Three methods are employed for the establishment of a weak form to the coupled system. The first one is the
penalty multipatch isogeometric analysis on multipatch geometries. Correspondingly, the decom-
position of the interface conditions but not de-
terminate the condition number of the matrix $\text{T}^\text{t}$. In the mortar method the choice
$N^\text{N} = N^\text{P}$ is made, so that the trans-
formation matrix $\text{T} = (C^\text{N})^\text{t} (C^\text{P})$ is symmetric, pos-
titive definite and diagonally dominant. A unique interface method must be identified so
that the above integrals can be evaluated. Especially in case of data exchange between B-Splines surfaces and
Finite Volume elements, the bases are always non-conforming across the interface. For this reason each fluid
node is orthogonally projected onto the B-Spline surface. Then, the integration is performed at the sub-element
level. If the discrete virtual work over the interface is to be preserved, namely $\delta W^\text{S} = Y^\text{S} \delta V^\text{S}$ on $\Gamma^\text{S}$, then
matrix $\text{T}$ can be used for the force transfer.

**Flow over semispherical pressurized membrane**

A pressurized semispherical membrane is employed in a fluid-structure inter-
action environment for the comparison of the results obtained by the classical
FEA and IGA for the discretiza-
tion of the structural field. The mem-
brane has Young’s modulus, poison’s
ratio and structural density equal to $10^3$ KN/m$^3$, 0.3 and 1700 Kg/m$^3$, re-
spectively, whereas it’s radius and it’s
thickness are equal to 50 cm and 1 mm,
respectively. In addition, the membrane is subject to internal pres-
sure equal to 10 N/m$^2$ so that it stays in
semishperical shape when no other loa-
ding conditions are prescribed. For the structural problem both classical FEA and IGA are employed us-
ing the software Cast3m++, Chair of Structural Analysis. Prof. Dr.-Ing. Kai-Uwe Bletzinger. The fluid is as-
sumed to be the air, modelled as a Newtonian incompressible fluid with density and dynamic viscosity equal
$1.22$ Kg/m$^3$ and $18.77$: $10^{-5}$ Kg/m$^s$, respectively. OpenFOAM, see http://www.openfoam.org/, is
an open source software which was used in this study for the fluid problem. On the other hand, EMPIRE, see http://empire-st-bt.tum.de/ is used for the communication of the fields across their interfaces.

**Non-matching grid data transfer between classical finite element and isogeometric grids**

The metrics of the interface are transferred through the so-called
Non-matching grid data transfer between classical finite element and isogeometric grids, which is based on the minimization of the gap function $d^\text{S} - d^\text{P}$ between the structural and the fluid mesh displacement fields in the
$l^2(\Gamma^\text{G})$ space, namely:

$$\int_{\Gamma^\text{G}} (d^\text{S} - d^\text{P}) \mu \text{d} \Gamma^\text{G} \quad \forall \mu \in (l^2(\Gamma^\text{G}))^\text{t}$$

In its discrete form, the mortar method writes:

$$d^\text{S} - d^\text{P} = (C^\text{N})^\text{t} (C^\text{P})$$

where the hat in the above vectors indicates that they contain the re-
spective degrees of freedom. The coupling matrices are given by:

$$(C^\text{N}) = \int_{\Gamma^\text{G}} (N^\text{N})_i \mu \text{d} \Gamma^\text{G}$$

$$(C^\text{P}) = \int_{\Gamma^\text{G}} (N^\text{P})_j \mu \text{d} \Gamma^\text{G}$$

$N^\text{N}$, $R$ and $N^\text{P}$ being the basis function matrices for the Lagrange Multipliers field $\mu$, the structural and the
fluid mesh displacement field across the interface, respectively.

Figure: Modelling and discretization of the semispherical membrane.