

Paper Title: Forest Fire Spread Simulation and Fire Extinguishing Visualization Research

1. Summary

This paper introduces a lightweight approach to model forest fire spread using cellular automata within a virtual 3D environment. It accomplishes this by constructing a library of plant models represented as cells, as well as creating detailed 3D geometric models of plants to accurately replicate the combustion process of individual plants. This approach allows for the simulation of large-scale forest fire propagation and an in-depth analysis of the various factors influencing how forest fires spread. This paper presents an innovative approach to modeling forest fire dynamics in a virtual 3D environment. It achieves this by leveraging cellular automata and creating comprehensive plant models, enabling the simulation of large-scale forest fire propagation. Additionally, the study explores various fire suppression methods, enhancing the overall visual representation of forest fire occurrences and their management within an interactive simulation. This comprehensive approach contributes to a more immersive and realistic depiction of 3D forest fire scenes, particularly by capturing the dynamic changes in plant materials as fires spread.

1.1 Motivation

This paper further explores the principles of the forest fire spreading and extinguishing. This visualization of the model, when applied in real-time to help plan fire strategies and training, not only supports the training of firefighters and managers and helps improve fire control and prevention, land management, and firefighter distribution-based training strategies, but it is also used as a decision aid to provide decision support

1.2 Contribution

This study greatly enhanced the immersion and realism of the 3D forest fire scene by simulating the changes in plant materials during the spread of a forest fire

1.3 Methodology

The proposed approach is an innovative approach to modeling forest fire dynamics in a virtual 3D environment. It achieves this by leveraging cellular automata and creating comprehensive plant models, enabling the simulation of large-scale forest fire propagation. It considers a diverse set of factors, encompassing both static elements such as the presence of flammable materials and the topography, as well as dynamic variables like weather conditions.

1.4 Conclusion

In conclusion, this study primarily centers around the development of a fire propagation model based on the principles of cellular automata. The main aim is to visualize the way flames advance within 3D virtual forest settings. The critical dynamic influencers affecting the course and velocity of forest fires are incline, wind direction, and wind velocity. Moreover, rainfall serves as a hindrance to the spread of fires.

2 Limitations

Because of the generality of the model created in this research, while it is capable of replicating the observed final fire boundary, it lacks the ability to capture the distinctiveness of fire behavior due to the absence of test on a larger sample of fire. This includes behaviors like deflagration and re-ignition.

3 Synthesis

In the future, enhancing the rational structure of fire extinguishing visualization is to build a more comprehensive system for managing forest fire incidents, decision-making, and fire extinguishment. This will enable the efficient allocation of firefighting resources in forest fire-affected areas and offer effective visual decision support for forest fire rescue operations, fire damage evaluation, and post-fire recovery efforts.