Federal Remediation Technologies Roundtable (FRTR)
May 21, 2024 - Meeting

Robotics, Digitalization in Decommissioning, and AI

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FIU Applied Research Center

Florida International University

A vibrant, 58,000 student-centered public research university located in Miami, Florida.

Among the largest Hispanic-serving institutions in the U.S. and is designated a Minority-Serving Institution.

As a top-tier research institution, research is a major component in FIU mission.

DOE's Environmental Restoration Mission:

DOE Office of Environmental Management has over 30 years managing and directing the cleanup of contaminated nuclear facilities across the United States due to the legacy of R&D and production of nuclear weapons (i.e. Nuclear Weapons Complex)

DOE Office of Legacy Management is committed to fulfilling DOE's post-closure responsibilities and ensuring the future protection of human health and the environment

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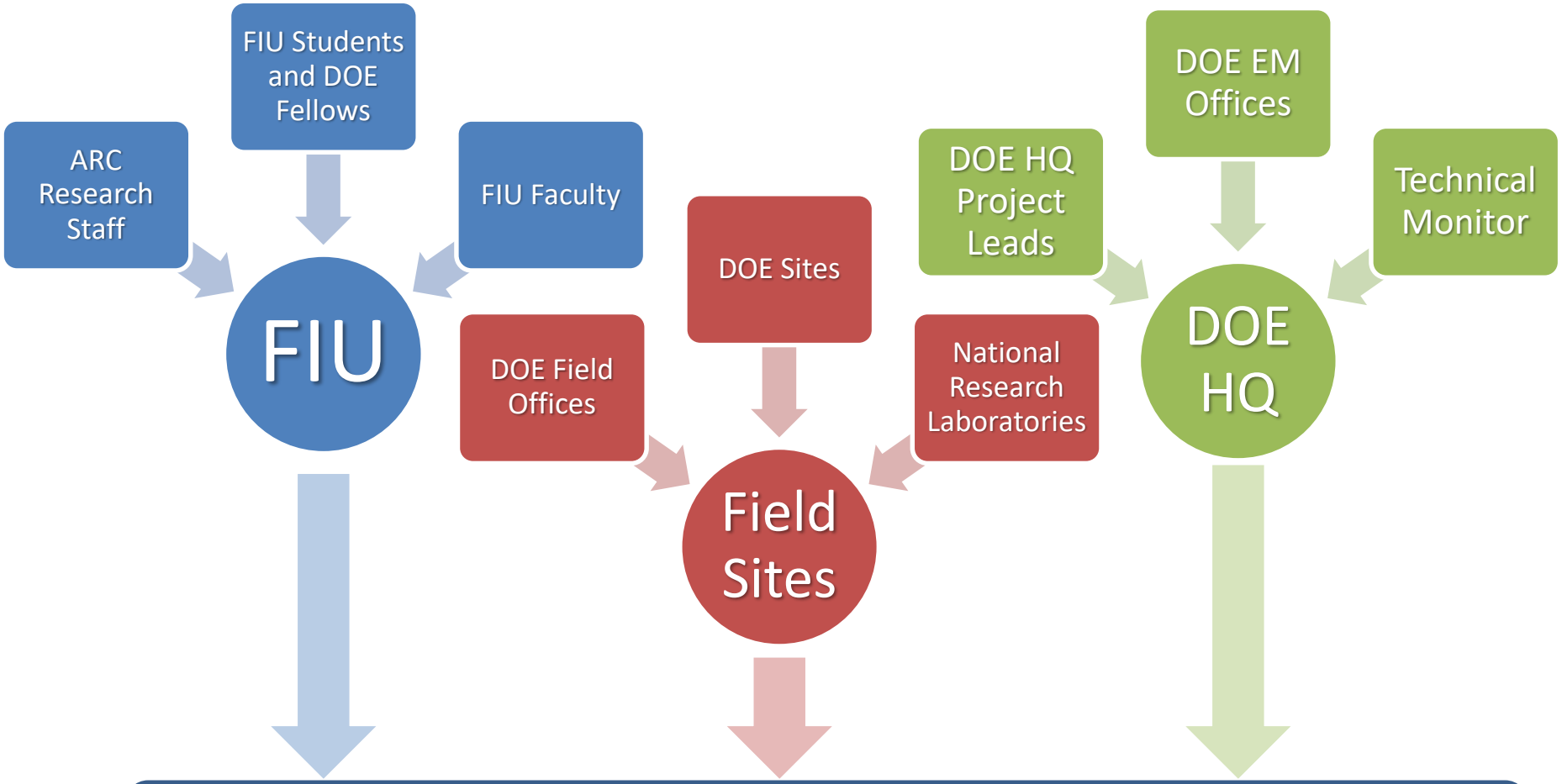
Cooperative Agreement Team



