FIU Project 3 – Waste and D&D Engineering and Technology Development
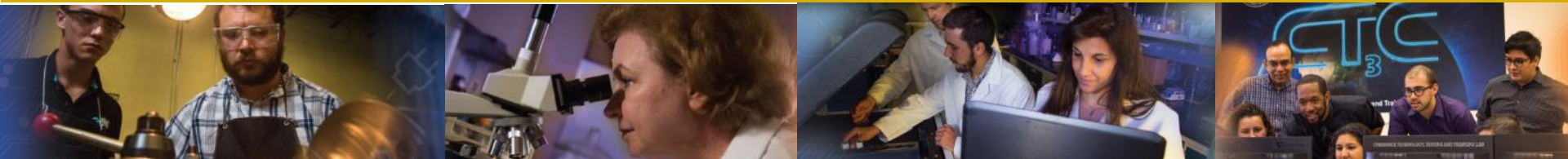
Presented: August 7, 2019

Dr. Himanshu Upadhyay

Project Tasks and Scope

Task 1 Waste Information Management System (WIMS)

- Manage complex-wide waste forecast information for planned treatment/disposal
- Provide web-based system to receive, organize, and report DOE waste forecast streams via a common application

Task 3 Knowledge Management Information Tool (KM-IT)

- Maintain and preserve D&D knowledge by enhancing communication, information sharing, and distribution to assist future D&D projects and workforce

Task 6 Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

- Develop a pilot-scale infrastructure using machine learning/deep learning and big data technologies for structural health monitoring of facilities using investigate a imaging technologies deployed at FIU mock up facilities

Knowledge Base for Environmental Management
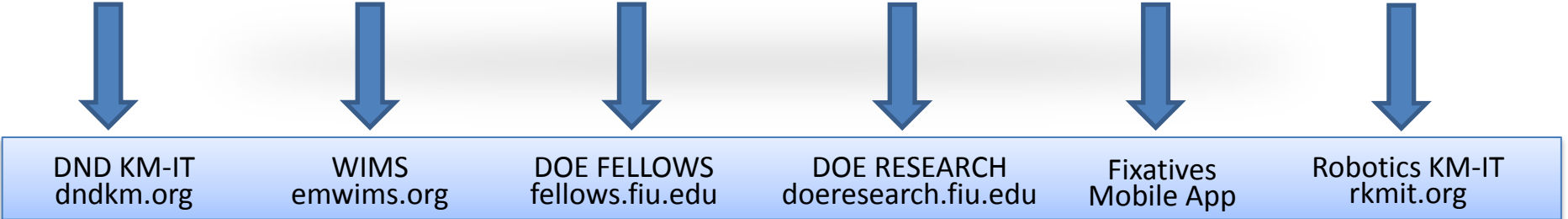
DND KM-IT
dndkm.org

WIMS
emwims.org

DOE FELLOWS
fellows.fiu.edu

DOE RESEARCH
doeresearch.fiu.edu

Fixatives
Mobile App

Robotics KM-IT
rkmit.org

Knowledge Base for Environmental Management

https://kbem.org/

Knowledge Management Information Tool (KM-IT)

www.dndkm.org

KM-IT Modules

- D&D Hotline
- Technology Module
- Vendor Module
- D&D Research
- Mobile applications
- Lessons Learned
- Documents
- Pictures/videos
- Search tools
- Training
- Specialists
- Best Practices

www.dndkm.org

Task 3 – Knowledge Management Information Tool (KM-IT)

Accomplishments Year 9:

- KM-IT development and enhancement.

- FIU completed enhancing and optimizing the web crawler to search and retrieve information related to D&D from within KM-IT as well as from OSTI and identified internet sources/websites.

  – Search KM-IT

  – OSTI Search

  – Search Web

Task 3 – Knowledge Management Information Tool (KM-IT)

Accomplishments Year 9:

- Researchers and DOE Fellows continued to research the latest penetration testing, malware analysis and forensics tools to secure KM-IT system and infrastructure
  - Regularly performed penetration testing on network, KM-IT database and application servers.
  - Trained DOE Fellows in DOE-EM Cybersecurity lab on advanced security tools commonly used in the industry.

