Simulating Glass Bending via Smoothed Particle Hydrodynamics

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Abstract

Electric vehicles are the future of the automotive industry. At the moment, electric vehicles suffer from large batteries, commonly stored below the passenger cabin, taking up precious vertical space. In order to improve passenger comfort, car manufacturers are looking for ways to make the cabin appear more open. One possible solution is the utilization of larger glass panels for the windscreen and roof. Such glass panels would be required to feature complex bends (bends in two directions simultaneously) with small radii, to conform to current design philosophies and aerodynamic demands.
At the present time, complex small-radii bends for large sheets of glass can not be produced in an industrially acceptable timeframe. The goal of this project is to make such complex bends possible. In order to identify processing schemes that make the production of glass sheets with complex bends feasible, a smoothed particle hydrodynamics (SPH) simulation of the bending process is being developed. SPH is a particle-based simulation method that enables the simulation of large deformations and free surface flows. The proposed SPH simulation will contain a viscoelastic model of glass in the tranformation region between the transitioning temperature and the liquidus temperature.
The simulation will calculate the bending behavior of glass sheets with various temperature and force distributions across time. An optimization algorithm will compare the resulting shape with the target shape and iterate over the temperature and force distribution, until the ideal profile is reached. Real-world limitations of the temperature and force distributions will be taken into account. The resulting ideal profile will then be used to identify possible processes, which, in the next step, will be used in trial runs in experimental furnaces.

Keywords: Smoothed Particle Hydrodynamics, PySPH, Viscoelastic Material Model

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