# LITERATURE SURVEY ON VR BASED SOFT TISSUE SURGICAL SIMULATION

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## ABSTRACT

Virtual Environments have been used to train medical surgeon's field. Using these simulators, occupants and surgeons can grow or progress their skills in precise surgical processes. Modeling and simulating the live tissues is a very complex and puzzling process as it requires a huge amount of hardware power and advanced algorithms to be run on real time. This tissue modelling eminence fluctuates ranging from surgery types: neurosurgery, heart surgery, abdominal surgery, plastic surgery, minimal invasive surgery etc. Deformation accuracy and the computation time are the two substantial constraints in soft tissue modelling for surgery simulation. Hence it has branded in the surgery territory the required surgery types can be categorized under three major title which are surgery planning, Surgery training and scientific analyzing. In this paper we analyse various soft tissue modeling techniques.

KEY TERMS: VR, soft tissue, FEM, MSM

## I.INTRODUCTION

Virtual reality is excessively a computer technology to make a simulated environment. It is a old-style user interfaces.VR dwellings the user esoteric an understanding, looking a screen in front of them, users are absorbed and capable to interact with 3D worlds. It pretend as many senses as possible, such as vision, hearing, touch,even smell, the computer has transmuted into a gatekeeper to this artificial world.VR structures are used software and hardware to craft and manage a virtual, interactive 3D setting that includes filmic and sometimes audible and tactile elements. They commonly contain various types of display, sensor, and user-tracking and navigation technologies.

In medicine and the military, virtual reality training is an attractive alternative to live training with expensive equipment, dangerous situations or sensitive technology. Commercial pilots can use realistic cockpits with VR technology in complete preparation platforms that combine virtual flight and live instruction. Surgeons can train with virtual tools and patients and transfer their virtual skills into the operating room, these studies have previously commenced to display that such training primes to faster doctors who make scarcer mistakes. Police and soldiers are talented to conduct virtual raids that avoid laying lives at risk.

The surgery simulation and visualization can provide an actual and immersed virtual environment for doctors by fusing multiple technologies. It can reproduce the task extracts from visual, audition and tactile angles. Surgery simulation provides strong support on the stages of preoperative planning, Intraoperative assistance and postoperative rehabilitation, in which Geometry modelling and physical modelling are fundamental technologies .In the early growth, conversion of soft tissues is the key technology in virtual surgery simulation. Transformation model includes two kinds of methods: Finite element and Mass-spring model. Finite elements method has good firmness and high precision. But it is hard to implement and compute. Comparably, Mass-spring is easier and has little computation. Mass-spring has been applied into many fields, such as transformation of soft tissues, cloth deformation and water surface, Mass-spring model based on tetrahedron in which each vertex links to each particle and each edge agrees to each spring. This model closes to elastic structure. Our group have suggested an intellectual platform for simulating the vein surgery based on Mass-spring. In traditional method, the force coefficient is set manually. Recently, mass spring model is recognized as a simple but powerful approach that well balanced the simulation speed and effect. The main advantage of using such a system is that it can effectively simulate improvement of cloth and it is relatively easy to implement.

The Mass-spring model of cloth has a mesh of mass points, each of them being linked to its neighbours by mass less springs of natural length greater than zero. There are three different types of springs: structural, shear, and flexion, which implement struggle to stretching, shearing and bending. Surgical simulations are graphical presentation that involves real-time interaction with deformable 3D objects. A surgical teaching classification must allow the trainee to interact with virtual soft tissue. Therefore, the inspiring tasks to develop the efficient models of living tissues so that the realistic simulation of tool–tissue interaction could be performed in real time.

Among the potential applications of deformable objects, human tissue modelling is one of the most demanding because of the complexity of tissue mechanics. From a purely mechanistic point of view, soft tissues exhibit complex material properties. They are on linear, anisotropic, visco elastic, and non homogeneous. Soft tissues deform substantially under the application of relatively small loads. In addition, it's quite difficult to obtain material properties of tissues in vivo. In areas such as surgical planning, the main objective is to reproduce tissue properties as accurately as possible to predict a surgery's exact outcome; the computation time is a negligible factor. In surgical simulation, however, a trade off has to be considered. On the one hand, computational issues have to be examined to allow physical simulation in real time; on the other hand, the model must be realistic enough to allow practitioners to acquire relevant surgical skills.

## II.SURVEY ON SOFTTISSUE SIMULATION METHODS

The finite element simulation of elastoplastic solids [1] which has a skilled of robustly and efficiently managing arbitrarily large deformation. Our model remains legal even when large parts of the mesh are inverted. The algorithm is straightforward to execute and can be used with any material constitutive model, and for both volumetric solids and thin shells such as cloth. Also give a mechanism for domineering plastic deformation, which allows a deformable object to be guided towards a desired final shape without sacrificing realistic behaviour.

**F** is a 3×2 matrix decomposed as **F** = **UˆFV***T*

**U** is a 3×2 matrix with normal columns

**F** is a 2×2 diagonal matrix

**V** is a 2×2 rotation matrix.

The framework is readily absolute to touch the in-plane behaviour of thin shells and cloth. Inversion does not occur for freely moving thin shells and cloth, since an “inverted” triangle is impossible to differentiate from a triangle that has been rotated 180$^0$_ out of plane. However, when triangles relapse to lines or point’s special heed is necessary. If this sign of the rotated angle is negative, the triangle can be considered inverted, and the signs of the entries are corrected as before. The bending model is independent of the in-plane model, and in-plane plasticity is analogous to the three dimensional case. In plastic bending, we can apply the plastic flow algorithm to the rest angles between each pair of adjacent triangles.

