

Project Description - 8

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ABSTRACT

In many parts of India, particularly in the northern regions, winter brings not only cold temperatures but also hazardous levels of air pollution. The combination of reduced sunlight, human activities, and agricultural practices such as crop stubble burning contribute to the formation of thick smog, severely impacting air quality. This phenomenon poses significant health risks, especially to vulnerable populations, with respiratory illnesses on the rise.

This term paper explores the development of a 3D game or simulation aimed at raising awareness about the detrimental effects of daily activities on air quality and health. By immersing users in a virtual environment, the simulation highlights the consequences of common practices such as vehicle emissions, industrial pollution, and burning of biomass for heating. Through interactive gameplay, users are encouraged to adopt sustainable habits that can mitigate air pollution and improve local air quality.

Drawing on data and insights from real-world pollution events, the simulation provides a compelling and educational experience, empowering users to understand the link between their actions and environmental health. By promoting behavior change and advocacy for cleaner air, this project seeks to foster a positive impact on public health and environmental sustainability.

1 MOTIVATION

Developing a simulation or game to address air pollution presents a compelling opportunity to raise awareness and inspire action towards mitigating this pressing environmental issue. Unlike other projects, creating a polluted environment offers a straightforward concept that can be feasibly

realized without intricate constraints. This simplicity allows for a greater degree of creative freedom, enabling developers to explore various aspects of air pollution and its impacts on health and the environment. Additionally, the abundance of readily available assets online simplifies the development process, reducing the need for extensive asset creation and facilitating efficient project implementation.

Despite its simplicity, the project's scale presents a significant challenge, requiring considerable time and effort to execute effectively. The comprehensive nature of simulating air pollution in a dynamic environment demands meticulous attention to detail and thorough testing to ensure realism and accuracy. Furthermore, the resource-intensive nature of rendering complex environmental effects may strain device capabilities, posing limitations on accessibility and usability. However, overcoming these challenges offers invaluable learning opportunities and the potential for impactful educational experiences that empower individuals to address air pollution effectively.

In conclusion, while the project may entail substantial investment in terms of time and resources, its potential to raise awareness, educate, and inspire action on air pollution makes it a worthy endeavor. By harnessing the power of simulation and gamification, developers can engage audiences in meaningful experiences that foster environmental consciousness and drive positive change. Despite the inherent complexities and challenges, the prospect of contributing to a healthier, cleaner future by addressing air pollution is a compelling motivation for undertaking this ambitious project.

2 PROJECT DESCRIPTION

2.1 Technical Details:

Our project consists of a model of a small polluted city, with smoke effects added to showcase the severity of the pollution and models of humans and vehicles added for realism.

Game Object - We used models of humans and vehicles from the unity assets store as gameobject. We have also incorporated smoke particle effects into project. A script was added for the movements of NPC as well as path of vehicles.

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In addition, we have also added animation to our vehicle model. A note to consider is that the vehicles and NPC have been scripted to show a real city and the crossings and paths have been considered in the same. We now talk about two points where we faced difficulty while making the project:

Vehicle animation - One significant challenge encountered in the development of the project was integrating realistic vehicle animations with textures and smoke effects to simulate vehicular emissions within the polluted environment. While animating vehicles themselves posed technical hurdles in terms of rigging, animation curves, and physics simulation for realistic movement, integrating textures and smoke effects seamlessly proved to be particularly complex. Ensuring that smoke emissions accurately reflected vehicle speed, engine load, and environmental conditions while maintaining performance and visual fidelity required intricate synchronization and optimization. Additionally, coordinating the timing and behavior of smoke effects with vehicle animations to simulate exhaust emissions realistically without causing visual clutter or performance degradation posed a delicate balancing act. Overcoming this challenge necessitated a combination of meticulous asset creation, shader programming, and iterative testing to achieve a harmonious integration of vehicle animations, textures, and smoke effects within the polluted environment, ultimately enhancing the realism and immersion of the simulation.

Glitching of NPC & assets - Another significant challenge encountered during the project was the glitching of non-player character (NPC) interactions with vehicles, leading to clashes between various assets within the environment. As NPCs and vehicles interacted within the dynamic simulation, issues arose with collision detection, pathfinding, and animation synchronization, resulting in unpredictable behavior and visual glitches. Ensuring smooth and realistic interactions between NPCs and vehicles while avoiding collisions and maintaining performance posed a complex technical problem. Additionally, clashes between various assets, such as environmental props, buildings, and terrain features, compounded the issue, further exacerbating glitches and visual inconsistencies. Addressing this challenge required thorough debugging, refinement of collision detection algorithms, and fine-tuning of NPC and vehicle behavior to prevent overlaps and conflicts. Iterative testing and optimization were crucial to identifying and resolving underlying issues, ultimately achieving smoother and more immersive interactions between NPCs and vehicles within the virtual environment.

