The Challenge
For clinical assessment and the examination of the upper gastrointestinal (GI) tract, consisting of stomach and esophagus, video-endoscopic imaging is applied. For documentation of these procedures, usually representative still images as well as video clips are used. Nevertheless, due to the tight tubular geometry of the esophagus on one hand and the compact design of endoscopic devices on the other, the field of view in the esophagus is considerably constrained. Furthermore, contextual information of the field of view is limited and inhomogeneous illumination interferes with the examination.

The »TubeStitcher«
In order to support gastroscopic examinations and enhance the documentation possibilities of the esophagus, Fraunhofer IIS has developed a novel approach providing panoramic images as well as a 3D reconstruction of the esophagus, based on the digital endoscopic video data.

Using endoscopic video sequences of the esophagus during a withdrawal from the stomach with constant speed as input data, s. Fig. 1a, the »TubeStitcher« software converts these videos frame-by-frame into a so-called panoramic map of the esophagus wall, similar to cutting a paper roll open and flattening it. In this »video map« each row relates to a set of pixels on the border of the esophagus at one point of time. Hence, as the endoscope is withdrawn through the esophagus, in each frame a new set of pixels on the esophagus wall is taken and converted to a new line in the »video map«. As the endoscope is withdrawn from the stomach upwards, the rows on the »video map« are arranged accordingly: rows on the bottom relate to frames on the lower end of the esophagus, whereas rows on the top relate to frames near the larynx, s. Fig. 1b. Once such a »video map« (or »esophagram«) has been obtained, it can be used to have a view of the esophagus wall in a different way, as it is now flattened and can be checked and »read like a map« in a very short time.

»TubeStitcher«
Panoramic mapping of the esophagus
**Benefits**

The »TubeStitcher« software converts esophageal endoscopic video data into an intuitively assessable »esophagram« for enhanced digital documentation in gastroscopy. These »esophagram« can provide the missing context information and can be used to examine the complete esophagus at a glance. Using digital linking mechanisms, regions of interest in the »esophagram« can be interactively tagged and provide the same regions in the original endoscopic video. Thus the »TubeStitcher« provides

- enhanced documentation of the esophagus,
- improved context-aware diagnosis,
- Interactive assessment of depicted lesions in a multi-view approach, and
- new educational possibilities.

Furthermore, the 3-dimensional reconstruction offers a condensed representation of the esophagus geometry, potentially highlighting deformations or perforations. Also, the »TubeStitcher« can conceptually be applied to video-sequences of other tubular structures such as the urethra, or the trachea.