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Artificial Intelligence: NASSCO Guidelines



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Artificial Intelligence Guidelines Session Overview



- Part 1 Intro What is AI and What Does AI Mean to Sewer Condition Assessment (SCA)?
 - Chris Macey (10 minutes)
- Part 2 AI Classifications for SCA and Illustrative Applications
 - Mike Russin (20 minutes)
- Part 3 AI Guidelines and Applications Beyond ADR
 - Chris Macey (20 minutes)

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Part 1 - What is AI and What Does AI Mean to Sewer Condition Assessment (SCA)?





Chris Macey, P. Eng. America's Technical Practice Leader, Condition Assessment and Rehabilitation, AECOM Member of NASSCO's Technical Advisory Council

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Artificial Intelligence (AI) and Sewer Condition Assessment

- NASSCO recognizes the advent of new and emerging software capabilities within the sewer inspection and rehabilitation industry that incorporates Automated Defect Recognition (ADR), Machine Learning (ML) and other advanced analytical techniques.
- Collectively these techniques are often characterized as Artificial Intelligence (AI)
- NASSCO is seeking to better define core AI tools and communicate this to industry through a Technical Paper to help de-mystify the topic with practical, easy to understand information guidance on its current technological state and existing and future applications.

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Automated Defect Recognition (ADR) and beyond

- An internal NASSCO workgroup representing a diverse cross section of expertise has been formed to develop the Technical Paper. The primary objectives include:
 - To document and categorize all the current ways AI techniques are currently being utilized to supplement the Sewer Condition Assessment (SCA) process.
 - To initiate the intelligent incorporation of ADR, ML, and other advanced automated analytical techniques into the SCA process in the short term to accommodate development platforms that are sufficiently advanced.
 - To provide a roadmap forward of "fit-for-purpose" assessment methods to guide the process.
 - To provide an overview of the next generation of AI Tools and Techniques to facilitate long term integration of AI into the Assessment and Management of Sewer Infrastructure.

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Some Key Definitions

- What is AI?
 - the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.
- What is ADR?
 - ADR is a software output, through the use of machine learning (ML) techniques, that can progressively identify defects "observed" within individual images of video.
- What is ML?
 - is the algorithmic process that helps software improve, like humans do, through iterative trial and error experiences using mass training data in order to make better decisions or choices.



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We're not replacing humans, just yet

- Primary ADR and ML goals include:
 - More efficient and faster production of inspection reports
 - Simplified operator workflows
 - Computer ADR processing with varying levels of human interaction and checking
 - Ability of ADR to code broader range of PACP defects increases with additional ML experiences.
 - Less time coding, more time operating camera equipment
 - Increased human focus on complex coding areas, less focus on areas devoid of defects or with defects of lower severity

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Challenges

- ADR and ML challenges:
 - Products at varying levels of defect coding capability using Group, Descriptor and / or Modifier
 - How many of over 200 codes will the product be capable of identifying?
 - Products level of accuracy, requiring further human corrective interaction
 - Accuracy Verification processes and industry acceptance.

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Automated Defect Recognition (ADR) and PACP

- An understanding of ADR will be incorporated to NASSCO's PA|LA|MACP training content.
 - ADR will be taught in a similar manner to other technologies, (e.g. Laser Profiling or side wall scanning), with further subject matter applied as an Appendix with links to the evolution of ADR within V8 of the PACP Manual (proposed release date of 2023);
 - Our current premise is that ADR will not affect the standardized PACP defect language but shall apply the current rules and application of PACP within the algorithm.
 - The primary purpose of PACP training and certification is to ensure that all data gathered to describe the conditions within a pipe are collected and coded in a consistent, reliable manner with adequate guidance on how to verify same.
 - This will not change
 - PACP is all about the accuracy of data. It is the PACP professional's responsibility to accurately and consistently code each defect and observation as per the PACP manual.

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AI and the SCA Road Forward

- NASSCO's mission is to set standards for the assessment, maintenance and rehabilitation of underground infrastructure and to ensure the continued acceptance and growth of trenchless technologies.
- We are excited about the new opportunities and benefits that ADR, ML, and AI bring to our industry and have thus formed this workgroup to move the technologies forward in a manner that benefits the industry, end user, and public at-large .



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Part 2- AI Classifications for SCA and Illustrative Applications





Mike Russin

General Manager, WinCan

Member/Past-Chair, NASSCO Software Vendor Committee

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Presentation Agenda

- Data Collection Today
- Automated Defect Recognition (ADR): What, How, Who?
- Current Status of ADR
- Industry Applications
- Office Benefits
- Field Benefits
- ADR Summary



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How is Data Collected Today?

