Fetoscopic mapping of placental surface vasculature

**Goal:** The most effective therapy for Twin-Twin Transfusion Syndrome (TTTS) in monochorionic twins is the fetoscopic laser occlusion of the anastomoses between the two fetal circulations. A complete closure of all anastomoses and in particular the arteriovenous anastomoses is a prerequisite for the improvement of the perinatal morbidity and mortality rates. The goal of this project is to develop a method which generates a complete and undistorted image of the placental surface during fetoscopy.

**Methods:** First, the fetoscope has to be calibrated in order to undistort the images distorted by the fish eye lens. A plate with a known pattern lies in a receptacle containing water and is filmed at different angles before the surgery. A developed algorithm locates the points in the obtained images and associates them with the corresponding points on the plate. From these correspondences the intrinsic camera parameters (focal length, principal point and radial and tangential distortion parameters) are calculated. This calibration is done fully automatically. Afterwards the placenta is filmed with the fetoscope. In an image, an algorithm automatically detects salient features which are scaling, rotation and illumination invariant. Corresponding features are found in an image sequence and are used to estimate the transformations from these images to an anchor image. Finally the images are stitched using a multi-band blending algorithm to avoid seams in the compound image while keeping the fine details.

**Results:** The method has been tested on 3 different ex-vivo placentas. The placenta images are undistorted up to pixel accuracy (mean calibration error: 0.35 pixels). The whole calibration process takes one minute.

Parts consisting of 10 images of the 3 different placental surfaces were successfully reconstructed. The algorithm needs 12 minutes to stitch 10 images, but it has not yet been optimized for speed.

**Conclusion:** The presented method constitutes the prerequisite to the creation of an undistorted image of the whole placental surface, which makes the proper localization of all anastomoses in the monochorionic twins possible.