D&D KM-IT Statistics as of July 2019

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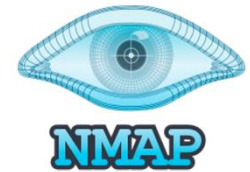
- D&D KM-IT web analytics to track usage metrics.
- 985 D&D technologies
- 1045 registered users
- 980 D&D vendors
- 195 Hotline questions/solutions
- 103 subject matter specialists

Yellow – 2012
Blue - 2019
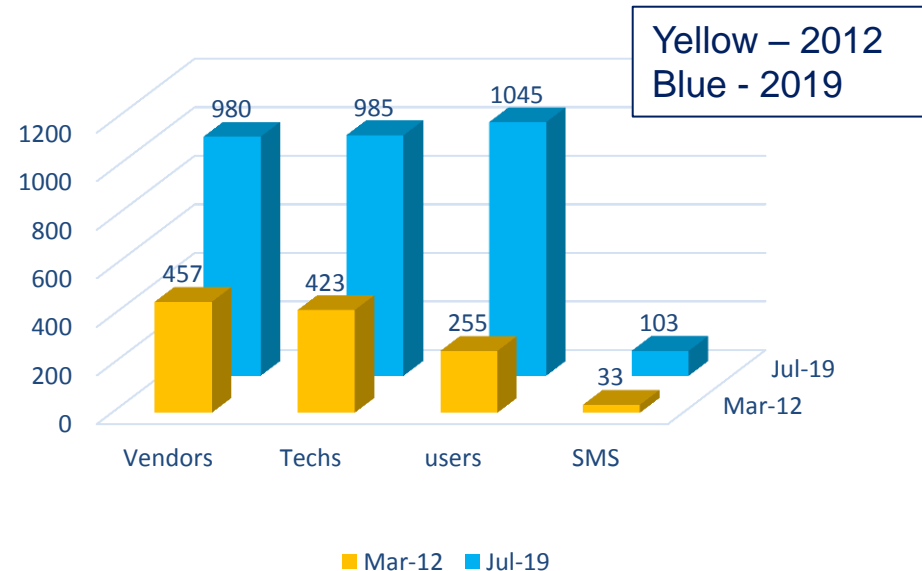
Growth from March 2012 to July 2019

Fully searchable resources – Original sources no longer available

- 169 ALARA Center reports archived (Hanford and SRS)
- 231 Innovative Technology Summary Reports archived

D&D KM-IT Statistics as of July 2019

FIU
Applied Research Center

- Year comparison activity on D&D KM-IT (2019 vs 2018)

- Double digit percentage increase on: Users, New users, Sessions and Pageviews

- Minor increase on: Pages per session and Avg. session duration

- Unchanged bounce rate

Jul 1, 2018 - Jun 30, 2019: ● Users
Jul 1, 2017 - Jun 30, 2018: ● Users

Users	New Users	Sessions
33.06%	31.61%	24.50%
13,370 vs 10,048	13,175 vs 10,011	14,996 vs 12,045

Number of Sessions per User	Pageviews	Pages / Session
-6.43%	28.22%	2.99%
1.12 vs 1.20	34,049 vs 26,555	2.27 vs 2.20