Main Camera - The main camera in the project plays a crucial role in providing the player with a dynamic and immersive perspective of the virtual environment. Assigned

to the character, the main camera serves as the primary viewpoint through which players navigate and interact with the cityscape. By being tethered to the character, players can seamlessly roam the city streets and observe various activities and events unfolding in real-time. The proximity of the main camera to non-player characters (NPCs) influences their reactions and behaviors, enhancing the sense of immersion and realism. As the main camera moves closer to NPCs, they may acknowledge the player's presence, initiate conversations, or adjust their actions accordingly, adding depth to the interactive experience.

Moreover, the movement speed of the main camera is directly controlled by the actions of the character, allowing for intuitive navigation through the city. When the character walks or sprints, the camera movement accelerates accordingly, providing a responsive and fluid gameplay experience. This dynamic camera control enhances player agency and engagement, empowering them to explore the environment at their own pace and style.

In summary, the main camera serves as the player's window into the virtual world, enabling them to navigate, observe, and interact with the bustling city environment. Its integration with character movement, NPC interactions, and environmental effects enhances immersion and gameplay depth, enriching the overall player experience in the project.



Interacting with NPC & Directional light usecase

Directional Light - We had used the pre-existing directional light feature present in Unity, and changed some components such as type, intensity, and range to fit our solar system model.

Finally, we also implemented all the 3-D environments in XR, which simulated the VR in our laptop device itself due to non-availability of a VR headset. This XR simulator is controlled using mouse and different keys on the keyboard. 'W' and 'S' keys can toggle the camera up and down while the 'A' and 'D' keys toggle the cameras left and right. This is in addition to the original keys that we had implemented above. However, the eclipse and seasons scene were not implemented in the XR simulator since it could only implement the general environment.

2.2 Effect of the pollution on environment of the city:

The smoke emitted by vehicles poses significant environmental challenges for the city, affecting air quality and public health. Vehicle emissions, including exhaust gases and particulate matter, contribute to air pollution, resulting in smog formation and respiratory issues among the populace. The combustion of fossil fuels in internal combustion engines releases pollutants such as nitrogen oxides, carbon monoxide, and volatile organic compounds, which react with sunlight and other atmospheric components to form secondary pollutants like ground-level ozone. These pollutants not only degrade air quality but also contribute to the formation of haze and respiratory illnesses, impacting the overall well-being of city residents.



Cars emitting pollution

Similarly, factory smoke exacerbates environmental degradation within the city, emitting a range of pollutants and toxins into the atmosphere. Industrial activities such as manufacturing, processing, and power generation release emissions containing particulate matter, sulfur dioxide, and heavy metals, among other pollutants. These emissions contribute to smog formation, acid rain, and soil contamination, posing risks to both human health and ecosystem integrity. Factory smoke can also contain hazardous chemicals and volatile organic compounds, which may persist in the environment and bioaccumulate in the food chain, further exacerbating environmental risks and public health concerns.

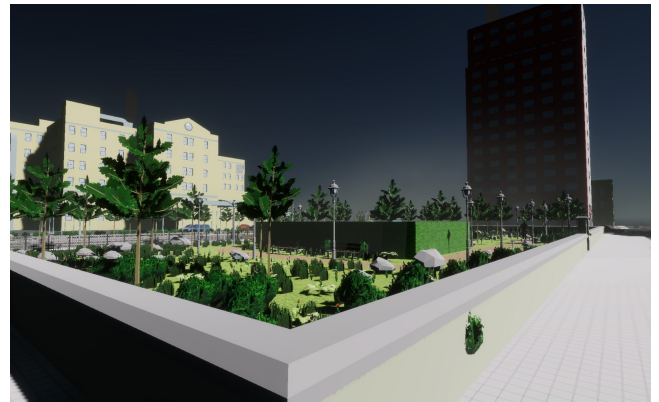


NPC in a residential area



Factory emitting pollution

In response to these environmental challenges, the city has implemented various measures aimed at mitigating the impacts of smoke pollution and promoting environmental sustainability. One such initiative involves the creation of parks and gardens throughout the city, providing green spaces for residents to enjoy recreational activities and improving air quality through enhanced vegetation and carbon sequestration. By increasing green cover and biodiversity within urban areas, these parks serve as natural buffers against pollution, helping to mitigate the effects of vehicle and factory smoke on the local environment.



