SEISIM

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Abstract

SEISIM simulates an expected earthquake evacuation scenario in Istanbul and analyzes the impact of collapsed buildings and roads, sufficiency of assembly zones, and crowd behavior. By combining real map data with agent-based modeling and high-performance visualization, SEISIM supports urban planning and disaster preparedness with actionable insights.

Introduction

Evacuating dense urban areas after a major earthquake is challenging due to collapsed infrastructure and unpredictable crowds. SEISIM simulates realistic evacuation scenarios using agent-based modeling and real GIS data, helping assess assembly zone sufficiency, road blockages, and crowd behavior for better disaster planning.

Solution

SEISIM models earthquake evacuation as a dynamic, agent-based system over a real-world road network. Each agent represents one or multiple pedestrians navigating toward the nearest assembly zone while responding to environmental changes such as blocked roads. The simulation uses rule-based movement logic influenced by crowd dynamics, congestion, and local decision-making. By iterating over discrete time steps, SEISIM evaluates the efficiency of evacuation flows and identifies critical bottlenecks in the urban layout.

SEISIM is developed in collaboration with civil engineering department. It integrates an AI model to predict building collapses based on structural and seismic data. The dispersion radius is calculated using a formula researched and validated by the CE teammate. The resulting debris dispersion from collapsed structures is used to assess road blockages by considering road lanes and building stories. This allows SEISIM to simulate realistic impacts of structural failure on evacuation routes, enhancing the accuracy of the overall simulation.

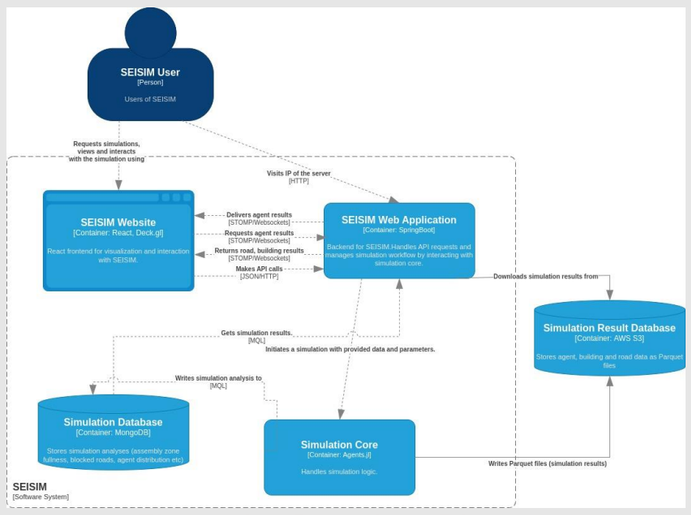


Figure 1 – Container Diagram

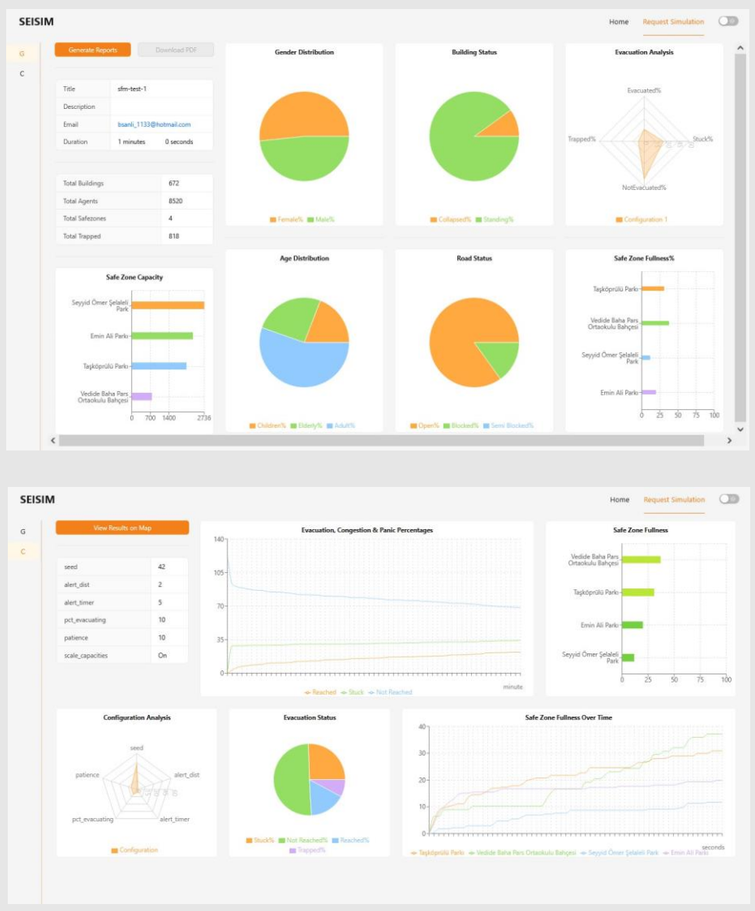
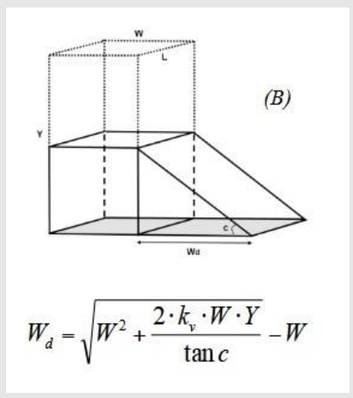


Figure 2 – Finished Product



$$W_d = \sqrt{W^2 + \frac{2 \cdot k_v \cdot W \cdot Y}{\tan c}} - W$$

Wd = Debris spread area (m)
W = Building width (m)
Y = Building height (m)
kv = Building volume loss ratio
c = Collapse angle

Figure 3 – Estimation of debris with Wd for dense urban areas

Target Market

SEISIM is designed for urban planners, architects, disaster response teams, municipal governments, and NGOs focused on earthquake preparedness. In earthquake-prone, high-density regions, there is a critical need for tools that can reveal evacuation challenges, assess infrastructure vulnerabilities, and support informed decision-making for emergency planning and urban design.

Results & Conclusion

Collapsible buildings were predicted using machine learning based on structural, geotechnical and seismic properties, and their impact on road closures was analysed using a suitable debris dispersion model. These engineering-based data provided realistic infrastructure inputs to SEISIM simulations.

SEISIM effectively simulates pedestrian evacuation in earthquake scenarios, highlighting how collapsed buildings and congested roads create critical bottlenecks and influence crowd movement. The simulation provides valuable insights for improving urban disaster preparedness and infrastructure design.

Future work includes enhancing agent decision-making with more sophisticated behavioral models, incorporating multi-hazard scenarios, and expanding to other urban areas. Challenges remain in scaling the simulation for very large populations and improving model accuracy.

Acknowledgement

We thank **Bilgin Avenoğlu** and **Seda Selçuk** for their support as project advisors, and **Can Gölgeloğlu** for their help with GIS tools.