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Technology Roadmap

		2020	2021	2022	2023	2024
Tank Farm Hanford	Minirover	In-house Deployment	Site Deployment	Site Deployment	Technology Transferred	
	UT Rover	Conceptual Design	Evaluation	In-house Deployment	Site Deployment	
	Lateral Gamma		Integration	Cold Test Facility Deployment	Site Deployment	
	Off-Riser Sampler			Conceptual Design/Integration	Cold Test Facility Deployment	Site Deployment
	Long-Term Surveillance	Conceptual Design	Sensor Integration	Evaluation	In-house Deployment	Site Deployment
H Canyon SRNL	Wall Crawler	Conceptual Design	Sensor Integration	Evaluation	In-house Deployment	Site Deployment
WIPP MSIPP	Salt Closure Inspection	Evaluation	In-house Deployment	Site Deployment		
Rifle Cell LM	Aerial Lidar	Evaluation	Site Deployment			
	Ground Radar		Evaluation	Integration	Site Deployment	
Wearable SANDIA	Exoskeleton		Conceptual Design	Integration	In-house Deployment	Site Deployment

Facilitating "Full Deployment" and Technology Transfer to the End User

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- Extensive test/evaluation and cold test in-house (FIU) before deployment
- Test/Evaluation of technologies in cold or hot environments at DOE facilities
- Facilitate the introduction and transition of technologies to end users
- Training of operators
- Training of STEM students

