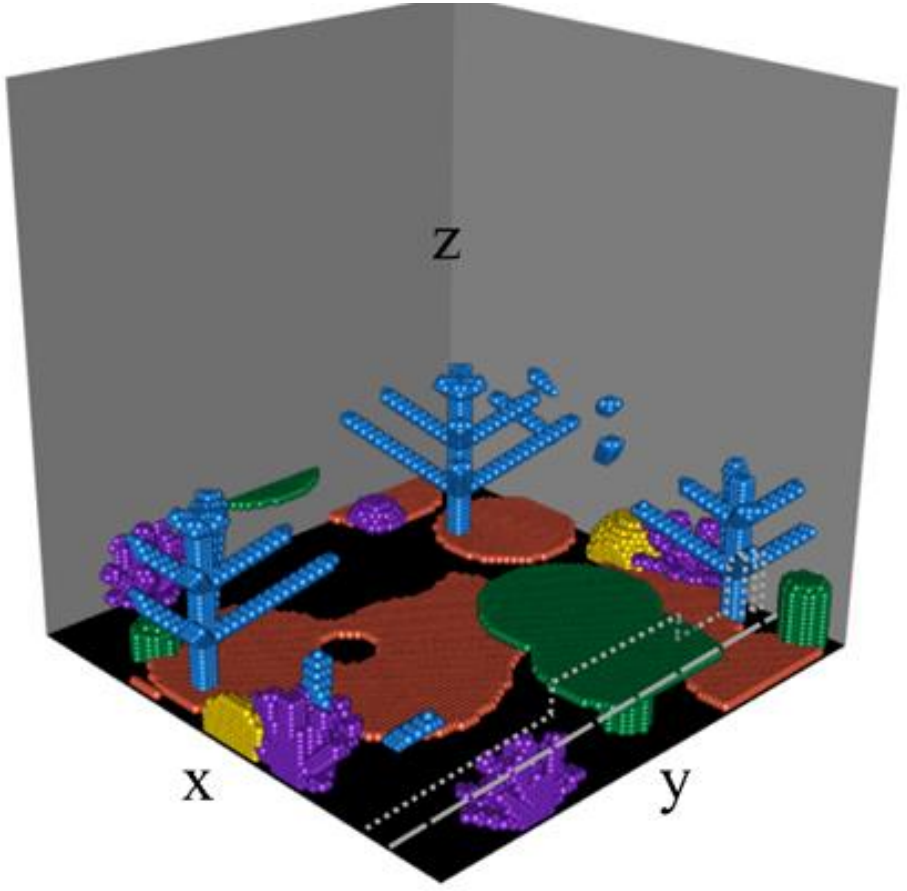
Simulating Coral Competition and Growth in a 3D Environment

