The numerical simulation of flows involving moving boundaries is of great interest in various engineering fields (e.g. aeronautics, transports, turbo-machinery, bio-fluid mechanics, ballistics, wind energy) and several problems of industrial pertinence require the study of the interactions between structures and the fluid (aeroelastic effects of manoeuvring aircraft, deployments of control surface, the flow of blood through arteries, etc.) or the analysis of the behaviour of multiple bodies in relative motion (store release from an aircraft, space launch vehicle separation, air refuelling, helicopter landing, etc.)

This PhD research work is dedicated to developing and assessing a computational methodology including remeshing and interpolation strategies for CFD simulations involving moving bodies in a three-dimensional domain. The strategy aims at handling large displacements without compromising the flow solution accuracy due to constraints on the mesh quality and on the CFD method. The partial remeshing strategy is developed for hexa-dominant meshes, focussing on minimizing the region to be remeshed and interpolated. The idea at the core of the methodology is to create a conforming connection between the body-fitted meshes created for each body, with each body-fitted grid rigidly following the movement of the respective body. To create the conforming connection, pyramids are used to transition from hexahedra to tetrahedra and two strategies are proposed with the goal of improving the quality of the resulting mesh.

The interpolation is carried out using the augmented Radial Basis Function (RBF), where polynomial terms are added to the radial functions for improved accuracy. Moreover, we propose an octree-based strategy for donor selection to ensure a well-distributed cloud of points around the target point.

To explore the capabilities of the performed developments several test cases are investigated for various characteristic flow conditions, including compressible and incompressible flows and laminar and turbulent regimes, and for varied rigid body motions of large amplitude, including translation and rotations.

The suggested approach was implemented and tested within the HEXPRESS/Hybrid and FINE/Open software package, edited by NUMECA Int.