GR-306

Improving Wildfire Propagation Simulations Using Cellular Automata to Help Emergency Management

Abstract

The objective was to improve the accuracy of the proposed CA model by Freire et al. [2019] in simulating wildfire propagation to reduce uncertainty intrinsic to a probabilistic approach. This was an attempted by incorporating the fire weather indices that account for relevant meteorological, climatological, and fuel stress and flammability conditions that affect the ability of, and therefore the probability that, fuel within a cell can ignite within a given time step. Along with this the capability to account for burn rate for cells with varying fuel load factors unlike in the constant burn rate used by Freire et al. [2019], for each time step based on empirical and probabilistic data was studied which was specific to a certain prior fire incident.

Introduction

Cellular Automaton is a discrete computational model, made up of grid cells, each of which has a limited number of states. In Freire et al. [2019] study, probabilistic CA model was used. It implemented a wind propagation rule to simulate the spread of wildfires to non-adjacent cells to model the impacts of fire spotting. The wind speed and the angle formed between the new cell's displacement vector and wind direction were used to describe how a fire spreads. However, their study assumes a constant burn rate for all cells and does not account for fuel stress, which influences the probability that a cell will catch fire. This aspect can be refined by not assuming a constant burn rate for each cell regardless of fuel conditions.

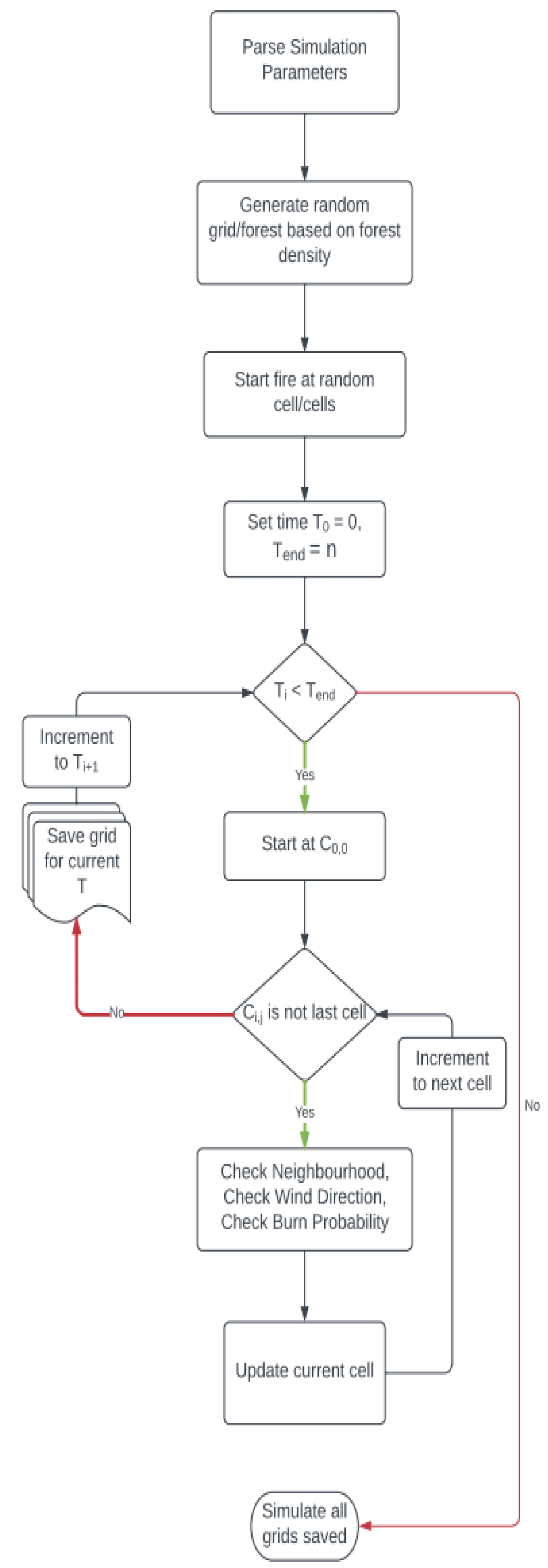
Research Questions

1. Do any additional parameters will result in more accurate simulation of real time wildfire incident?

Acknowledgements

https://www.fire.ca.gov/incidents/2020/7/20/gold-fire/

Results



Future Plans

Run more simulations on real fire incidents and improve the parameters.

Add parallelization in the code flow.

Materials and Methods

In our model, the simulation is triggered by passing the input parameters such as grid size, initial burn probability, forest density, fuel type, etc. It is initiated using a random grid or real-time map data. The simulation begins at T0 and ends at Tend. Starting from the first cell, C0, to the last cell, Cend, propagation rules based on local meteorological, climatological, topological, and fuel loading parameters are applied to each cell value (C) at each time step T. At each time step, the new grid is saved when all the cell values have been updated. At the final stage of the simulation, the animation is executed using all the grid matrices.

Conclusions

In the efforts of implementing the more accurate model in simulating the wildfire, we took additional meteorological factors into consideration. We compared the simulation results with actual fire spread data.

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References

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