The deformation approach,[2] mass-spring system and tissue deformation is simulated as a method of force propagation between the mass points on a per-node basis. When an external force has applied to a node, the force propagates from the point of the stimulated node, to its neigh boring nodes via to the interconnecting springs. The process proceeds in a well-ordered approach from the nearest neighbours to the utmost ones, until constrained by the maximum penetration depth. To realize the propagation mechanism, a list of nodes is created based on the breadth-first search which arranges the layers of nodes in the neighbourhood to the contact point in the order of increasing depth. The list has headed with the stimulated node, followed by its neighbours, from the nearest to furthermost ones. Each node is visited once during the searching process. Deformable simulation revenues on a node-by-node basis, ensures the sequence has given by the list. Note that, in the force propagation mechanism, the nodes in the same propagation layer interact with each other via the interconnecting springs. The sequence of such intralayer force propagation is disregarded since its effect on the simulation is not significant, which has been deep-rooted by a research that compares the difference in the deformed shapes as simulated by employing different intralayer propagation sequences. It Illustrate, the sequence simply follows the order of breadth-first traversal in the mass-spring system.

An efficient numerical algorithm for computing deformations [3] of soft tissues with applications to real-time surgical simulation. It based on the finite element method using the total Lagrangian formulation, where stresses and strains are exact with reverence to the original configuration. That allows for pre-computing of most spatial derivative before the instigation of the time-stepping procedure. There are two methods are implemented in this algorithm, one is explicit time integration and the another one is implicit time integration. It has used explicit time integration that eliminates the need for iterative equation solving during the time-stepping procedure.Stability analysis of the algorithm suggests that due to much lower stiffness of very soft tissues. For computational efficiency reasons most researchers in the surgical simulation community use mathematical models based on linear elasticity that allow pre-computation of solutions. These models are incapable of providing realistic predictions of finite deformations of the tissue, because the deformations are assumed to be infinitesimal. Linearity of the material response is also assumed. Researchers working on the theory of elasticity and the finite element method have shown that the principle of superposition cannot be used for systems undergoing large deformations.

A mass-spring model [4] consists of a set of point masses that are connected by ideal weightless elastic springs. The points masses are either derived from the edges of a two dimensional polygonal mesh for representing surface of the object, or they might originate from a three-dimensional mesh mode representing both the surface and internal structure of the object. The other spring component obeys Hooke’s law, which states that the force with which the spring pushes back is linearly proportional to the distance from its equilibrium length with the external forces and internal forces.

The paper [5] describes a real-time model of vascularised organs such as the liver. The model takes into account separate constitutive laws for the parenchyma and vessels, and defines a coupling mechanism between these two objects. In, visco-elastic model of the liver .It suggests as well as material parameters experimentally measured *ex vivo* on perfuse liver. In a patient specific model of hepatic vasculature is proposed. The material properties of vessels are modelled by non-linear constitutive law. This idea does not agree for real-time performance as the vessel walls are modelled with large number of finite elements. Together with a mapping of position and forces. The experiments presented in the evaluation section confirmed that vascular structures play important role in tissue behaviour.

This paper [6], describes a simulation system done by the implicit numerical integration scheme for multiple bodies deformation that uses tetrahedral meshes. It will creating the springs in between the contact surfaces of the liver and gallbladder, convert the contact forces into the internal forces from the tensions of springs. For mass-spring models, when a concentration of large forces occurs in a small region of the soft body, the simulation result falls into the problem of local deformation called “super-elastic” effect method. It makes an unrealistic. To overcome this problem, we derive a couple of constraints on the length of springs as an additional post processing step for the implicit integration. These constraints can prevent the soft bodies from over-stretching and over-compressing, which domain the volumes and geometry properties of the soft bodies during the simulation.

The volume preservation model[7] has used in our method for a multi-organ system by point masses and springs. The organs that anatomically connect to each other are jointed together by high stiffness springs for simulation of soft organ deformation. It does not rely on any direct constraint on the volume of hexahedrons, but rather than two constraints on the length of springs and the third constraint on the direction of springs. To deliver reliable interaction between the soft tissues and kinematic instruments we incorporate the position-based attachment to accurately move the soft tissue with the tools. A trial has been designed for assessment of our method on porcine organs. Using a pair of freshly harvested porcine liver and gallbladder, the real organ deformation is CT scanned as crushed truth for evaluation.

## III.Conclusion

The selection of tissue samples will challenge the current suppositions need to be addressed in our future work. We have presented an elastically deformable model of cloth objects and we have studied it’s unrealistic behaviour compared to that of real tissues .We have shown that this behaviour,known as finite element method, could not be improved by merely adjusting the model’s parameter. Therefore we proposed another method of Mass spring model, based on a low-cost dynamic inverse procedure. This realistic cloth object model could help us in a various situations in which constraints had not been adequately handled before. Hope that this work will contribute to the field of soft tissue surgical simulation

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