Nejc Hirci

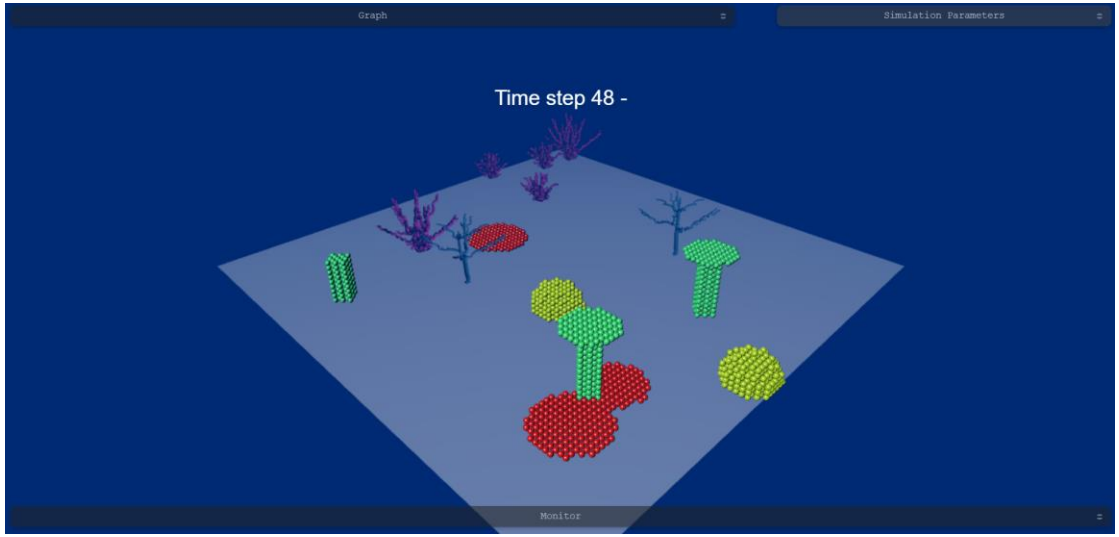
Introduction & Problem Statement

- **Problem**: Coral reefs' vulnerability to climate-induced changes.
- **Importance**: Ecosystem preservation, marine biodiversity.
- **Challenge**: Need for advanced, accurate 3D simulation models for effective reef restoration.

