Application of Robotics, Machine Learning, and Artificial Intelligence Technologies to Site Remediation

Recap of June 6th, Session 1

Advances in Robotics and Unmanned Aerial Systems to Support Site Characterization and Remediation

FRTR Spring 2022 Meeting

Kent C. Glover, Air Force Civil Engineer Center
Jean P. Pabon, U.S. Department of Energy

Motivation for Spring 2022 Topic

Artificial intelligence technologies are beginning to transform how people and machines work together.

- Robotics and unmanned systems provide opportunities to access dangerous or toxic environments, and improve worker safety.
- Advances in machine learning are making it possible to process and analyze large data sets in new ways to support remediation decisions.

FRTR member agencies need to

- Share information and advances in artificial technology, and
- Understand how to apply artificial intelligence technologies to site cleanup.

Meeting Objectives

- Review recent technology advances supporting site characterization and remediation.
- Identify potential benefits, risks, and limits of robotics and unmanned aerial systems to support site characterization and remediation.
- Discuss appropriate use of machine learning and artificial intelligence to support remediation decisions.

June 6, 2022	*Advances in Robotics and Unmanned Aerial Systems to Support Site Characterization and Remediation*
June 13, 2022	*Advances in Processing Large Data Sets and Machine Learning for Remediation Decision Support*

Climate Resiliency and Long-Term Surveillance of Nuclear Facilities and Repositories Using Aerial and Ground Mobile Platforms

Anthony Abrahao and Leonel Lagos, Florida International University

Objectives

- Assess remote sensing, geophysical technologies and other non-evasive technologies for characterizing and monitoring U.S. legacy management (LM) disposal cells.
- Investigate extent and depth of erosion features without removing cover due to risk of exposure from radiological materials.

Result

- Digital twin technologies provide updated, abundant, and reliable spatial data and trends and are useful tools for making optimal and safer decisions.

Potential Use of Drones and Robotics for Radiological Characterization, Site Surveys and Emergency Response

Boby Abu-Eid and Stephanie Bush-Goddard, U.S. NRC; and Amoret Bunn, Pacific Northwest National Laboratory

Unmanned Aerial Vehicles in Radiological Monitoring, Survey, and Emergency

- Perform radiation monitoring and surveys; characterize sites to focus remediation and decontamination on hotspots; support development of exposure pathways; monitor erosion and potential spread of contamination; and focus on risk mitigation.

Results and Future Research

- Approach – Compare traditional and small unmanned aircraft systems (sUAS) data.
- Commercially available instrumentation can be used for detection at levels needed for decommissioning sites.
- Next Steps – Optimize, integrate, validate for other radionuclides, detectors and environmental conditions.

Wearable Robotics and Exoskeletons to Improve Worker Safety

Jason Wheeler, Sandia National Laboratory; Department of Energy – Environmental Management Office (DOE-EM)

Objectives

- Understand challenging work that may benefit from wearable technology.
- Explore whether emerging exoskeleton devices can support workers and reduce the risk of musculoskeletal injury due to acute over-exertion, chronic overuse and increased risks associated with PPE.

Approach

- Replicate industrial tasks in controlled lab setting for neuromechanical analyses.
- Examine ability of assistive devices and/or biofeedback to reduce work-related injuries.
- Participants are evaluated with and without devices.

Multi-Scale Thermal and Electromagnetic Technologies Toolbox for Improved Mapping and Monitoring of Contaminated Groundwater Discharges to Surface Water

Ramona Iery, NAVFAC Engineering and Expeditionary Warfare Center, and Martin Briggs, USGS

Objective

- Develop and validate a multi-scale thermal and electromagnetic toolbox for mapping and monitoring groundwater - surface water interactions.

Results

- Toolbox for adaptable real-time investigations including remote areas.
  - Backpack-sized sUAS
  - Thermal infrared mapping
  - Programmable with active or autopilot
  - Data visualization tools
- Capable of mapping groundwater discharge locations at high resolution.
- When combined with dye dilution tests, groundwater inflow can be quantified with distance along a stream channel.

Using Drones, Aircraft, Sensors, Satellite, and Other Next Generation Emissions Measurement Technology at a Landfill

Susan Thornloe, Center for Environmental Solutions and Emergency Response, U.S. EPA ORD

Benefits

- Site access not needed to monitor cover material for failures, air emissions, and leaching to water resources.
- Satellite data coupled with statistical analysis and modeling are useful to identify hotspots and understand spatial distribution of emission sources.

Next Steps

- Team with Carbon Mapper and Scientific Aviation to conduct high-altitude and low-altitude remote sensing.
- Conduct ground-based measurements in conjunction with aircraft and satellite measurements.

June 13th Presentations

Advances in Processing Large Data Sets and Machine Learning for Remediation Decision Support

- The DOE Altemis Project: Combining Innovative Technologies to Improve Long-Term Management of Radionuclide-Contaminated Sites
- Use of In situ Real-Time Monitoring for Early Warning Systems at SRS F-area and D-area Coal Ash Basins
- Artificial Intelligence and Machine Learning Techniques for Long Term Monitoring of Soil and Groundwater Contamination
- Application of Imaging Spectroscopy and Machine Learning to Chemometrics
- Overview of NIEHS Projects Applying Machine Learning to Support Remediation Decisions