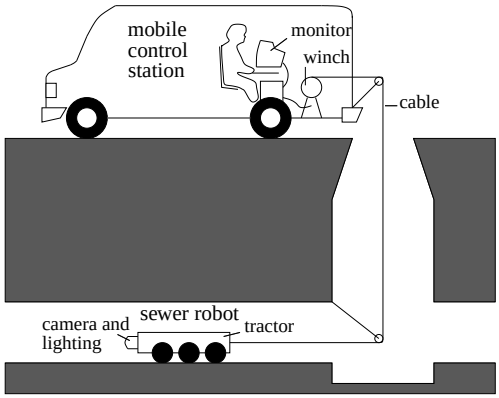
Measuring the Shape of Sewer Pipes from Video

Juho Kannala
Machine Vision Group
University of Oulu, Finland
juho.kannala@ee.oulu.fi

Sami S. Brandt
Laboratory of Computational Engineering
Helsinki University of Technology, Finland
sami.brandt@tkk.fi

Abstract

- We describe a method for recovering the interior shape of a sewer pipe from a video sequence acquired by a fi sh-eye lens camera.
- The method is based on solving the general structure-from-motion problem by tracking interest points across successive video frames.
- The proposed method can be additionally used in other applications to recover the scene structure from fi sh-eye image sequences.



A typical sewer inspection system

Overview of the Method

Due to the fi sh-eye lens we need modifi cations to conventional structure-from-motion approaches, such as [1].

- Camera calibration (fi sh-eye method [3])
- Feature extraction (Harris corners)
- Feature tracking (three-view constraint is utilized)
- Reconstruction (bundle adjustment)

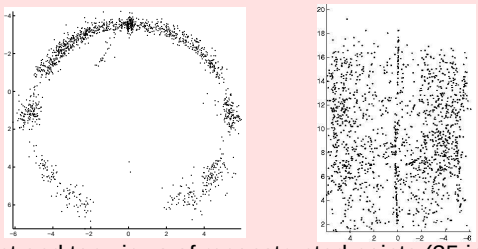
Geometry of Fish-Eye Views

- Calibration gives the transformation that warps the original fi sh-eye image to a perspective one. Multiple view relations, defi ned by the essential matrix and the trifocal tensor, hold between the warped images.
- Since the image correspondences are measured from the original images we need modifi cations to the usual way of estimating the geometry.
- According to our knowledge, the three-view constraint has not been previously utilized in the case of fi sh-eye image sequences.

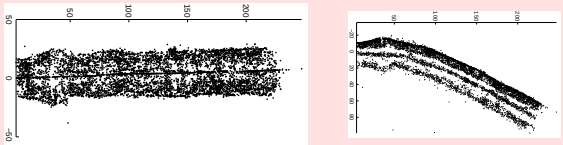
Experiments

Experiments with real videos of concrete pipes show that the shape of a sewer pipe can be recovered solely from the video.

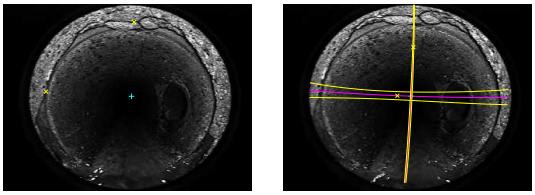
- The experimented sequence contained 159 images and covered about two meters of the pipe.
- The reconstruction was concatenated from six bundle adjusted pieces.
- Improving the effi ciency of the bundle adjustment would be important in the future.



Front and top views of reconstructed points (35 images).



Front and side views of the reconstruction (159 images).



Epipolar curves and envelopes.

References

[1] Fitzgibbon, A. W., Zisserman, A.: Automatic 3D model acquisition and generation of new images from video sequences. In *Proc. EUSIPCO*, 1998.

[2] Kannala, J.: Measuring the shape of sewer pipes from video. Master's Thesis, TKK, 2004.

[3] Kannala, J., Brandt, S.: A generic camera calibration method for fi sh-eye lenses. In *Proc. ICPR*, 2004.