Hanford's Tank Farm

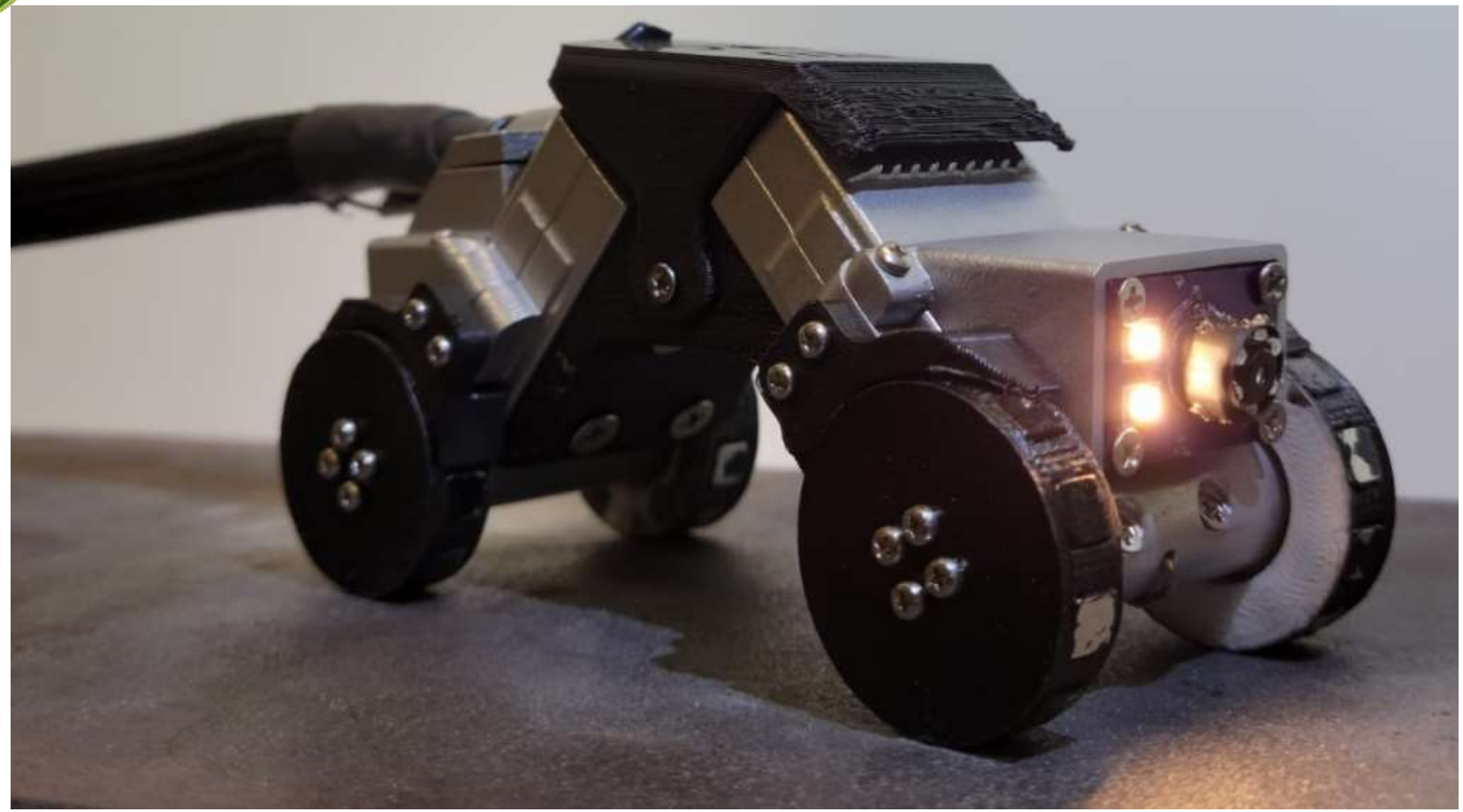
177 TOTAL TANKS

149 SINGLE-SHELL TANKS Constructed 1943-1964

28 DOUBLE-SHELL TANKS Constructed 1968-1986

Hanford site has 56 million gallons of radioactive waste left from the past production of nuclear weapons. The HLW is being stored in underground tanks