Avg. Session Duration	Bounce Rate
2.09%	0.61%
00:01:31 vs 00:01:29	79.07% vs 78.59%
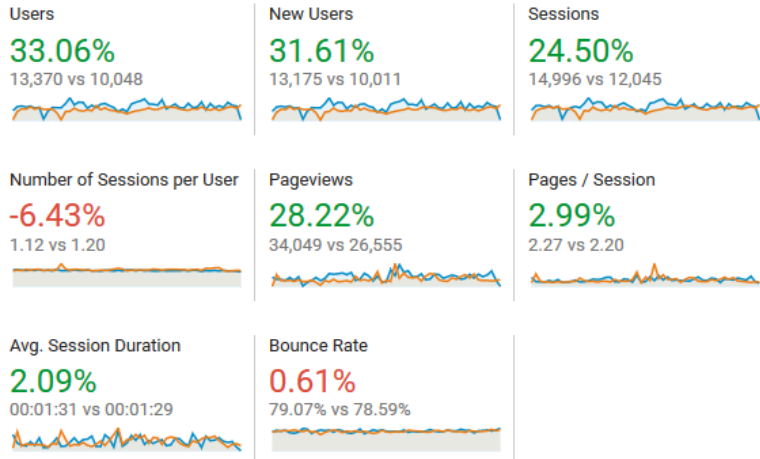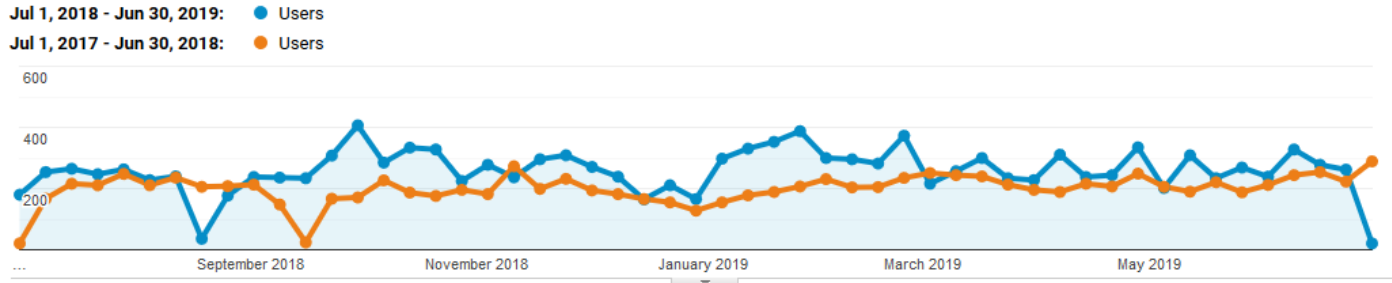
■ New Visitor ■ Returning Visitor

Jul 1, 2018 - Jun 30, 2019
94.7%
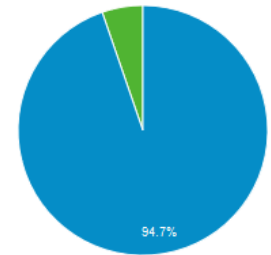
Jul 1, 2017 - Jun 30, 2018
6.4%
93.6%
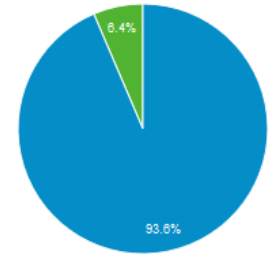
Task 3 – Knowledge Management Information Tool (KM-IT)

Accomplishments Year 9:

- FIU presented D&D KM-IT research at WM2019, demonstrated at FIU booth and student alumni pavilion

    Abstract: 19107

    Title: Robotics on KM-IT Platform
    Authors: Himanshu Upadhyay, Walter Quintero, Leonel Lagos, Peggy Shoffner
    Session: D&D General - Posters

Task 3 – Knowledge Management Information Tool (D&D KM-IT)

Proposed Scope for Year 10

- KM-IT Development and Enhancement
  - Enhance D&D Research module for multiple DOE EM sites, universities and national labs

- KM-IT Outreach – Community Support
  - Participation in industry conferences and workshops
  - Newsletters and mass communications
  - User support, including requested ad hoc specialized reporting

- KM-IT Maintenance & Administration
  - Cybersecurity & Administration of KM-IT Infrastructure
  - Content Management (Published technologies/vendors, news, lessons learned/best practices on the KM-IT platform)
  - Web Analytics (Quarterly update of Google analytics, server log analysis, and metrics reporting)
  - KM-IT Application and Database hardware upgrade

