Reconstruction of 3D Textured Models from Images

Czech Technical University in Prague, Department of Cybernetics
Radim Šára, sara@cmp.felk.cvut.cz
http://cmp.felk.cvut.cz

CENTER FOR MACHINE PERCEPTION

One of the goals of computer vision is to build automatically 3D textured geometrical model from a set of uncalibrated 2D images. For example, a tourist would like to make a few Prague Castle snapshots from different viewpoints and later would like to automatically get a 3D model for presentation on his home computer or an internet vendor would like to display on the web 3D models of their product range.

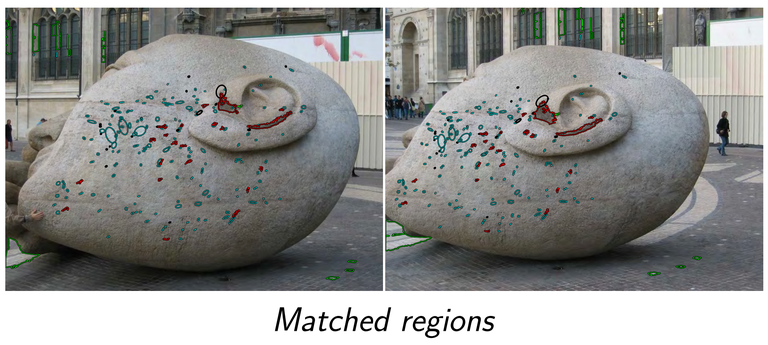
The idea of 3D reconstruction is based on the assumption that each scene point, which shall be in the final model, shall be visible in at least two different **input images**.

A few input images

The points in images which represent the same scene point are called **correspondences**. First, some highly discriminative points/regions in the input images are found.

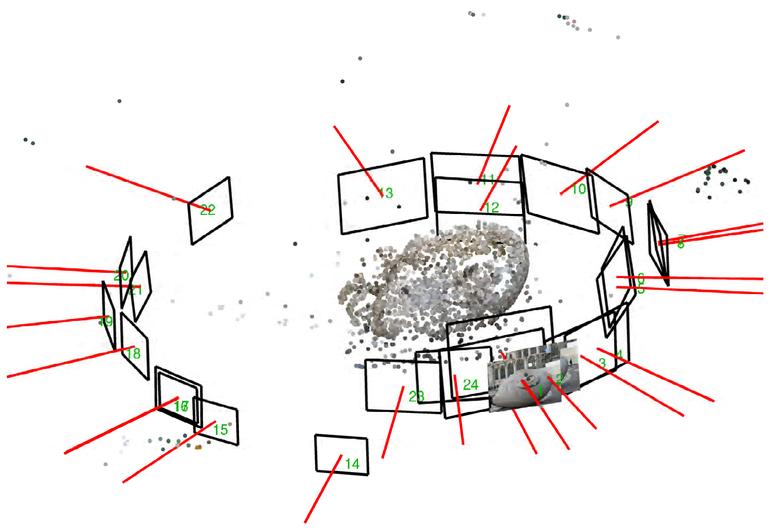
Detected regions

Similar regions in image pairs are matched and become such correspondences. All correspondences have to satisfy a joint geometric condition known as epipolar constraint.



Matched regions

Camera positions and internal camera parameters (e.g. focal length) are found from the set of correspondences by **autocalibration**.

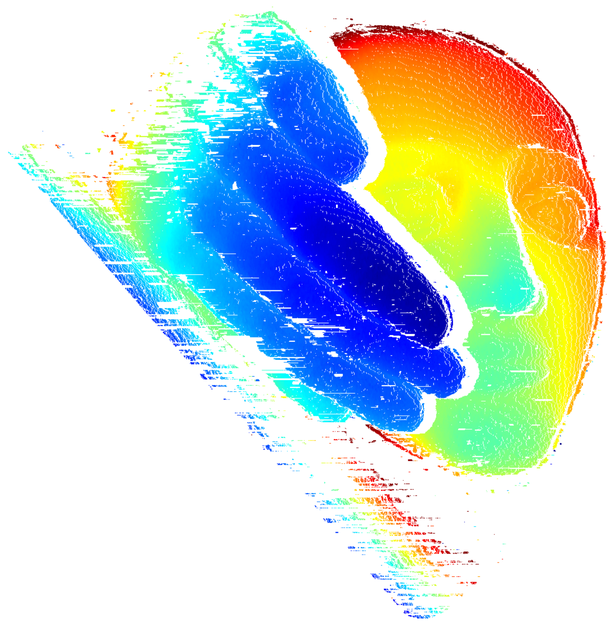


Autocalibrated camera image planes (rectangles) and focal lengths (sticks)

Pairs of cameras suited for stereopsis are automatically selected. For each such pair the input images are **rectified**.