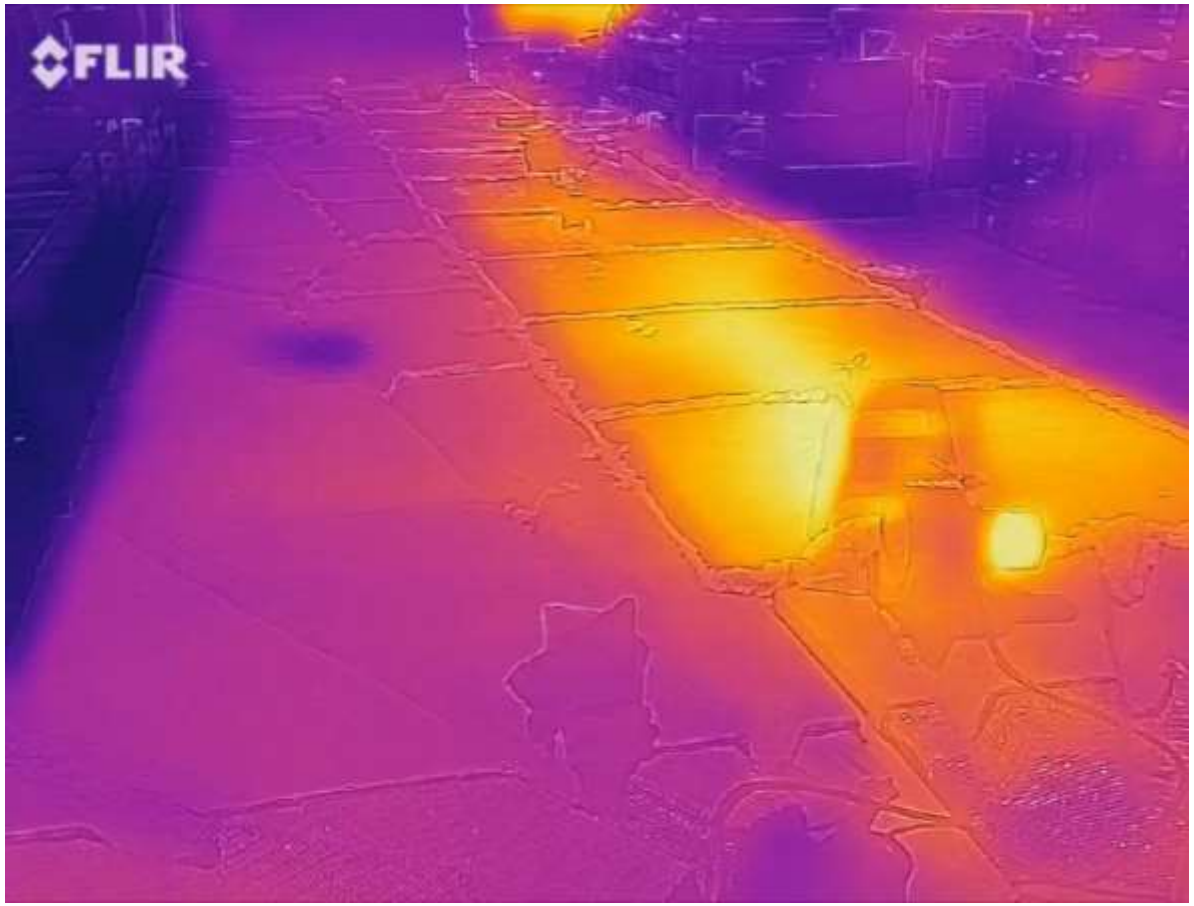
Miniature Rover Inspection Tool for DST Inspections



Aluminum 3D Printed Body
Patented Flexible Chassis

Control Box
Game Controller

FIU Test Bed – Hanford Double Shell Tank



Traversing weld seams
Elevated Temperatures
Corroded Surfaces

Extensive in-house testing duplicating DOE site conditions

WRPS's Cold Test Facility Training – Mach 2022

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AP-105 Double Shell Tank Deployment – March 2022

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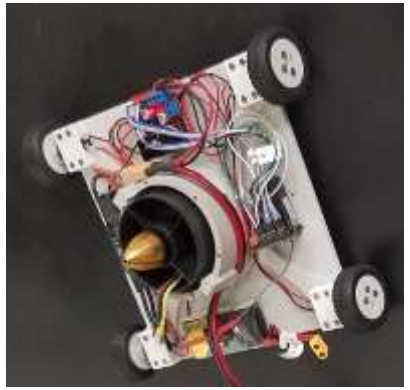
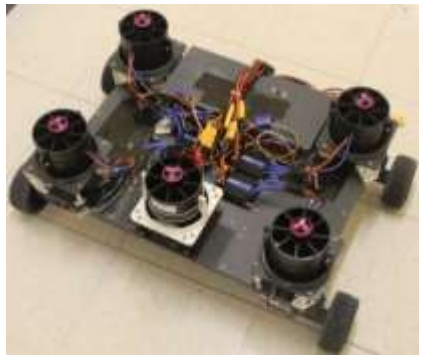
Single Shell Tanks Applications
WRPS Cold Test Facility Deployment