Waste Information Management System (WIMS)

https://www.emwims.org
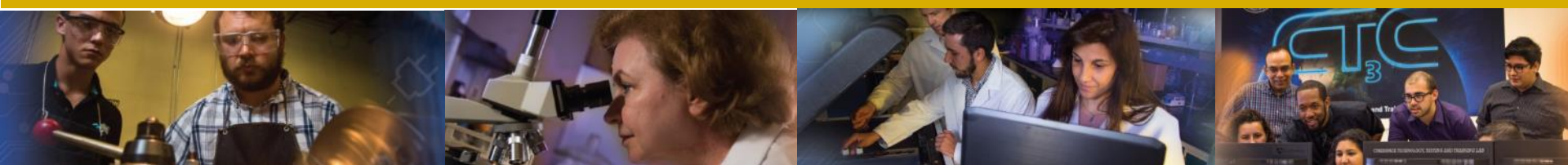
Task 1 – Waste Information Management System

Accomplishments Year 9:

- Easy-to-use tool to visualize and understand the forecasted DOE-EM waste streams & transportation information.

- WIMS is deployed and available at https://www.emwims.org

- Various modules of WIMS are Forecast Data, Disposition Map, Successor Stream Map, GIS Map, Transportation, Reports and Help.
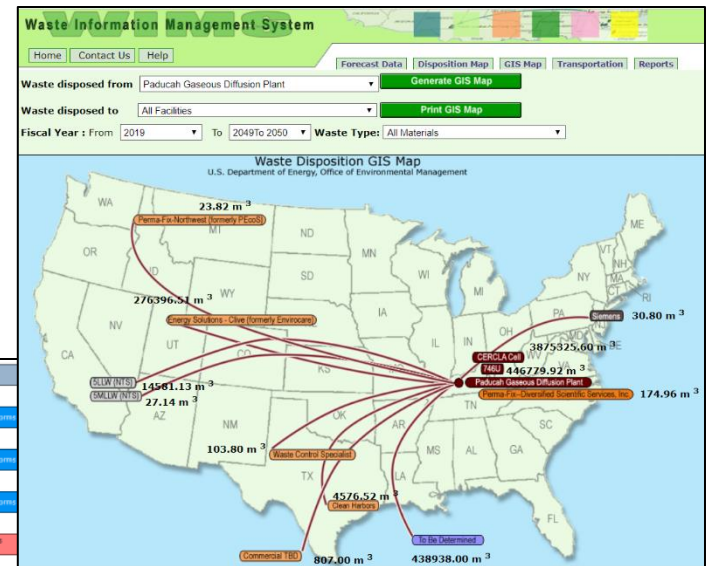
Task 1 – Waste Information Management System

Accomplishments Year 9:

- Upgraded WIMS application framework & published updated system on March 30, 2019.

- FIU successfully upgraded the WIMS application to the latest Microsoft.Net framework 4.6.1 from framework 1.1 (Win 2003)
  - Deployed Database and Application servers with updated framework.
  - Configured WIMS application to execute on upgraded framework.
  - Upgraded WIMS components, controls and modules to the new framework.
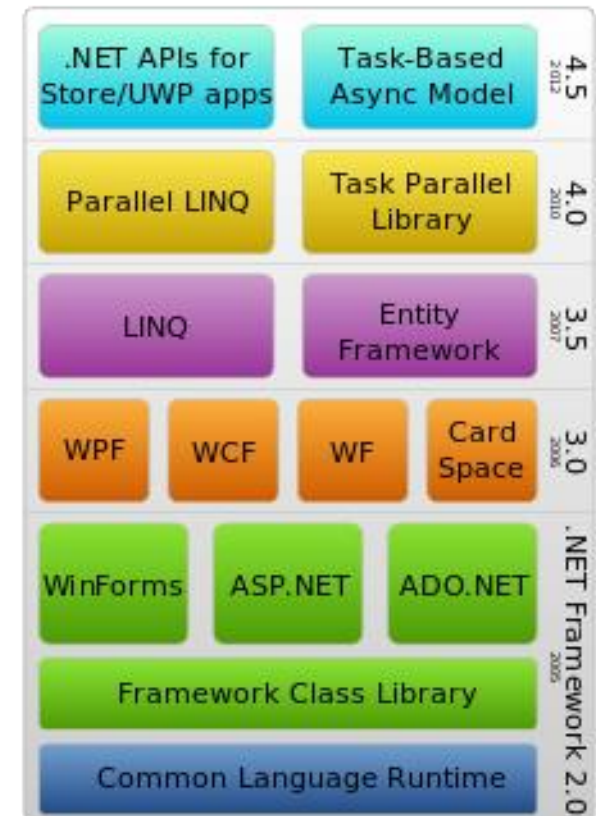
Task 1 – Waste Information Management System

