A study on the usefulness of Support Vector Machines for the realtime computational simulation of soft biological organs

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Context

• Surgical simulators
• Realistic and realtime – surgery planning, surgical simulation
• Speed vs accuracy – Supercomputing, desktop computing
• Continuum mechanics based vs soft computing
• Artificial Neural Networks (ANNs) already tried in literature – Genetic algorithms, fuzzy logic
• Try Support Vector Machines (SVMs)
Simulation using ANNs – Literature review

• A short literature review about the surgical simulation by different means is available in [1] – finite elements (with/without condensation and precomputation), meshfree methods, hardware acceleration, neural networks mimicking spring-mass dynamics

• Reference [1] also contains references that have used ANNs for surgery simulation/structural analysis/mechanics
In reference [1],

- A pig liver is simulated in realtime
- The liver is assumed to be homogeneous, isotropic, and hyperelastic
- Hyperelastic material constants were taken from the literature.
- ANN was employed to achieve realistic simulations in realtime, using just a desktop computer.
- The ANN was trained using the dataset generated by performing hyperelastic analyses on the liver geometry, using the commercial finite element software package ANSYS.
- The trained ANN model (Radial Basis Function Network (RBFN)) used for simulation
ANN vs SVM

• References [3-13] contain information on ANNs, SVMs, and their comparison
• SVMs look promising
SVM codes

• Many codes are available online for free
• Present work uses [2]
Problem definition

- Obtain the geometry of a pig liver.
- The liver is assumed to be homogeneous, isotropic, and hyperelastic.
- Hyperelastic material constants were taken from the literature.
- An SVM is employed to achieve realistic simulations in realtime, using just a desktop computer.
- The SVM is trained using the dataset generated by performing hyperelastic analyses on the liver geometry, using the commercial finite element software package ANSYS.
- The trained SVM model used for simulation.
- Note down speed & accuracy.
Comments about the present work

• The methodology followed in the present work closely follows the one followed in [1] except that [1] uses Artificial Neural Networks (ANNs) while the present work uses Support Vector Machines (SVMs) to achieve realistic simulations in realtime.

• Present work is just a concept (as of now). The concept has not been implemented and verified yet.
Future work

• Implement the concept
• Verify the concept
References


Thank You!