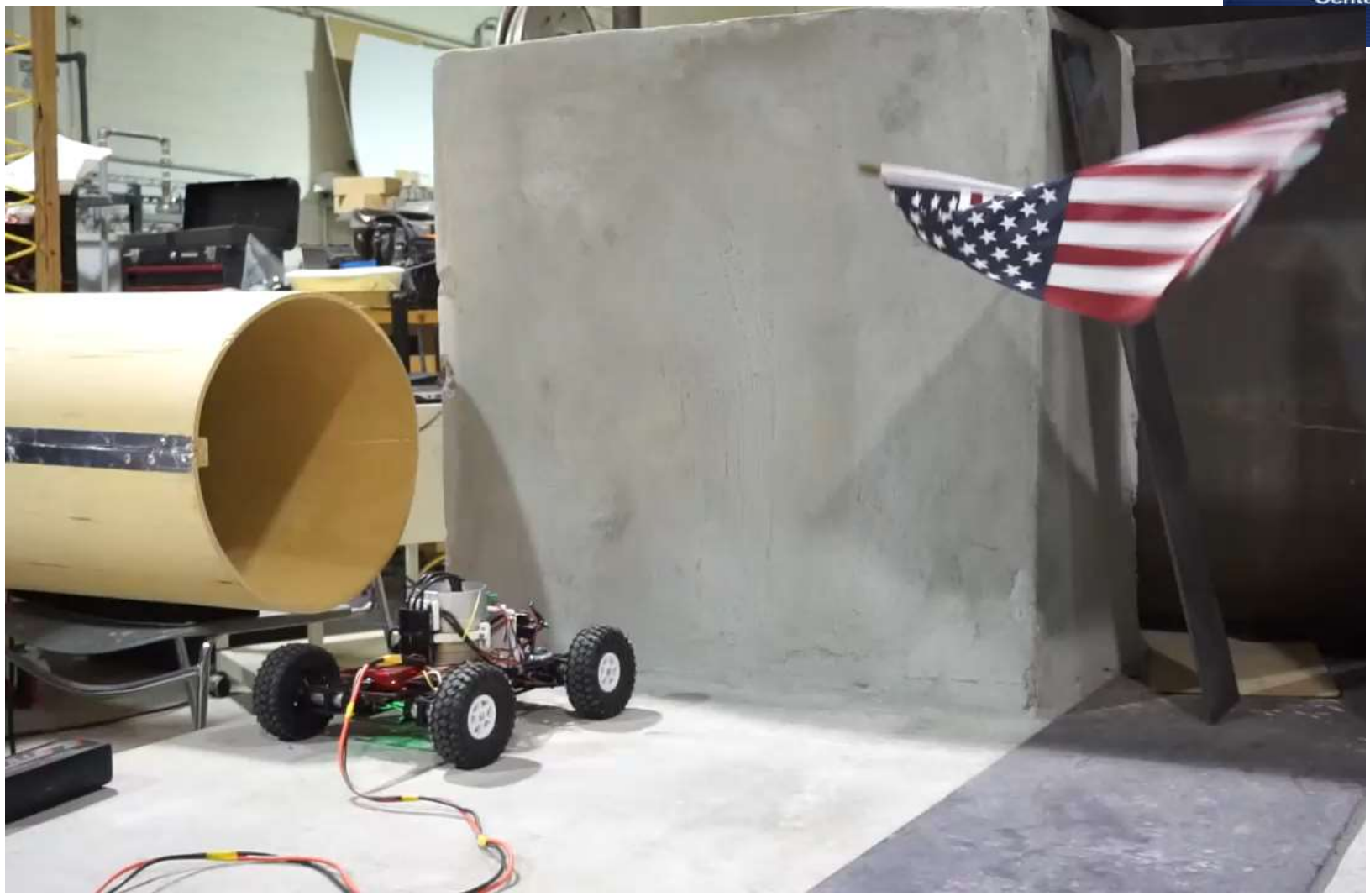
Lateral Gamma Scanner Pipe Crawler Cold Test Deployment – WRPS Cold Test Facility – Summer 2023

SRS H-Canyon Concrete Wall Repair

H-Canyon Concrete Wall Repair Prototype







Deployment of Robotic Platform Integrated with a Ground Penetrating Radar – LM Mexican Hat Disposal Cell, Utah

Deployment of Robotic Platform Integrated with a Ground Penetrating Radar – Carlsbad New Mexico