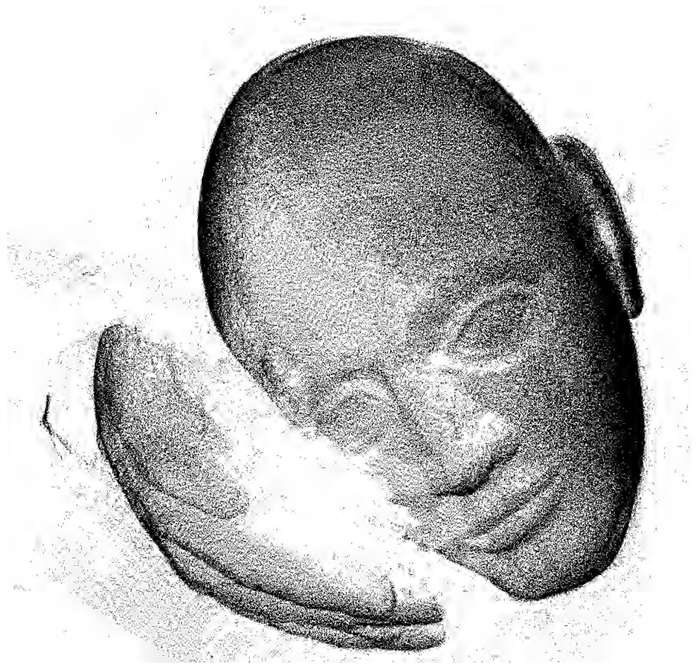
Rectified stereopair

Rectified images allow faster stereopsis whose goal is to find as many corresponding point pairs as possible. The result of this process is called **disparity map** where color encodes the horizontal shift (disparity) between the left and right images.



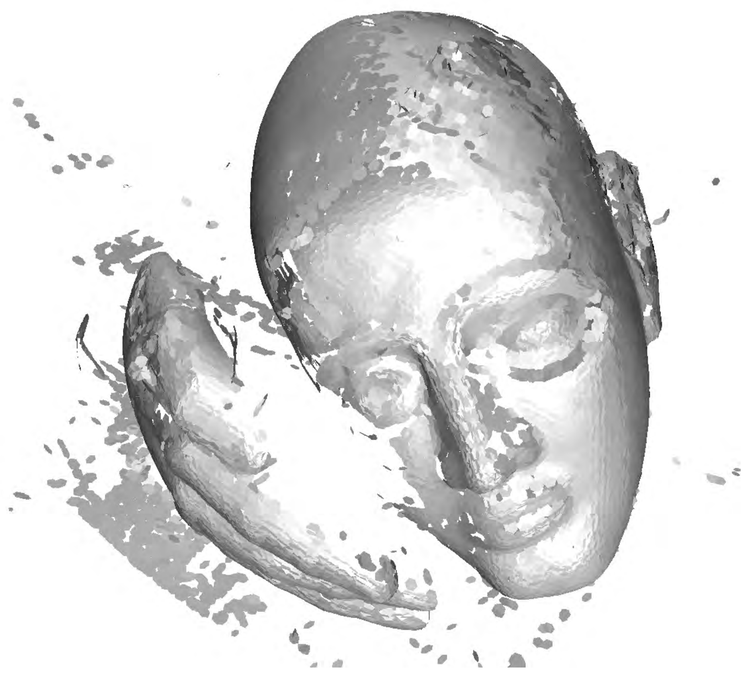
Disparity map

For each colored pixel of the disparity map camera parameters are used to reconstruct the position of individual 3D point in the scene giving rise to **a point cloud**.



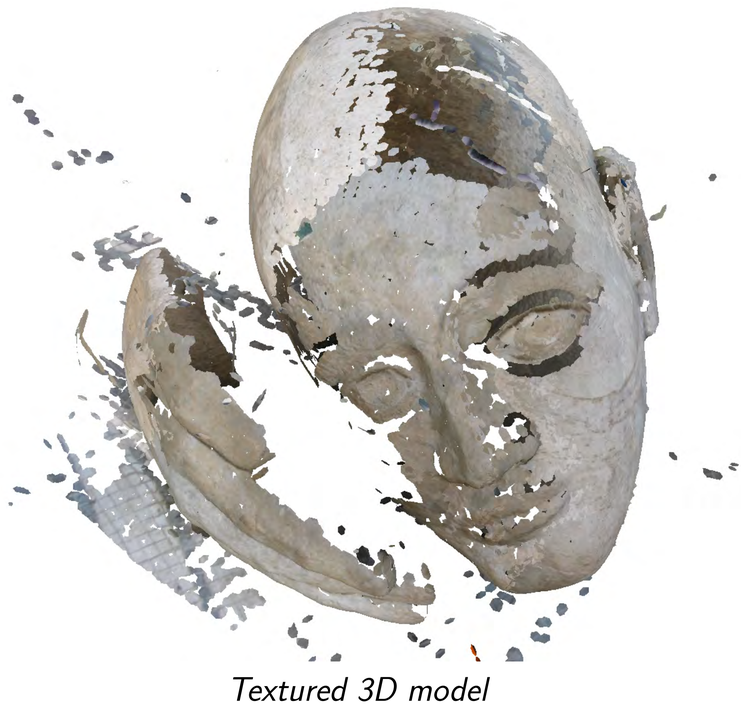
Reconstructed point cloud collected from all stereoscopic pairs

The point cloud is filtered and reorganized into **fish scales** which are local approximations of the surface. Each fish scale represents small patch of the surface and is described by a position, an orientation, and a size.



3D model

Finally the color/texture is assigned to each fish scale.



Textured 3D model