Accomplishments Year 9:

- FIU presented WIMS research in 2019 Waste Management Symposia.

Title: Waste Information Management System with 2018-19 Waste Streams
Authors: Himanshu Upadhyay, Walter Quintero, Leonel Lagos, Peggy Shoffner
Abstract and Session: 19106, Poster Session 2 – Characterization

Walter Quintero presenting WIMS poster at WM2019

Task 1 – Waste Information Management System

Proposed Scope for Year 10

- Integrate 2020 waste stream and transportation data into WIMS.
  - Update WIMS modules – Forecast Data , Waste Stream and GIS map
  - Update and Publish reports
  - Update and Publish Transportation Module
  - Publish updated application on secured socket layer

- WIMS Identity Management
  - Design and develop Registration Database
  - Develop Authentication Module
  - Authorization Module Development

- Upgrade WIMS Report Server & Report Function
  - Deploy and integrate report server
  - Design, develop and publish reports
  - Integrate report in WIMS application

Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

FLORIDA INTERNATIONAL UNIVERSITY

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Site Needs:

Assess the structural integrity of aging facilities in support of ongoing surveillance and maintenance (S&M) across the DOE complex.

Objectives:

Under this subtask for FIU Performance Year 9, FIU will develop a pilot-scale infrastructure to implement structural health monitoring using scanning technologies, machine learning / deep learning and big data technologies. This pilot system is intended to serve as a starting point to engage the DOE field sites on related data sets and their decision making needs.

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

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Applied Research Center

Accomplishments Year 9:

- Set up mock-wall in outdoor test facility that simulates structural conditions of D&D facility.

- Collected over 28,000 images from different wall sections.

- Data variation contains different light exposure, wall angles and scale ratios.

- Image data sets are stored in the Big Data Platform.

- Data subsets are replicated in local storage networks for increased I/O transfers.

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Accomplishments Year 9:

Baseline Model Development and Categorization

The baseline was created from images collected from the outdoor D&D mockup facility.