Digitalization in Decommissioning

- Facilitates virtual walk downs by developing 3D models and digital environments (Digital Twins)
- Supports the development of VR/AR for training
- Supports the various stages of decommissioning (characterization, inventory, decontamination, size reductions, waste management and disposal)
- Trimble X7 3D LiDAR (Light Detection and Ranging) use to develop high quality 3D point cloud scans using laser beams
- The SPOT robot used to navigate indoor/outdoor environments
- Kromek Sigma 25/50 Gamma detector
- Data post-processed by using various software tools (i.e. AutoDesk ReCap, SCENE “video Pro)

Digitalization of Decommissioning with SPOT/Trimble X7

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- High-quality detailed scans produced with Trimble X7 (LiDAR fixed in place during scanning)
- SPOT integration allows for autonomous navigation through the facilities
- Focus will be on implementing sequential stops during SPOT deployment for Trimble X7 to activate and scan

3D Laser Scanning of ARC's High Bay Facility

Digital Facility Walk Downs

Courtesy of Nucleco (Italy) and IAEA: Laser Scanner “Faro S150 + and SCENE “video Pro”

Nuclear Waste Identification, Classification and Segregation using Computer Vision and Robotics Arm

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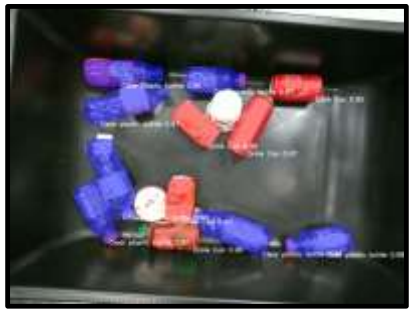
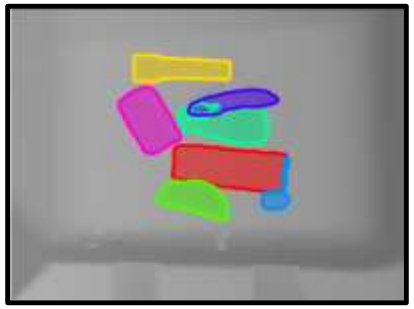
- Implemented multiple algorithms for object detection and related tasks such as YOLOv7 (Object Detection & Instance Segmentation), STEGO (Unsupervised Semantic Segmentation)
- The segmentation model developed recognizes and provides polygons of objects seen through images via an array of pixel coordinates
- A depth camera mounted on the end effector of the robot provides a stream of images and the corresponding depth information
- These images are fed into the model and a Point in Polygon (PIP) algorithm is used to grab all pixel coordinates corresponding to the objects and obtain their depth data in order to construct a 3D Point Cloud





Robotic Arm Segregating the Waste

Nuclear Waste Identification, Classification and Segregation using Computer Vision and Robotics Arm

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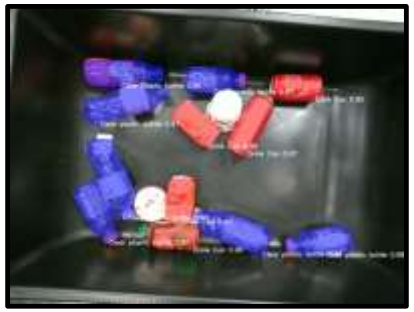
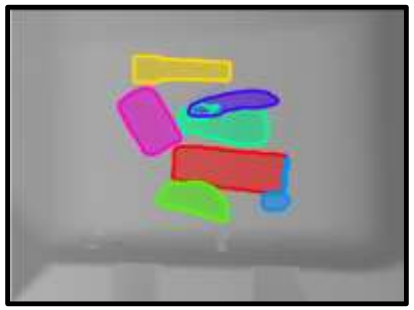
Integration to Robotic Arm:

- Robot Operating System 2 (ROS2) is used to publish the arm's joint states and frame of references used to make the cameras point relative to a world frame of reference constructed by the Point Cloud
- Through the use of a behavior tree and inverse kinematics, the arm can move to an identified object, activate gripper or suction (end-of-arm), and place the object in a separate bin based on the object classification
- ROS2 is also used to publish the depth camera information and glue together each component such as the behavior tree and Point Cloud program

