Liz Marai
Reading and Research Fall 2000
Modeling the Length of Wrist Ligaments

12/19/2000

1 Proposed Goals

We are trying to evaluate the length of wrist ligaments, using a shortest path algorithm and manifold models of the bones. We have developed and implemented the shortest path algorithm during the summer, and we have tested it on the wrist distal ligaments of a single patient (the one for which we had manifold models). The question was how to extend this to the other patients.
Note that the scans of the same bone for different patients are not aligned, that is, they are translated and rotated in space one wrt the other. Moreover, the length of one scan is different from one data set to another (some forearm bones are scanned from wrist to approximately half forearm, others from wrist to quarter forearm a.s.o.). We were looking for an algorithm that would align the manifold model with a given bone; for a method to cut the manifold model at the right length; and finally, for a method to deform the manifold model to fit the actual bone.

2 Achieved Goals

We have an algorithm for the automatic alignment of the long bones. This algorithm uses SVD and a manifold-bone distance minimization method to find the right alignment transform.
We have an algorithm for chopping manifolds at a given length. This was more difficult to get than we initially thought. Note that the manifold model depends on the manifold mesh underneath it; that the manifold mesh has its vertices organized in parallel rings; that the ring information is not recorded anyway in the manifold; that the rings are not perpendicular on the bone long axis, and therefore one could accidentally break a ring in the process of cutting; and, finally, that if you do that, you can't regenerate nicely the bottom of the manifold anymore. But we have it working now.
Also note that on this occasion Cindy and I traced down/fixed several bugs in the manifold support code.
We have the deforming code working for 6 out of 18 data sets. We'll need to extend the deforming procedure to work on the data sets that have very short ulna spikes (that is: the canonical ulna manifold has a pretty big spike on it, which normally deforms nicely to fit the spike on a given ulna bone; some patients have very, very short spikes, and the manifold folds over during deforming). We'll also need to get to Trey Crisco for the data sets he gave us that have corrupted animation transforms.

We have generated with the above procedure manifolds and distance cubes for the 6 data sets I mentioned earlier. We have distal ligament paths and length graphs as a function of wrist rotation for these data sets (3 injured and 3 healthy wrists). For now, these graphs show increased ligament lengths (well, the dorsal ligament for sure) in the case of the injured wrists.
I haven't started writing on my research comp paper yet, but there's still time for that. I gave a presentation in the sci-viz group meeting, and I think that helped put my ideas in order.

3 Evaluation of success

I would say I'm very close to what I wanted to achieve till the end of December, that is, manifolds and distal ligaments for the data sets we have. I think the amount of work exposed above is worth an A.