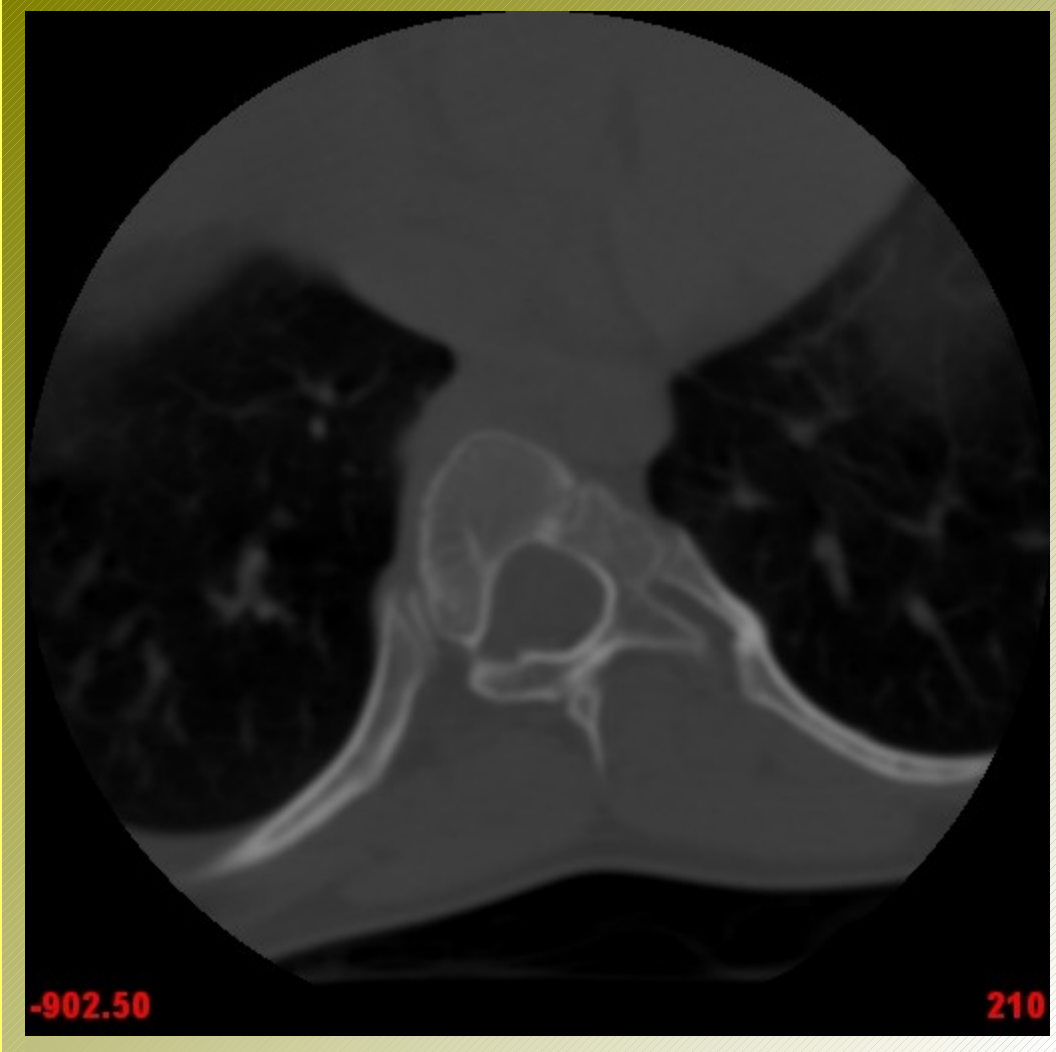


Automated Spine Segmentation

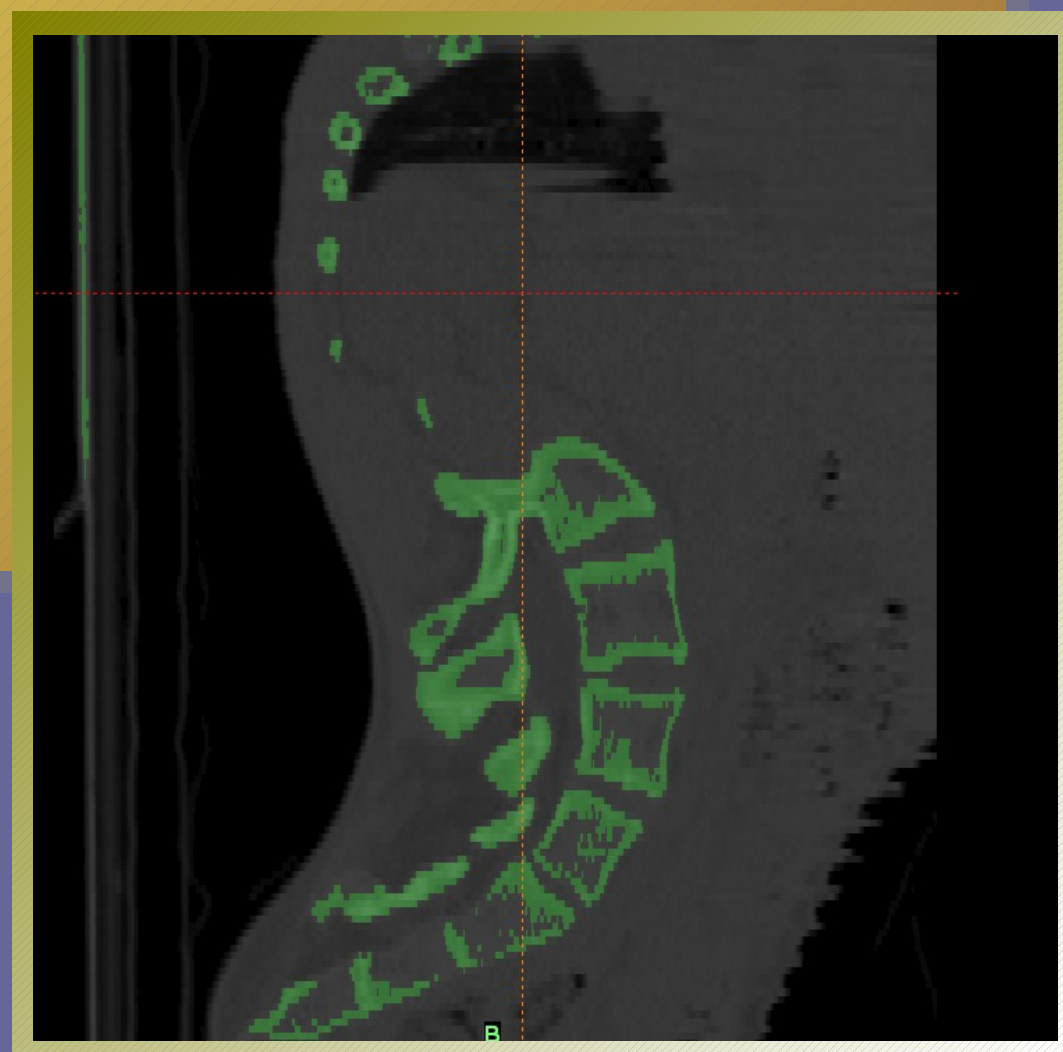
Brady Catherman, Dr. Jain, Dr. Guarino

CT images are a series of x-ray images, known as slices, that are stacked on top of each other to create a volume of binary data. Each slice shows a layer of tissue that is a few millimeters thick. Here you can see a single layer from a CT image of a human spine.



When these slices are stacked on top of each other they form a complete image.

Manual segmentation requires a human to go through the slices one slice at a time and clean up a rudimentary form of segmentation that a computer can perform in a few seconds.