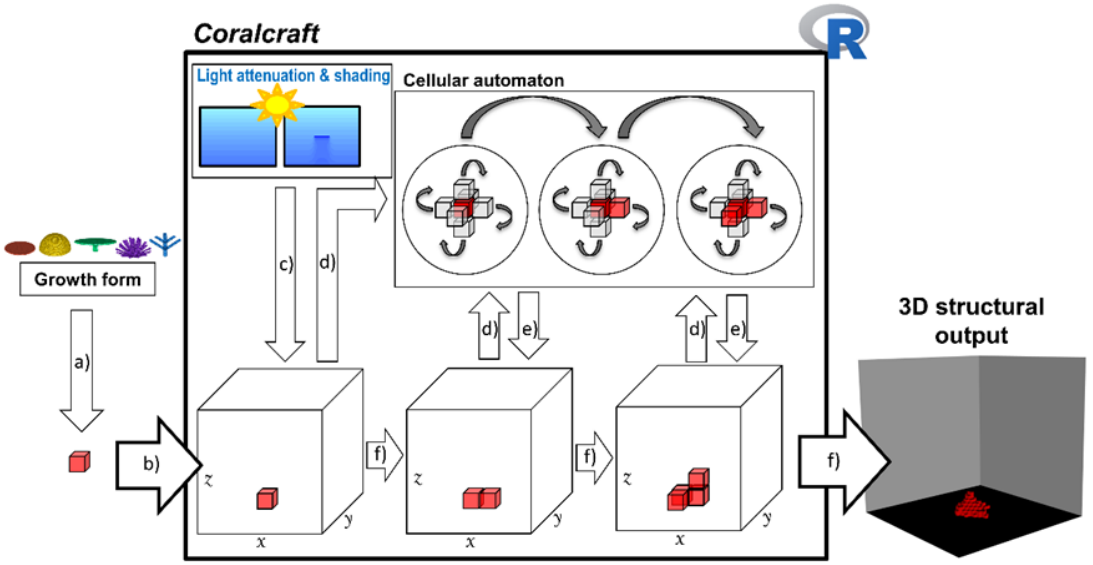


Goals of the Proposed Solution

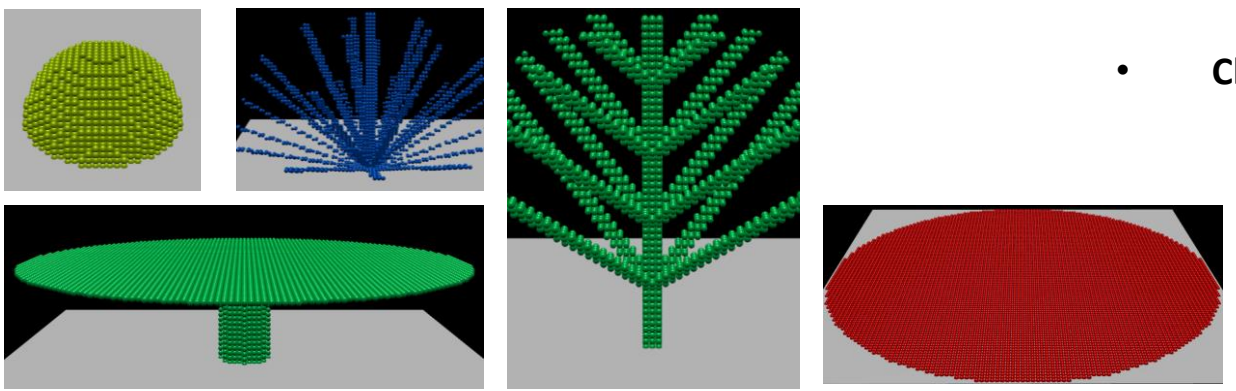
- **Objective**: Develop a realistic, real-time 3D coral simulation model.
- **Inspiration:** Adapt and extend models based on recent research (e.g., Cresswell et al. [1]).
- **Proposed extensions:** optimization improvements, additional sedimentation process, and an improved growth submodel.

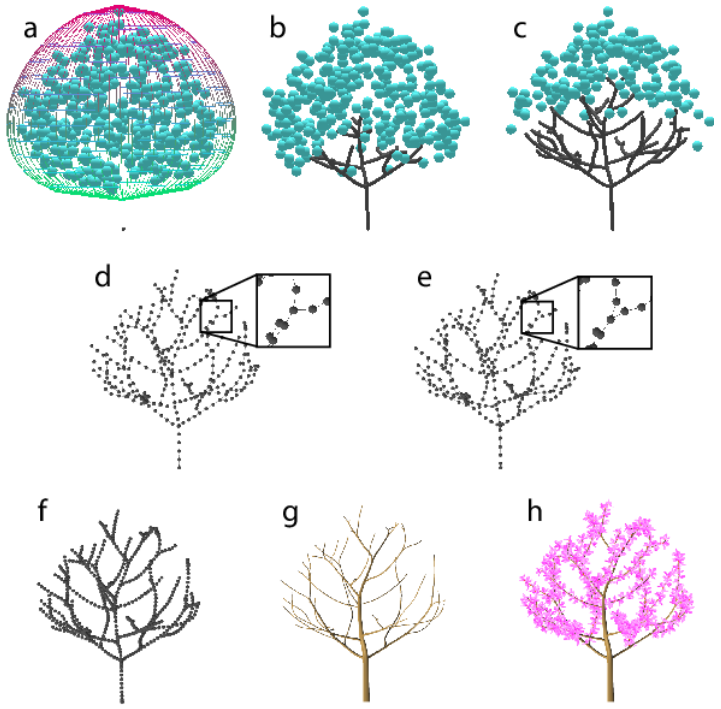


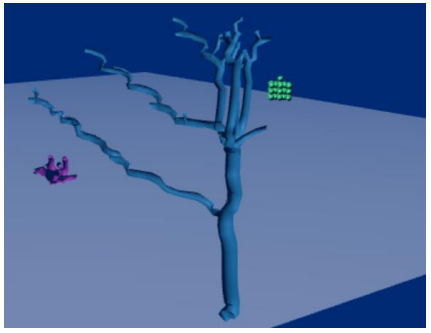
Simulation Model (*Coralcraft*)

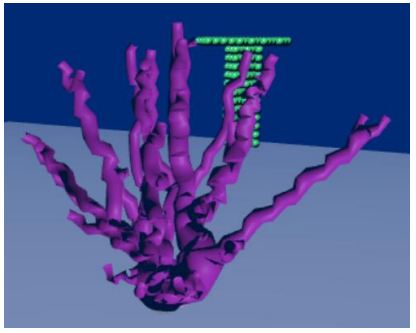


- **Components**:
  - Five coral morphologies: branching, tabular, encrusting, hemispherical, corymbose.
  - Processes: Growth, reproduction, mortality, hydrodynamic disturbance.
- **Challenges:**
  - Not implemented for real-time rendering and simulation.
  - Very simplistic growth model, based on cellular automata.



