Agenda

1. About SewerAI
2. Why AutoCode™?
3. How AutoCode™ Works
4. Case Studies
5. Condition Assessment Services & Subscriptions
6. Use Cases, Benefits, & Conclusion
1. About SewerAI
Sewer Experience

Combined 80+ years in sewer condition assessment

- Services Contracting
- Software Design
- Certification Training
- Camera Operation
- Civil Engineering
- Project Management

Matt
CUES SoLID FX

Bill
Pipe & Plant Solutions

Eric
NASSCO Trainer

Sri
PhD Civil Engineering

Jessy
CCTV Technician

Paul
CCTV Technician

Yaman
Wastewater Conveyance
SewerAI Timeline

- **Feb 2019**: SewerAI Founded
- **Jan 2020**: Esri Partner Network
- **March 2020**: NASSCO Membership
- **Aug 2020**: $2M USD Seed Capital Raised
- **Nov 2019**: SFPUC Pilot Project Approved
- **May 2020**: Pipe & Plant Solutions Adopts AI
- **Jul 2020**: EBMUD Project Awarded
- **Dec 2020**: >~1.75 MM LF (~525 km) Currently Assessed with AutoCode™

Walnut Creek, CA
AutoCode™ automatically identifies conditions in a sewer pipeline, directly from CCTV images
2. Why AutoCode™?
Sewer Infrastructure Is Deteriorating
CCTV Inspection:

**Process** Can Be Expensive, Slow

- “Capture & assess” method most common
- Camera hardware idles ~2/3s of time while in pipe

**Reports** Can Be Inconsistent or Incomplete
Why AutoCode™?

Increasing production

No CAPEX required
Use your existing camera equipment & software
Condition Assessment is Hard

- Operators miss 20% of defects in pipes (226 in P/LACP)
- Limited training and development opportunities


The probability to inspect correctly a pipe in poor condition 4 is close to 80% and thus the probability to overestimate the condition of the pipe is close to 20%. In general, the probability to overestimate the condition of a pipe (FN) is higher than the probability to underestimate its condition (FP). For pipes in bad condition, the probability of FN is 20% whereas for pipes in good condition the probability of FP is 15%. This uncertainty might have serious consequences on rehabilitation decisions since missed defects can lead to failure or collapse. The influence of this biased information on the reliability of rehabilitation programmes and on costs is still to be investigated (on this topic see also the work of van Riel, Langeveld, Herder, & Clemens, 2017).
• 4 individuals from engineering dept at large sewer agency each coded same 13 videos of pipe segments
• SewerAI AutoCode™ inferences completed on same videos

• Human agreement/consensus was limited to 20% of all observations
Why AutoCode™?

Improve the quality of condition assessment.
Reduce need for re-inspections & re-mobilizing due to mistakes.
Data Management Difficulties

Data Storage & Submittal
Compiling project data, & delivering to clients can be painful & slow

Approval & Validation
Can be a slow process with difficulties collaborating
Why AutoCode™?

Improve How You Manage Data

Manage, Store, & Share your project deliverables from a single location, remotely
3. How AutoCode™ Works
Terms

**AI (Artificial Intelligence)**
Automation of tasks involving characteristics of human intelligence (recognizing objects & sounds, problem-solving, learning)

**Deep Learning**
Ability to learn based on specific examples & feedback provided (Supervision).

**Computer Vision**
Enabling a computer to identify & understand content of digital images (photos & videos).
2 PRIMARY METRICS MEASURE THE A.I.
**AutoCode™**

- Upload data to SewerAI cloud
- Data is hosted for streaming in Chrome web browser
- AutoCode™ is deployed
- SewerAI PACP technicians review all outputs of the AI
- Customer notified when reports are ready
Inspection Hardware No Longer Idle

Operational cost per is reduced as per day footage inspected increases

**2X to ~3000 ft+**

**MORE PRODUCTION**

**MORE EFFICIENT REVIEW**

**AUTOMATED LABELING**
4. Case Studies
Case Study
SFPUC Pilot Project Scope

• Original project scope was to do full NASSCO PACP 226 code labelling on **179 miles** (~289 km) existing lateral videos.

• Worked with SF to break project into **4 phases** so we could deliver the codes they are most interested in as quickly as possible.