- A total of 28,000 images were collected.
  - 14,000 images were classified as "baseline" (all sections containing "CL" tag).
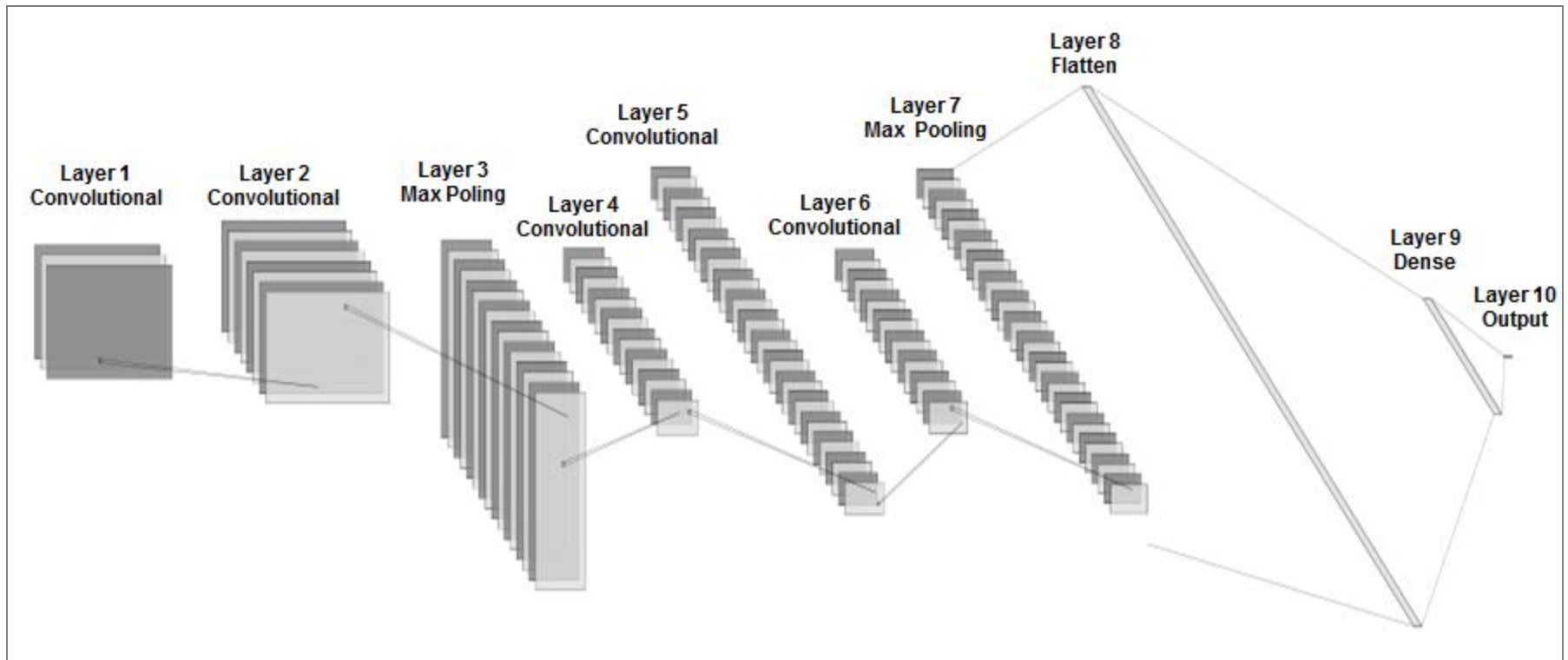 - 14,000 images were classified as "deteriorated".

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Accomplishments Year 9:

Deep Convolutional Neural Network Architecture:

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Accomplishments Year 9: Results

Model Accuracy

Confusion Matrix

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Accomplishments Year 9: Classification of Wall Images

