Problem: Mathematically surface matching of maps of the human torso.

Subjects with scoliosis (a spinal deformity) present with various asymmetries of the back of their trunk. We are interested in how the trunk surface features have changed either due to treatment or natural history.

Adolescents with scoliosis have scans of their back taken every 3-6 months with a laser scanner. The scanner produces a 200x200 3D cloud of points that represent the surface. The images at two different points in time are different due to measurement error, positioning error, normal growth, changes in weight, and real changes related to the scoliosis. We would like to tease out the changes due to scoliosis from the other sources of change. An additional complication is the trunk is relatively smooth and featureless often without steep gradients.

In order to minimize noise in the system, the subject stands in a positioning chariot and is instructed to hold their breathe during the 0.6 seconds required to take the scan. Positioning is far less controlled for the minority of subjects who have neuromuscular conditions and cannot stand or sit upright without support.

To align the images I1 and I2, we have used translation, rotation and scaling in both manual or semi-automated modes. The manual method of alignment involves overlaying and manipulating the points to provide a best-fit. The solution is dependent on operator interpretation and may be prone to “over-fitting”. The semi-automated technique is dependent upon accurately locating common points on both images. External markers are placed upon bony landmarks by palpating the trunk. There is human error at this stage. Is it possible to accurately fit the surfaces without common points? How should we accommodate for normal growth?

Once the two images are “fit” together, the depth component is subtracted to provide a difference map. Is there a better method to mathematically model the differences in depth such as curvature descriptions?

We have serial datasets from a representative set of subjects and a laser scanner for acquiring test objects and validation.