How contact interactions may depend on the shape of Cauchy cuts in N-th gradient continua: approach "à la D'Alembert"

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Navier-Cauchy format for Continuum Mechanics is based on the concept of contact interaction between subbodies of a given continuous body. In this paper it is shown how -by means of the Principle of Virtual Powers- it is possible to generalize Cauchy representation formulas for contact interactions to the case of N-th gradient continua, i.e. continua in which the deformation energy depends on the deformation Green-Saint-Venant tensor and all its N-1 order gradients. In particular, the explicit representation formulas to be used in N-th gradient continua to determine contact interactions as functions of the shape of Cauchy Cuts are derived. It is therefore shown that

i) these interactions must include edge (i.e. concentrated on curves) and wedge (i.e. concentrated on points) interactions, and

ii) these interactions cannot reduce simply to forces: indeed the concept of K-forces (generalizing similar concepts introduced by Rivlin, Mindlin, Green and Germain) is fundamental and unavoidable in the theory of N-th gradient continua.