Real-Time Computer Modeling in Prevention of Chronic Wounds

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Pressure ulcers are a major public health issue. While in interactions with external supports such as shoes, seats or mattresses, human soft tissues can suffer from discomfort that may transform into pains or tissue injuries. Indeed, the mechanical interactions between such external supports and skin tissues, usually below a bony prominence, generate shear stresses and normal pressures that can affect soft tissues integrity.

Current prevention techniques are mainly based on daily skin inspection to spot red patches or injuries. Nevertheless, most pressure ulcers occur internally and are difficult to detect early.

Estimating internal strains within soft tissues could help to evaluate the risk of pressure ulcer. For this, a subject-specific biomechanical model (e.g. a Finite Element model) can be used to assess tissue internal strains from measured skin surface pressures. However, any realistic 3D non-linear Finite Element model, with different layers of tissue materials for skin, fat and muscles, requires somewhere between minutes and hours to compute, therefore forbidding its use in a real-time daily prevention context. During this talk, we will present our proposals to optimize these computations by using a reduced order modeling technique (ROM) based on proper orthogonal decompositions of the pressure and strain fields coupled with a machine learning method.

3 points summary:

- Why is a patient-specific model of the soft tissue required to provide a personalized pressure ulcer prevention device?
- How to build a patient-specific Finite Element model of the soft tissues in interaction with external supports?
- How to run in real-time such a model so that is can be used by an embedded medical device for pressure ulcer prevention?