authentication and account management, the website ensures secure access and provides personalized experiences. Donors can register, log in, and manage their profiles, creating a seamless donation journey. By integrating with a database, the website enables efficient data storage, retrieval, and processing. This allows for real-time updates of the leaderboard and accurate recording of donations. The application helps people by bridging the gap between those who have spare computers and those who need them. It provides an easy and convenient platform for individuals and organizations to make meaningful contributions, promoting digital inclusion and access to technology. The website's effectiveness lies in its ability to streamline the donation process, increase transparency, and foster a sense of community engagement. By gamifying the donation experience through the leaderboard, it motivates users to donate more and surpass their own contributions. Additionally, user authentication ensures the security of personal information and builds trust among users.

While the 3D donation website offers a valuable platform for computer donations, there are certain limitations to consider. Firstly, the accuracy of the leaderboard may be affected by potential discrepancies in data input or reporting. Practicability could be a concern, particularly if the website faces scalability issues when handling a large number of simultaneous users or high volumes of donation data. Adequate server resources and efficient database management are essential to maintain smooth performance and prevent bottlenecks. Optimization is another aspect to consider. The website should be optimized to provide a seamless user experience across different devices and network conditions. Load times, responsiveness, and user interface design should be of concern to this.

To address the limitations, future plans include implementing stricter data validation measures to enhance the accuracy of the leaderboard. Scaling the back-end infrastructure and optimizing database management will improve practicability. Ongoing optimization efforts will focus on refining the user interface, minimizing load times, ensuring a seamless experience across devices, resolving these limitations, and enhancing the effectiveness of the 3D donation website.

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