Mixed Reality & Simulation

Forest Fire

WS 2023/24

Upload a zip-file with your name ff-[last name].zip (eg ff-konrad.zip) to moodle (Upload - Forest Fire (15 points)).

The zip-file should contain:

- Code-files containing your algorithm
- Protocol
- Short video

Assessment:

- Functionality/Algorithm (3 points)
- Performance/Parallelization (3 points)
- Random fires & tree growth - parameterized (2 points)
- Clickable/start a fire (2 points)
- Protocol (Screenshots, description of project, algorithm & neighborhood) (3 points)
- Video (2 points)

Algorithm:
Create a forest fire simulation using a two dimensional cellular automaton with three states S=Tree, Fire, Empty. Choose between Moore - or Von Neumann - neighborhood. The minimum grid size is 1024x1024. The boundary condition can be chosen accordingly.

- An empty cell with a burning tree will become empty:
  $s_C(t)$=Fire $\rightarrow$ $s_C(t+1)$=Empty

- A cell containing a tree will catch on fire, if at least one neighbor is on fire:
  $s_C(t) = \text{Tree} \rightarrow s_C(t+1)=\text{Fire}$ if $\in N_C$ where $s'(t)=\text{Fire}$
- A cell containing a tree without a neighbor on fire will catch fire with a probability p or stay a tree with a probability (1-p):
  $s_C(t) = \text{Tree} \rightarrow s_C(t+1)=\text{Fire}$ with probability p if $\notin N_C$ where $s'(t)=\text{Fire}$
  $s_C(t) = \text{Tree} \rightarrow s_C(t+1)=\text{Tree}$ with probability 1-p if $\notin N_C$ where $s'(t)=\text{Fire}$
- An empty cell will grow a new tree with a probability g or stay empty with a probability (1-g):
  $s_C(t) = \text{Empty} \rightarrow s_C(t+1)=\text{Tree}$ with probability g
  $s_C(t) = \text{Empty} \rightarrow s_C(t+1)=\text{Empty}$ with probability 1-g

Performance:
Calculate values for cells in parallel using multiprocessing or multi-threading programming. Consider using OpenMP, OpenCL or Compute Shader. Measure the time (in ms) of your algorithm for calculating 1, 10, 100, 1000 and 10000 steps.

Other requirements:
The probabilities for starting a random fire (p) and growing a random tree (g) should be configurable inside the application.
Use the mouse input to click on a specific tree to start a fire at the position of the click.

Documentation:
Create a short ($\sim$ 2 pages) **protocol** containing a description of your solution. How does your algorithm work? How is it run in parallel? Did you use Moore or Von Neumann neighborhood? What's your boundary condition? Also include some screenshots showing your algorithm at work.
Include the results of your performance measurements (1, 10, 100, 1000, 10000 steps) in the protocol. Also add the PC specifications (CPU, RAM, Graphics card) you ran the simulation on.
Create a short ($\sim$ 1 min) **video** showing random fires and random tree growth, manipulating the probabilities (p & g) & fires started by clicking.