Ear Detection in 3D profile images based on surface curvature

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Motivation and Goal

Helix
Crus Antihelicis
Antihelix
Scapha
Antitragus
Fossa Triangularis
Crus Helicis
Cavum Conchae
Tragus
Lobule (Ear Lobe)
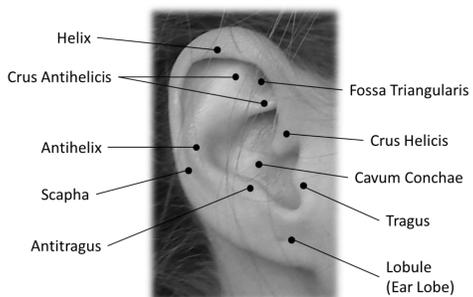
In forensic image analysis, the outer ear (auricle) is one of the most important characteristics for identifying unkown persons. The uniqueness and the permance of the auricle also make it an interesting characteristic for automated biometric identification systems. In order to buid a fuly automatic ear identification system, it is neccessary to reliably detect the ear in the input images.

Our ear detection algorithm exploits the fact, that the auricle has a characteristic, richly structured surface. This surface consists of convex and concave surface curvatures, which are forming the specific topology of the ear region. The ear detection is invariant to rotation and robust to scale and pose variation.

Additionally, our approach extracts the outline of the ear, which can be used as features in the subsequent recognition step.
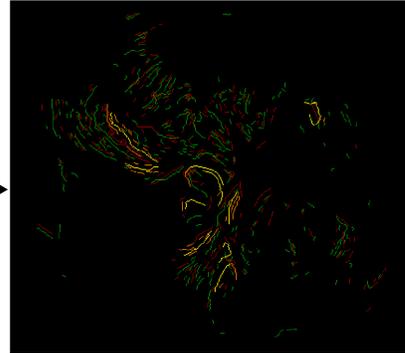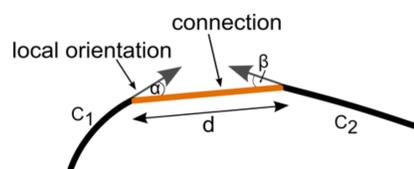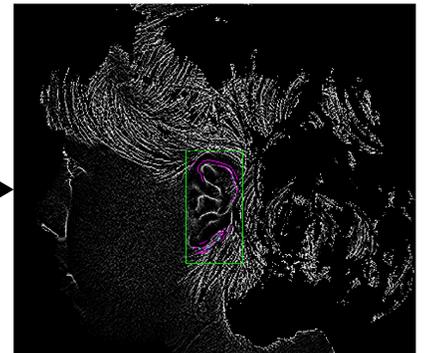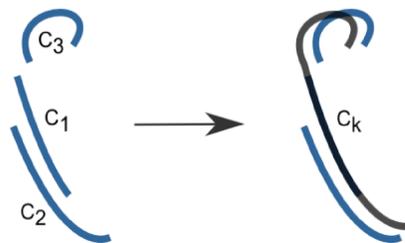
Detection Approach
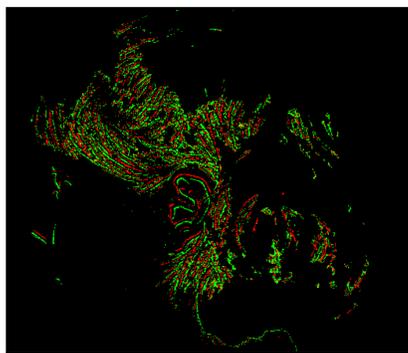
Calculate the mean curvature values on the depth image. Project all points with a sufficiently large curvature value to a 2D image (red represnets concave, green represents convex).
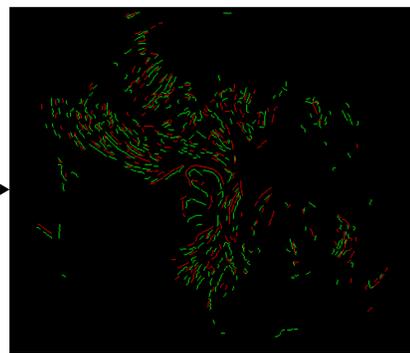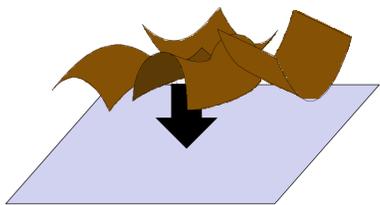
Thin structures to a width of 1 pixel and remove all structures, which are smaller than a threshold. Re-establish missing connections between the thinned lines.

Select ear candidates from longest lines. The slope of the lines is smooth and does not change its sign. Form ear candidate sets by combing the candidates with neighboring lines.

Calculate a confidence score for each ear candidate set. Contraints for the acore are parallelism, smoothness, total slope and proportion. Select the candidate with the highest score.
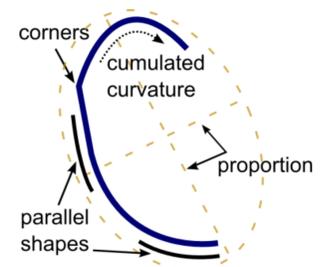
Performance Measures

The detection rate of our approach has been tested on the UND-J2 dataset, which was kindly provided by the Computer vision Lab of the University of Notre Dame. We consider a detection as successful, if more then 50% of the marked region and the manually generated ground truth are overlapping. Based on this we measured a detection rate of **95.65%.**

Future Work

Despite the promising results, we believe that the performance of our method can be further improved by having a closer look at the followng aspects:

- Enhancement of detection accuracy by searching for the tragus region inside the convex hull of the estimated ear outline.
- Replacement of the cumulated curvature criterion by an estimates for the typical slope distribution on the era outline.
- Enhance robustness against pose by using a different threshold for regions which are next to undefined regions.
- Use the extracted ear outlines as a basis for features for the subsequent ear recognition.

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