Università degli Studi di Pavia
Computational Mechanics & Advanced Materials Group - DICAr

SEMINAR

A Computational Framework for Tissue-Scale, Patient-Specific Prediction of Prostate Cancer Growth

Predictive medicine is a new trend in Medicine that aims at forecasting clinical outcomes of diseases and designing optimal therapies on a patient-specific basis. Methods of predictive medicine are based on mathematical modeling and computer simulations. Prostate cancer (PCa) is a major cancer among men worldwide and an ideal candidate to benefit from this approach to medical practice.

We present a continuous model for organ-confined PCa growth. We use the phase-field method to account for the healthy-to-tumoral transition and diffusion-reaction equations to model the dynamics of nutrients and the production of PSA. The growing tumor produces a mass effect that induces the deformation of the prostate. The stress fields may exert an inhibitory effect on the development of the tumor. Hence, we also explore the mechanical coupling of this deformation with tumor dynamics. Our simulations leverage Isogeometric Analysis (IGA) using a hierarchical basis of NURBS to accurately and efficiently compute tumor growth.

We used our model to perform tissue-scale, patient-specific simulations of PCa cases, based on the patient's prostatic anatomy extracted from medical images. These simulations show tumor progression similar to that seen in clinical practice.

REFERENCES:

[1] Lorenzo, Scott, Tew, Hughes, Zhang, Liu, Vilanova, Gomez, “Tissue-scale, personalized modeling and simulation of prostate cancer growth”, Proc. Natl. Acad. Sci. U.S.A., 113 (48), E7663-E7671 (2016).

[2] Lorenzo, Scott, Tew, Hughes, Gomez, “Hierarchically refined and coarsened splines for moving interface problems, with particular application to phase-field models of prostate tumor growth”, Comp. Meth. Appl. Mech. Eng., 319, 515-548 (2017).

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