IsoGeometric state concatenation method for reduced order simulation of complex accelerator cavities

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In the numerical modelling of linear accelerator structures, the simulation domain is often restricted to single RF cavities, since the direct numerical treatment of the whole chain is too computationally expensive. The resource requirements in terms of both CPU time and memory become even more challenging when a large number of simulations needs to be performed, as is the case for, e.g., uncertainty quantification or shape optimization.

The use of IGA in cavity simulation has been proven to be beneficial both in terms of accuracy and of overall reduction of the computational cost \cite{1,2}. However, the simulation of large and complex structures remains an overwhelming task.

In order to overcome these difficulties we consider the extension to the IGA setting of the State Space Concatenation (SSC) method recently introduced by Flisgen et al. \cite{3,4}. In the SSC approach, the complete computational domain geometry is decomposed into smaller sub-domains in which the fields are modelled by means of low dimensional modal bases. By placing the interfaces between neighbouring sub-domains at suitable locations, where the domain geometry approaches that of a waveguide, physical knowledge about the waveguide dispersion relation may be exploited to a priori select the most relevant elements of the local modal bases. The model for the complete system is then recovered by treating each sub-domain as a dynamical system with given Input/Output characteristics and by coupling the I/O “ports” of neighbouring cells.

In order to study the accuracy and stability properties of the IGA/SSC method, we cast it into the form of standard Domain Decomposition methods. As a by-product, our more abstract representation of the SSC allows for straightforward extension of the approach to other physical applications ranging from Quantum Mechanics to Structural Vibrations.

**Keywords:** Domain Decomposition, Isogeometric Analysis, Linear Accelerator, State Space Concatenation.

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**REFERENCES**