Parks made by city to fight pollution

Additionally, the city has implemented zoning regulations to designate specific areas for industrial activities, ensuring that factories are located away from residential areas and sensitive environmental habitats. By consolidating industrial activities in designated zones with proper infrastructure and pollution controls, the city aims to minimize the impact of factory smoke on air quality and public health while promoting sustainable industrial development. Moreover, the city encourages healthy habits among its citizens, such as jogging and outdoor exercise, to promote physical activity and reduce reliance on vehicles for transportation. By promoting active lifestyles and sustainable transportation options, the city seeks to reduce vehicle emissions and improve overall air quality, fostering a healthier and more livable urban environment for its residents.



We can see a clear separation of Factory from rest of the city

3 USER REVIEWS

- To further understand the advantages and shortcomings of our project, we conducted a survey regarding the project and what they felt about it. The results we obtained were then studied and analysed to find out a lot of interesting observations.
- **Study Group** - We asked N=20 participants to take part in our survey. We floated a form in our hostel to allow people to download the project and interact with it first-hand. The people were selected at random and were asked to fill out a Google form. Further, we also asked our respective friends back home to try to include a diverse pool of people. The final test group contained people from different educational backgrounds (engineering, pure sciences, commerce, etc.). There were around 13 males and 7 females in the study, all having a basic understanding of how to use computers and Unity.
- **Survey** - Our form consisted of 5 MCQs and 1 descriptive question. The questions were about the specifications and age of the device that participants used to run our VR project and their experience in installing our application and running the VR project.
- **Easiness** - Overall, it was easy to handle our VR project. This was deducted from responses of google form, which has maximum response ratings and ease of using the project. This can be attributed to several factors, but the most relevant of them all would be the fact that the project uses only 5 input keys to work through the entire project, which are similarly mapped as most modern games. Another factor that may be relevant could be the familiarity of Air-Pollution in urban areas with people irrespective of their background. However, we were not able to find any conclusive evidence for the same.
- **Installation of Application** - We also tried finding out how easy or difficult it was for the participants to download the project from the GitHub repository they had received. This survey showed that a larger number of

people found it more difficult to download the project as compared to the ease of using the project. This result was something we were expecting beforehand. Furthermore, it was seen that people who were physically present for the survey, whom we had helped when they got stuck, gave an average higher score in terms of ease than people who did not live on the IIT Kanpur campus.

- **Other technical considerations** - We also tried to understand the relations between technical aspects of the devices that the participants were using and the ease/difficulty they faced while using the data. It was seen that as the RAM of the device being used decreased, the ease of using the project also decreased. This result is trivial. However, we saw that the difference between 16GB and 8GB RAM was not as high as the difference between 8GB and 4GB RAM. This result could be a consequence of not having a large enough study group or personal bias of the participants, but it could be an interesting topic to study further.

CONCLUSION -

The development of a 3D game or simulation targets air pollution awareness, especially in regions like northern India where winter exacerbates the issue. Through immersive virtual environments, users witness the consequences of common practices like vehicle emissions and biomass burning. Interactive gameplay encourages sustainable habits to mitigate pollution and improve air quality. Real-world data enhances the educational experience, empowering users to understand the link between their actions and environmental health. Technical elements like smoke effects and realistic models deepen immersion and authenticity.

The project aims to foster behavior change and advocacy for cleaner air through engaging storytelling. By highlighting the impact of human activities, the simulation prompts users to make informed decisions. It represents a holistic approach to addressing air pollution, combining education, technology, and advocacy. Ultimately, the project seeks to contribute to a healthier and more sustainable future by inspiring action. Through its interactive and educational nature, the simulation offers a compelling tool for raising awareness and promoting positive change.

COMPARISON WITH OTHER 3D GAMES OR SIMULATION

In comparison to other 3D games or simulations addressing air pollution, our project stands out for its comprehensive approach and immersive experience. While some simulations may focus solely on one aspect of pollution, such as vehicle emissions or industrial pollution, our project covers a broader spectrum of common practices contributing to air quality degradation, including biomass burning and human activities.

Unlike other simulations that may lack real-world data integration, our project draws on authentic pollution events

and insights to provide a more compelling and educational experience. Additionally, our emphasis on interactive gameplay sets us apart, as users are not only observers but active participants in shaping their virtual environment and learning about the consequences of their actions.

Moreover, the technical sophistication of our project, with realistic models of humans, vehicles, and smoke effects, enhances immersion and engagement, surpassing the visual appeal of many other simulations. By offering a platform for users to not only understand but also actively combat air pollution through sustainable behavior change, our project takes a proactive stance towards environmental advocacy.

Furthermore, our project's focus on fostering behavior change and advocacy for cleaner air distinguishes it as a tool for empowering individuals to make a tangible difference in their communities. Ultimately, our project aims to not only raise awareness but also inspire action, making it a standout contribution to the field of environmental education and sustainability in the realm of 3D gaming and simulation.

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