Sample Baseline Images   Input image feed to CNN model for Classification

Model Prediction = "Baseline"
94.35% probability

Model Prediction = "Degraded"
97.13% probability

Model Prediction = "Baseline"
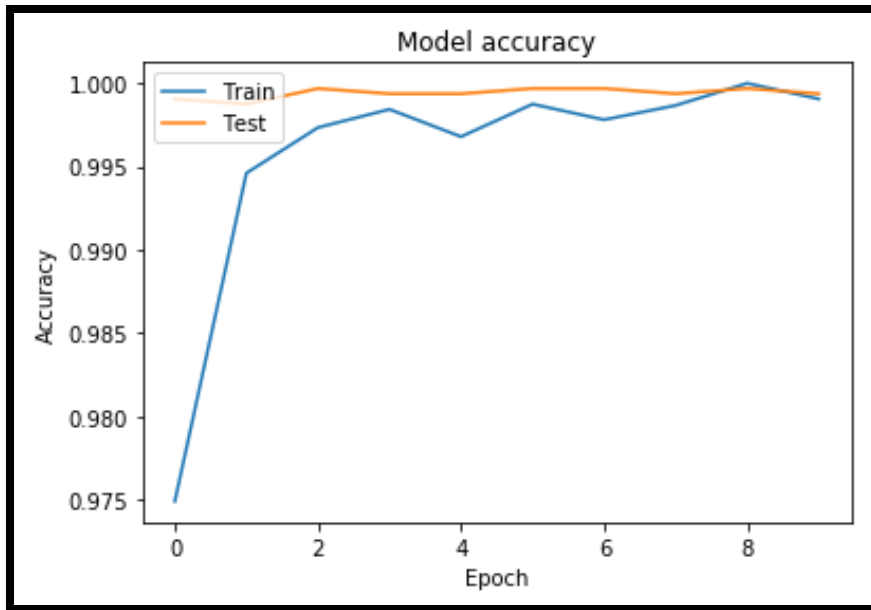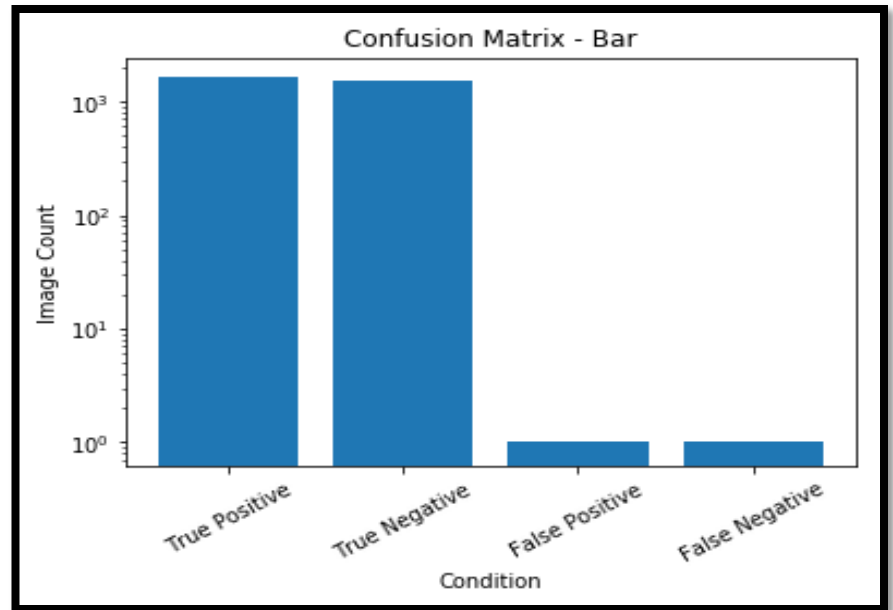87.63% probability

Model Prediction = "Degraded"
97.16% probability

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Accomplishments Year 9:

Presented this research at WM2019.

The poster focused on the methodology and approach of this research. Conference attendees had a lot of interest in this research focused on Artificial Intelligence and Big Data technologies.

Abstract: 19108

Title: Big Data Framework with Machine Learning for D&D Applications
Authors: Himanshu Upadhyay, Leonel Lagos, Anthony Abrahao, Walter Quintero, Santosh Joshi

Walter Quintero and Alejandro Koszarycz at WM2019 presenting poster.

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Accomplishments Year 9:

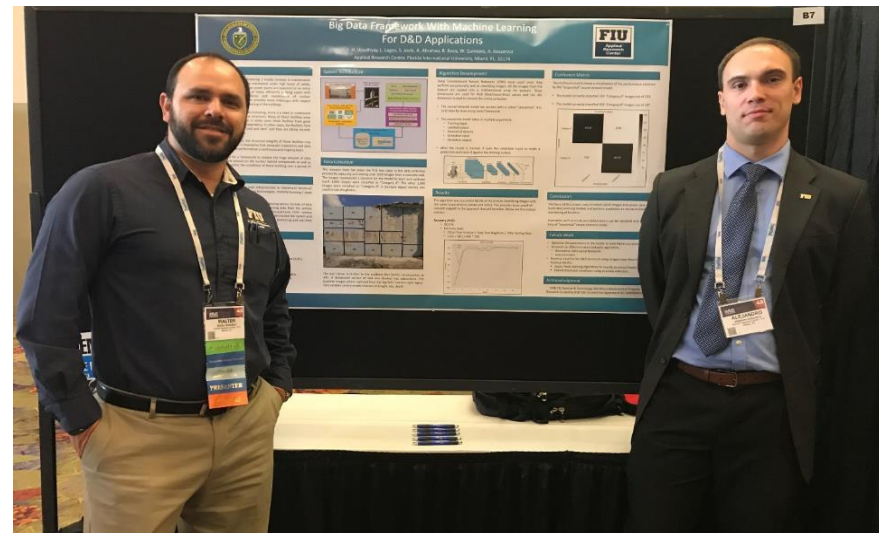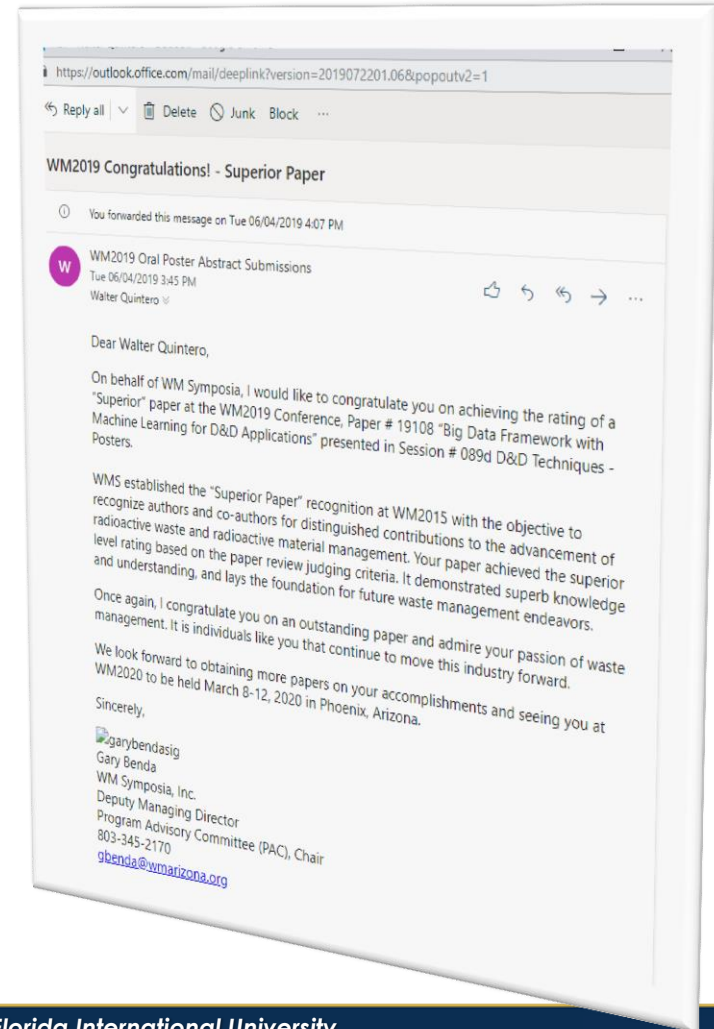WM Symposia awarded the rating of a "Superior Paper" for the "Big Data Framework with Machine Learning for D&D Applications" paper.

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Proposed Scope for Year 10

- FIU will use the LiDAR technology to collect point cloud data by scanning the D&D mock up facility at FIU.

- The point cloud data collected from LiDAR will be stored on a Hadoop distributed file system for storage and processed with distributed nodes using parallel processing.

- FIU will continue to work on the development and optimization of the convolutional neural network algorithm to classify structural wall images using the point cloud data and images.

- FIU will research, design and develop the object recognition algorithm using computer vision to identify cracks and structural defects in the mock up wall.

Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Proposed Scope for Year 10

- FIU plans to deploy an integrated big data and machine learning server infrastructure using Docker containers and a Kubernetes orchestration framework for image data storage and processing.

- Algorithms and big data technologies developed under this research will help in surveillance and maintenance of D&D buildings to identify cracks, defects and other irregularities using LiDAR or other scanning/imaging technologies.

- Identifying anomalous sensor data collected from various monitoring applications across DOE-EM sites.

- This research task will also support the Ph.D. studies of the DOE Fellow – Roger Boza working on image recognition, neural network design and optimization for image processing and object recognition.