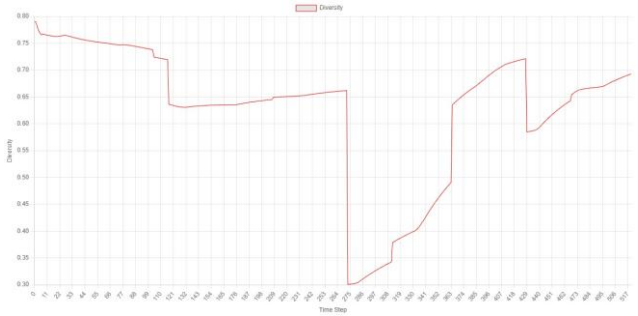


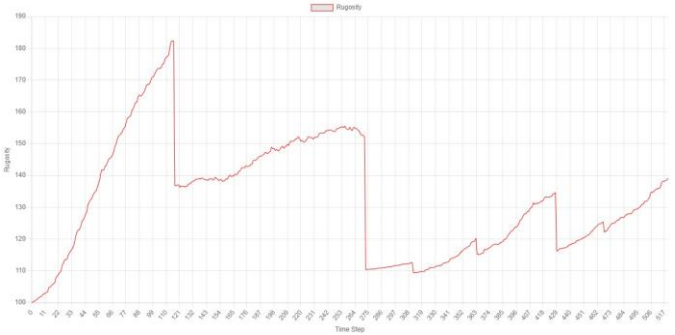


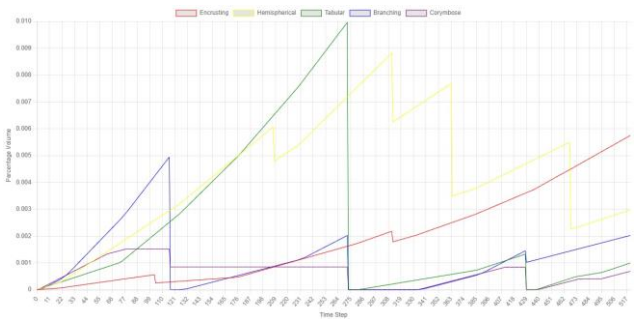


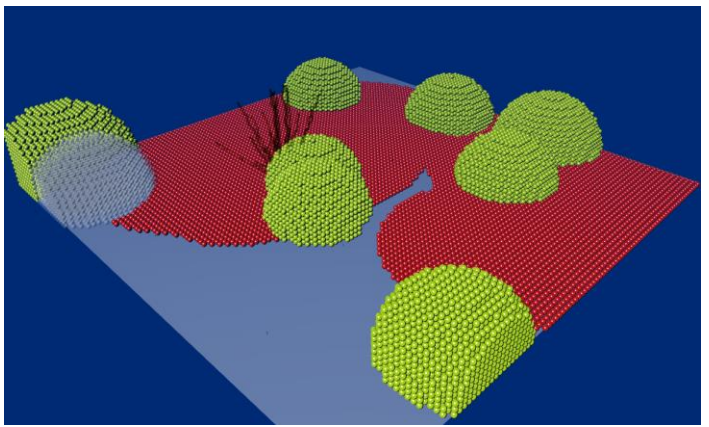
Growth Extension

- **Approach**: Adapt space colonization algorithm for realistic branching corals.
- **Advantages**:
  - Mimics tree-like branching patterns seen in branching and corymbose coral morphologies.
  - Enhances visual realism and ecological accuracy.
  - Allows for greater diversity in simulated coral structures.



