Geometric Integration for High Fidelity Visual Computing Applications

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To be able to take into account a multitude of physical effects, high fidelity simulations are nowadays of growing interest for analysing and synthesising visual data. In contrast to most numerical simulations in engineering, local accuracy is secondary to the global visual plausibility. Global accuracy can be achieved by preserving the geometric nature and physical quantities of the simulated systems for which reason geometric integration algorithms like symplectic methods are often considered as a natural choice. Additionally, if the underlying phenomena behaves numerically stiff, a non-geometric nature comes into play requiring for strategies to capture different timescales accurately. In this contribution, a hybrid semi-analytical, semi-numerical Gautschi-type exponential integrator for modeling and design applications is presented. It is based on the idea to handle strong forces through analytical expressions to allow for long-term stability in stiff cases. By using an appropriate set of analytical filter functions, this explicit scheme is symplectic as well as time-reversible. It is further parallelizable exploiting the power of up-to-date hardware. To demonstrate its applicability in the field of visual computing, various examples including collision scenarios and molecular modeling are presented.