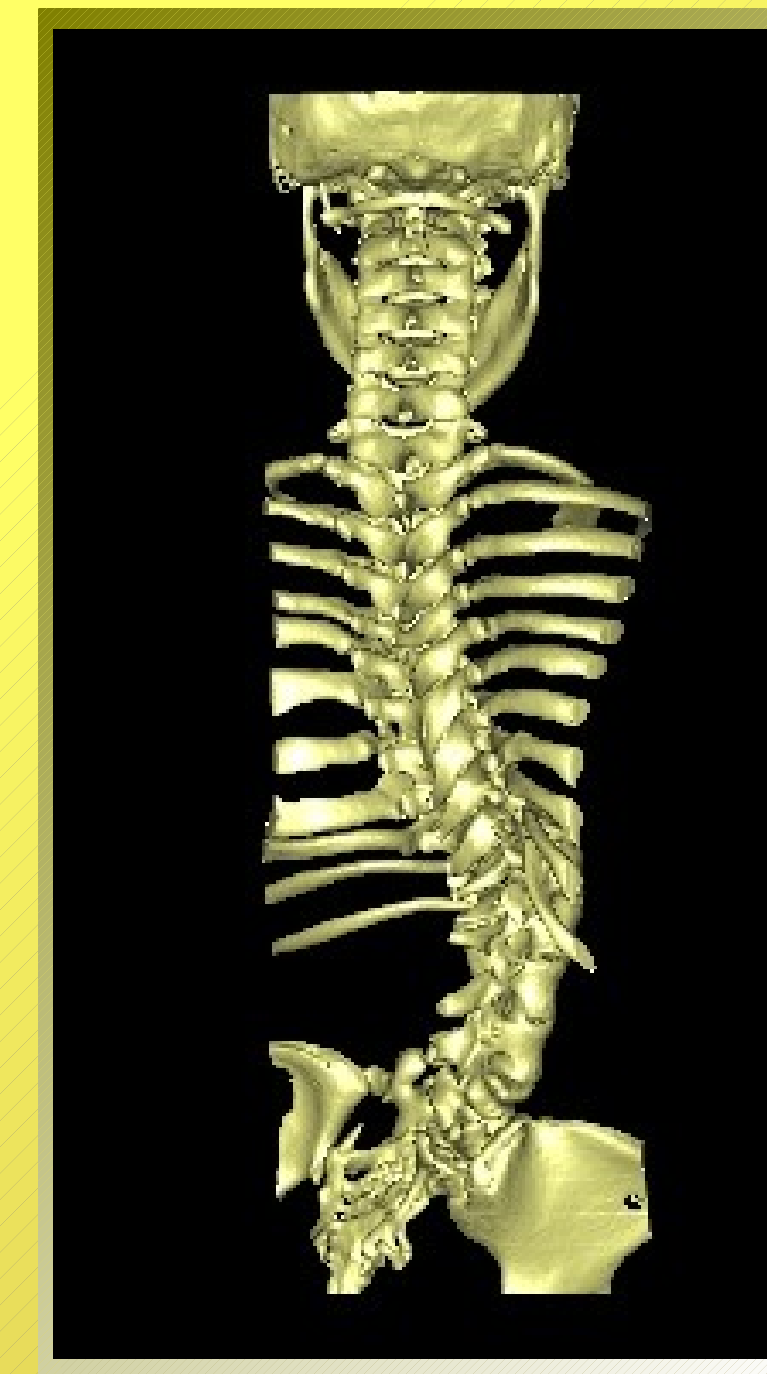


Spine Segmentation is the process of identifying individual components of a human spine from a CT images. It is a complex and time consuming process. It typically requires several hours to manually segment a spine. Our goal was to reduce the time required for a computer to perform segmentation by using a group of computers known as a Beowulf Cluster. We were able to reduce the overall time from almost 6 hours to under 4 minutes by using 59 computers.



Stereo Lithography images (known as STL images) of the volume data can be generated using a software package from Materialize® called Mimics®. These images hold a 3D map of the surface of the spine.

To perform segmentation using our algorithm you must create two 3D images. The first should be a basic surface map of a whole human spine. This is known as the primary image. The primary image can be generated using Mimics® in a short period of time.



The second image is of the hardest portions of each vertebrae. This is called the seed image.

Each vertex (the tips of the triangles used to create the surface) is used as a light source to illuminate the back of the triangles in the primary image. A series of light rays are generated from these points and are traced out to see what they illuminate. Each triangle in the primary image is marked with information about which vertexes in the seed image could see it.

One of the drawbacks of this algorithm is the number of calculations that it requires to process the information. Our goal was to reduce the time to calculate by designing the software to work on a large group of computers known as a Beowulf Cluster.

When we ran the program on a single processor it took 5 hours and 53 minutes. By running the program on the Boise State University Beowulf Cluster we were able to reduce the running time drastically. Using 8 computers the total running time was reduced to 22 minutes. The full cluster of 51 computers was able to reduce the total time to 3 minutes.

Because of our success with this project we are attempting to design a newer version that will eliminate the need to use STL images. The new version works directly on CT volume data. This algorithm will also be capable of segmenting materials other than spine and soft tissue. We expect to have this completed during the Summer of 2005.

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