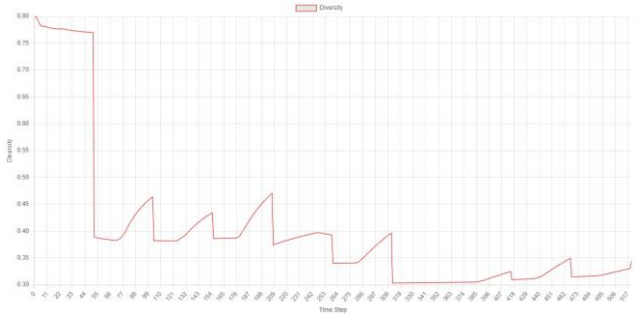


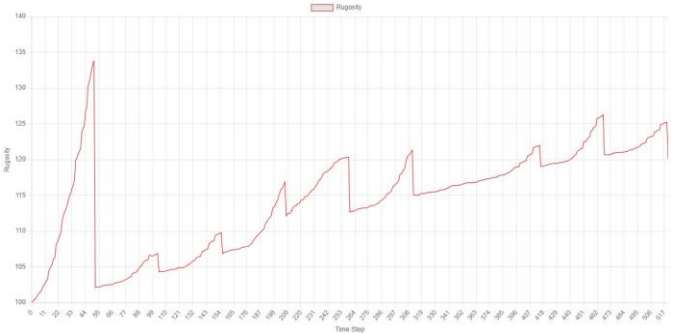


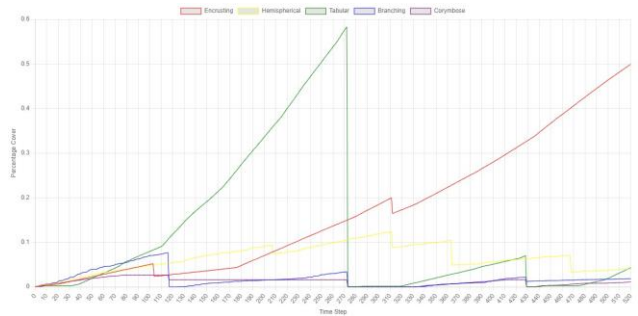


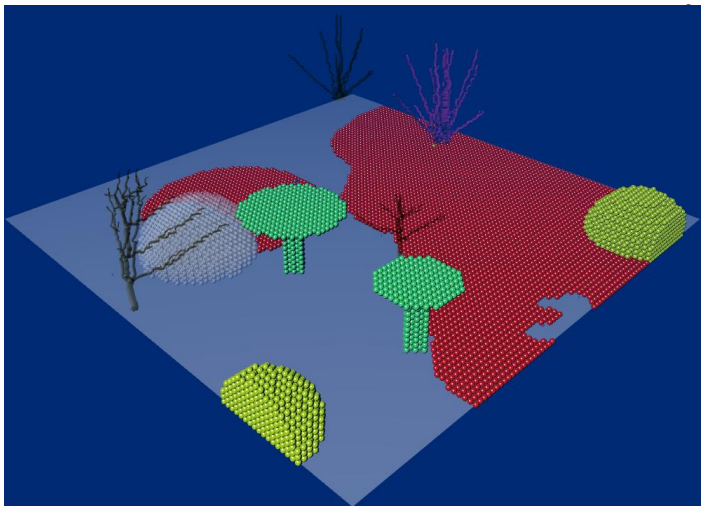
Results

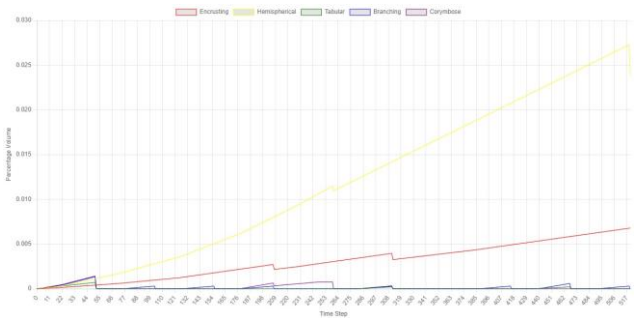
- 10-year growth under varying hydrodynamic disturbances.
- **Key Findings**:
  - Impact on coral diversity and structural robustness.
  - Differences between low and high disturbance scenarios.
  - Visual comparison with the baseline *Coralcraft* model.