• **950,000 total LF** (289,560m)
Case Study
SFPUC Pilot Project Scope

75% Cost Reduction

- SewerAI’s Labeling as a Service analyzed over **1M linear feet** of laterals

- 52,000 inspection surveys

- Would have taken Owner **8,800 hours** to review manually > $1M

- **Hardware neutral** (CCTV) **Hi-def** data not required

- Works for CCTV mainline & lateral data
Case Study
SFPUC Pilot Project Scope

• Some examples of findings...

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<thead>
<tr>
<th>Defect Code</th>
<th>Description</th>
<th>Number of Videos Observed In</th>
<th>Number of Observations</th>
<th>Example Snapshot</th>
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<td>B</td>
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D Deformed
DAGS Deposits Attached Grease
DNF Deposits Ingress Fine
X Collapsed
FTS Fitting Sweep Tee
Case Study
SFPUC Pilot Project Scope

- Some examples of findings...

<table>
<thead>
<tr>
<th>Defect Code</th>
<th>Description</th>
<th>Number of Videos Observed In</th>
<th>Number of Observations</th>
<th>Example Snapshot</th>
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Case Study Comparing 2 CCTV Projects

- Silicon Valley, CA, & ~10 miles apart
  - “Project A” (Santa Clara) occurred in June 2019
  - Project B (Los Altos) occurred in May 2020.
- Cleaning & CCTV inspection of 6”-12” VCP sewer mainlines
- Carried out primarily by same individuals, using same vehicle of vehicle chassis, & outfitted with same type of CCTV equipment systems.
Case Study
(New Data Collection)

- **Industry avg:** 1,273 LF/day (388 m/day) using “capture & assess” manual method
- **PPSI avg on ~102k LF project in May 2020 using AutoCode™-enabled workflow:** 2,691 LF/day
- Compare to 1,352 LF/day avg for similar project previous year
  - **98.95% Increase**
  - Same equipment/trucks used on both projects

Experimental and Numerical Study on Production Rate In Sewer Mainline Video Inspection
Reza Navab-Kashani; Leon F. Gay; and Alireza Bayat, M.ASCE
Journal of Pipeline System Engineering Practice, 2019, 10(2): 04019011
Case Study
(New Data Collection)

Results from 2019 Project w/ Manual Workflow

1,352 LF / day Avg
Case Study
(New Data Collection)

Results from 2020 Project w/ AI-Enabled Workflow

2,691 LF / day Avg
(98.95% Increase)
Case Study – Cross Bore Safety Audit

- Dataset of 1040 lateral inspection videos
  - ~25,000 LF
  - ~64 hrs of video playback
- 40 videos had known cross bores
- Duration of AI inferences:
  - 30 min
- 3,120 “positive windows” generated (OBI, OBP, BSV, BVV, HSV, HVV, B, DNF)
  - ~16 hrs of video playback

AutoCode™ ~3.8x Faster Compared to Manual Playback & Review
5. Condition Assessment Services & Subscriptions
Products & Services

Labeling as a Service:

• AI-Assisted Data Labeling for PTZ Mainline, Push, Lateral Launch

• PANO Labeling (Manhole/Mainline)

• Full PACP, LACP, MACP

• Charged per LF (or MH survey)
AutoCode™ Inferences

QAI™ Quality Assurance Inference
- Blurry Images
- Camera Speed
- Camera Underwater
- Lens Obscured

Inference for the following PACP codes: OBI, OBP, OBS, OBC
All predicted labels reviewed by SewerAI Assessment Team
Includes AutoCode Level 4 & 5 Structural Defect Inference

Cross Bore Safety Audit

Condition Assessment

All 226 NASSCO PACP & LACP observation codes, or limited codes (such as Level 4 & 5)
PACP Deliverables & reporting formats

For specialized projects, or use cases involving non-gravity sewer assets
Requires training and development of custom AI models

Custom Solutions
**Products & Services**

**Inspection Management Platform**

- Store all your data
- Share inspections with your clients
- Access AutoCode™
- Web-based PANO Labeling (Manhole/Mainline)
- Charged per TB of data hosted
6. Use Cases, Benefits, & Conclusion
Applications & Uses

- QA / QC of CCTV submittals
- Operator training & development
- Database conversion
- Accelerating inspection (in field & office)
- Cross bore (utility conflict) safety / audits
- Data analytics for project execution & asset management decision support