

Objective Condition Assessment of Sewer Systems

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Background

- Picture recognition algorithms for determination of the condition of sewer systems
 - Fundamentals
 - Methodology
 - Results
 - Further action
- Summary

FIVE Extent of CCTV-Inspection in Germany (ATV/DWA survey 2001)





annual inspection volume:

45,000 – 50,000 km

annual inspection costs:

~250 million €/a

FIV Quality of inspection

Projekt Auftraggeber Straße Kläranlage	:			EntwBezirk	:	:			
Jatum : 09.09.1999 11:03 Anfangsschacht : 2-16865 Kanalnummer : 23505 Material : B Entwässerung : Regenwasser Baujahr : 1958 Untersuchung : in Fließrichtung Videoband : 424 Zustandsklasse : B I: 3		Berichtsnummer Endschacht Haltungsnummer Durchmesser Haltungslänge W.schutzzone Darstellung Berichtsdatei Plannummer		: 1 : 2-16866 : Querum_04 : 250 / 250 : 59,22 m : WSZ IIIa : wise untersucht : B300699.T01 : 0296					
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Mies-van-der-Rohe-Str.1 52056 Aachen Tel.: 0241/80-1							
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Mü1 K. Müller, FiW, 17/10/2006

FIV Quality of inspection

Background • Picture recognition algorithms for determination of the condition of sewer systems • Summary



Slide 5

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FIV Quality of inspection

Background
Picture recognition algorithms for determination of the condition of sewer systems
Summary



 real condition class of a sewer section is with a probability of 95 % within a confidence range of approx. ± 2.6 CC around the condition class determined





FIV Inspection System

Veranlassung • Picture recognition algorithms for determination of the condition of sewer systems • Summary



FIVV Fundamentals

Veranlassung
• Picture recognition algorithms for determination of the condition of sewer systems
• Summary

Data management

- Data base sewer
 - Post-sighting of records
 - New entry of section damage
 - Entry of joint position
- Data base picture
 - Generation of single pictures
 - Positioning of picture contents
 - web-based data base
 - fundamental picture-technical treatment or elimination of perturbations

FIV Fundamentals

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• Picture recognition algorithms for determination of the condition of sewer systems
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Creating single pictures

- Perspektive
- Unfolded View





FIV Fundamentals

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Redundant data

- fourfold datavolume, but
- quick access

Original processing



FIVV Fundamentals

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FIV Methodology





Elimination of perturbations





Elimination of perturbations





Elimination of perturbations



Ideal joint

- separate
- clearly limited
- constant from the top to the bottom
- thin
- dark
- vertical
- straight line

















Single, limited, constant, thin, dark straight line?











LESAM 20

Background • Picture recognition algorithms for determination of the condition of sewer systems • Summary









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Sliding Window





Approach for solution

Sliding Window





Approach for solution

Sliding Window





Approach for solution

Sliding Window







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Approach for solution:

FFT-Filter

Sliding Window



Approach for solution:

Sliding Window

Original FFT-Filter



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Results

- Data basis
 - 322 randomly chosen sewer sections
 - 9.241 pipe joints
- Recognition performance:
 - 9.194 joints were recognized correctly
 - 47 joints were not recognized (false-negative)
 - 33 "Non"-joints (false-positive)
- Recognition rate: 99.49 %





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• Summary

Multi-scale analysis



Background • Picture recognition algorithms for determination of the condition of sewer systems • Summary

Multi-scale analysis

• Scale 0



Background • Picture recognition algorithms for determination of the condition of sewer systems • Summary

Multi-scale analysis

• Scale 5



Background • Picture recognition algorithms for determination of the condition of sewer systems • Summary

Multi-scale analysis

• Scale 10



Background • Picture recognition algorithms for determination of the condition of sewer systems • Summary

Multi-scale analysis

• Scale 15



Background • Picture recognition algorithms for determination of the condition of sewer systems • Summary

Multi-scale analysis

• Scale 32



Multi-scale analysis

Classification



Results

- Data base
 - 322 randomly chosen sewer sections
 - 437 connections
- Recognition performance:
 - 369 connections were recognized correctly
 - 68 connections were not recognized (false-negative)
 - 37 "Non"-connections were recognized (false-positive),
 30 of which in the area of the joints
- Recognition rate: 84.4 % (98.1 %)

FIV Detection of areas with optical findings

Flow trace detection



FIV Detection of areas with optical findings

Detection of damage-free areas by means of entropy



FIV Detection of areas with optical findings

Detection of damage-free areas by means of entropy



FIVV ...an Example of Visualization

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FIV Current Status





Analysis of edge pictures for the detection of cracks



Five Further Action

Background
• Picture recognition algorithms for determination of the condition of sewer systems
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Analysis of perspective View

horizontal or vertical displacements



Five Further Action

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• Summary

Analysis of perspective View

• blockings / roots





LESAM 2007, Lisbon

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Fading out of damage-free areas is possible with a high quality

• …a numerical example…

- 718 sewer sections
- 19,068 pipes
- 9,318 pipes without optical findings
- 9,750 pipes with optical findings
- 1,382 pipes with damage-free connection
- 8,368 pipes damaged
- 10,700 pipes damage-free (= 56 % of the pipes)



Intensive damage analysis instead of expensive search for damages