- CCTV
 - Standard Definition
 - HD Definition
- HD Digital Scanning
 - Pipe
 - Manhole structures
- Push Cameras
- Jet Nozzle Cameras
- Drones
- 360 Zoom Cameras



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ADR: The What, How, and Who?

What is Automated Defect Recognition?

• Using supervised artificial intelligence to detect pipe defects/observations for field inspections

How is ADR being done?

 Through supervised machine learning by labeling images and classifying them manually according to the selected standard. (i.e NASSCO PACP)

Who is using ADR?

- Its industry wide!
 - Contractors
 - Municipalities
 - Engineering firms



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ADR: Current Status

Success

- ID Major Classification Groups
- Quick Video Processing
- Productivity Gains
- More Agile (Complete SaaS Setup)

Challenges

- Human supervision
 required
- Accuracy improvements
- Global standards
- Quality of data

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ADR: Industry Applications

1. Office Applications

- Applied to data collected in the field in an office environment
 - New Data Collected
 - Existing Data Sets

2. Field Applications

- Embedded into the inspection system
- Huge industry potential for improved workflows



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ADR: Office Benefit

- Data workflow enhancements
 - Relieve data choke points
- Enhanced QA/QC
- Near time GIS visual of assets
- Planning capabilities
 - Operational and Maintenance
 - Rehabilitation and Replacement
- Agile workflow
 - Cloud based (SaaS)



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ADR: Field Benefit

- Huge potential, think the evolution of AI in automobiles
 - Fully assist- 100% supervised
 - Semi Assisted- 50% supervised
 - No Assistance- 0% Supervised
- Continued 5G integration
- Evolution of 4K video/image
- Quicker, more accurate data collection



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ADR: Summary

- More data than ever being collected today with various inspection equipment.
- The what, how, who of Automated Defect Recognition (ADR)
- Current usage of ADR.
- Great success but still challenges that face ADR.
- Huge potential with future field applications with ADR.
- ADR is here to stay!

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Part 3 – Al Guidelines and Applications Beyond ADR





Chris Macey, P. Eng. America's Technical Practice Leader, Condition Assessment and Rehabilitation, AECOM Member of NASSCO's Technical Advisory Council

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AI is a big business! COVID is not slowing it down!



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NASCCO AI Guidelines White Paper

- What's in the Guidelines?
 - Al Defined as it is now and where we can see it taking us
 - ADR and its position in the marketplace
 - AI beyond ADR
 - Defects to Treatment
 - Deterioration Modeling
 - Capital and Operational Planning Tools

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Automated Defect Recognition is here and we can use it now

- Key aspects of defining ADR include:
 - Where is ADR at this time in the industry.
 - What screening levels are applied for field and office-based applications having fully or semi-autonomous processes.
 - Screening of current software and hardware products in the marketplace.
 - Benefits to the application of emergency and/or maintenance data captures.
 - Benefits/limitations, risks, and opportunities of using ADR applications.
 - Roadmaps for Verification







Score: 0.5215848

Score: 0.5331915

Score: 0.556528





Score: 0.63704455

Score: 0.6447362

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Life beyond ADR

- Key areas for development beyond defect characterization
 - Post-processing defects for RUL
 - Defect Cluster analysis and Initial Automated Treatment Assessment
 - Deterioration Analysis by Era, Size, Material, and Deterioration Process Drivers
 - Setting Objectives
 - Budget, Target Service Levels, Emergency and Catastrophic Repair Tolerance
 - Optimization
 - Genetic Algorithms, Monte Carlo and Other Optimization Techniques



PROJECT NO.

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Unlimited ability to model unique deterioration sub-groups













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There are numerous applications beyond Automated Defect Recognition but moving forward starts and is built on Accurate Defect Recognition



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AI Driven Capital Planning

- Long Term Condition State Forecast
 - Driven by PACP Data, Treatment Selection and **Deterioration Modeling**
- Incorporates User Defined Planning Goals/Criteria, Asset Level Treatment Methods and Costs
 - Inspect, Rehab/Repair, Replace, Meet ER Objectives
- Generate Long Term Annual Capital Forecasts using Monte Carlo Simulation Techniques
- Output includes Geospatial Time-Lapse Scenario Animation & associated CapEx



Network Level, **Segment Level Views,** and Optimization



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Summary: Part 3 Al

- Advancing ADR will have a profound impact on the way we amass accurate Defect Databases
- There is a considerable amount to do beyond AI in the Sewer Condition Assessment
- Optimizing treatments, establishing and meeting service level objectives are all built on intelligent and innovative use of the SCA data we collection
- Establishing roadmaps and clear guidelines for the use of these techniques will benefit us all ~ for this generation and many more to come!





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