Results

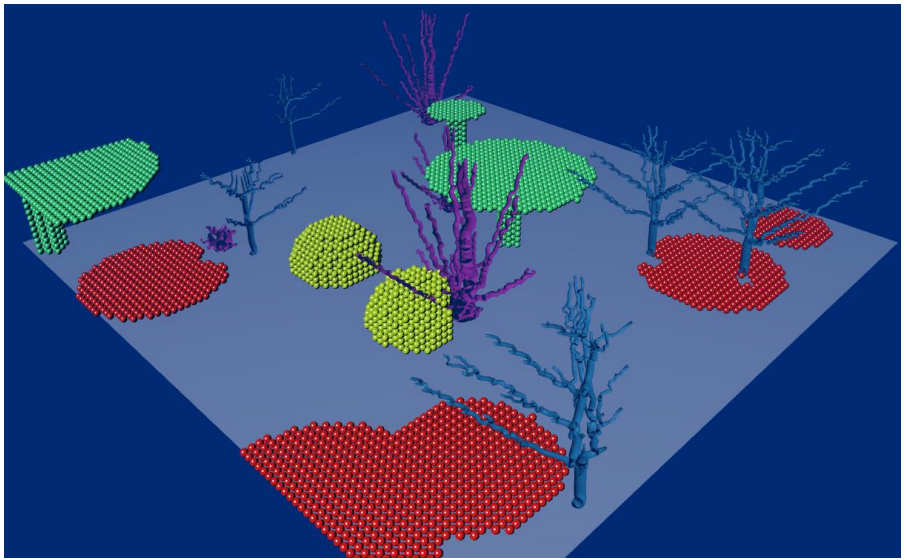
- 10-year growth under varying hydrodynamic disturbances.

Key Findings:

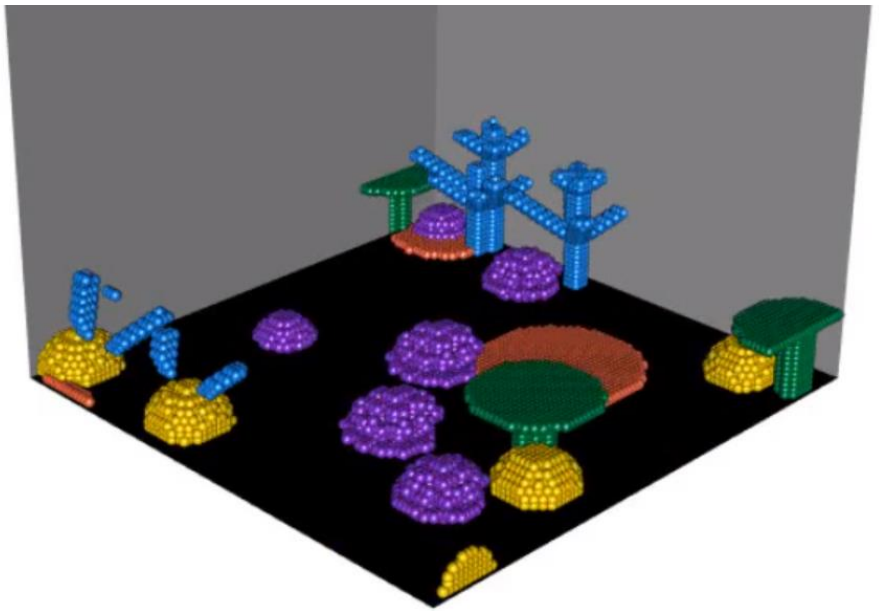
- Impact on coral diversity and structural robustness.
- Differences between low and high disturbance scenarios.
- Visual comparison with the baseline *Coralcraft* model.

Results

Our Model



Coralcraft



Conclusion

- **Achievements**: Real-time web-based model application, enhanced visualization, improved growth modeling.
- **Future Directions**: Further optimization, integration of fluid simulations, expanding the growth model complexity, with accretive growth