Furniture Design from Pose

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Introduction

The process of designing furniture can be thought of as an optimisation problem, where, for a given pose of a human being, say sitting, you try to optimise for the following:

1. Maximise the region of contact between the body and the surface - this can be thought of as a measure of "comfort".
2. Keep the top surface of the furniture as "smooth" as possible - you don't want sharp edges, this has to do with practicality (in terms of creation) and comfort.

However directly optimising for the region of contact - however that may be defined - using hard constraints will not yield a very solvable problem. We hence come up with the following problem statement.

Problem Statement and Our Work

We start with a skeleton in a sitting pose, and a height-field. The skeleton is held in a fixed position and the height field around it "evolves" into a chair. To evolve this chair, an error minimisation problem is set up with the following error components:

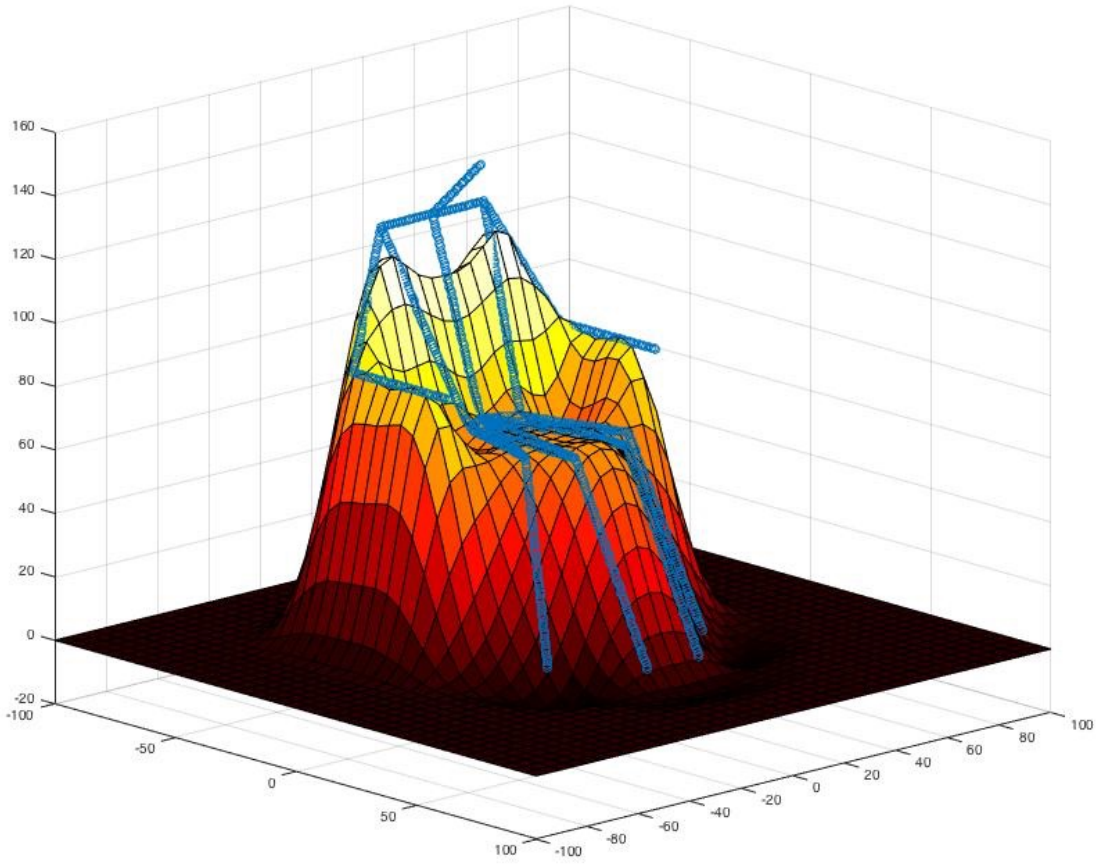
- Error for separation between the surface and points on the skeleton - this is a soft constraint for maximising the region of contact. This applies when the point on the skeleton is above the surface. Proportional to the vertical distance.
- Error for "collision" - you don't want a part of the skeleton to be *under* the surface. This soft constraint prevents that. Proportional to the vertical distance, but with a much larger weight.
- Error to ensure flatness - to try and prevent sharp edges. The region on which you sit should be as flat as possible - penalty proportional to the sum of absolute values of the laplacians at all points.

Finally, gradient descent is used to minimise this error function.

We also had another error metric: some prior knowledge about the surface, but we ended up not using it later.

We created a "composite skeleton" with > 1 set of limbs to simulate the small movements that we make while sitting.

Results



Distribution of Work

- Creation of the skeletons - Pratik, Siddhant
- Code to parse skeleton in Matlab - Devdeep
- Code for gradient descent - Pratik, Devdeep
- Error function for flatness - Siddhant
- Error function for gaps, collisions - Devdeep, Siddhant
- Error function for prior information - Anant
- Code to parse skeleton in Python - Anant
- Surface plotting, updates - Anant
- Main function - Pratik, Devdeep, Siddhant