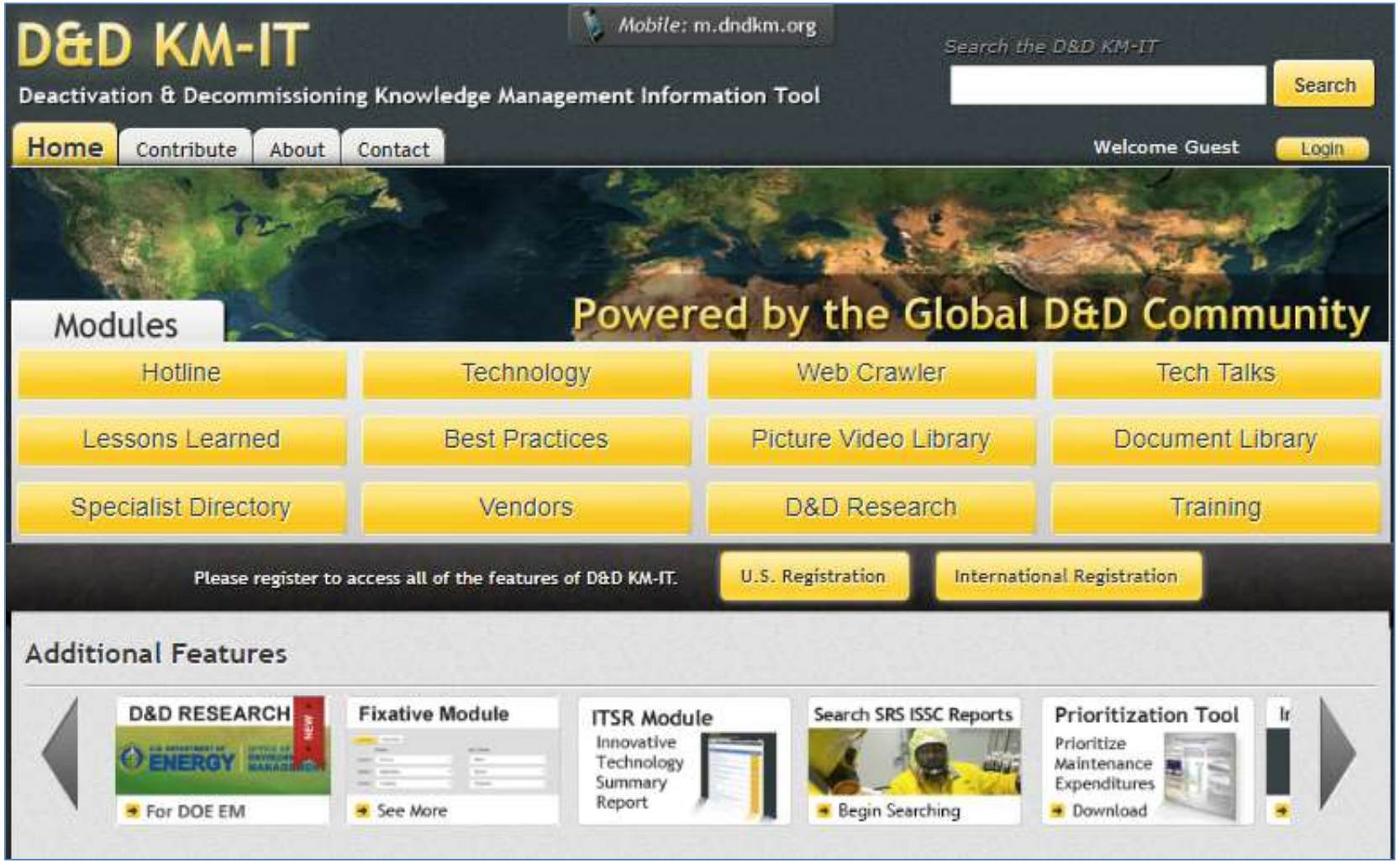




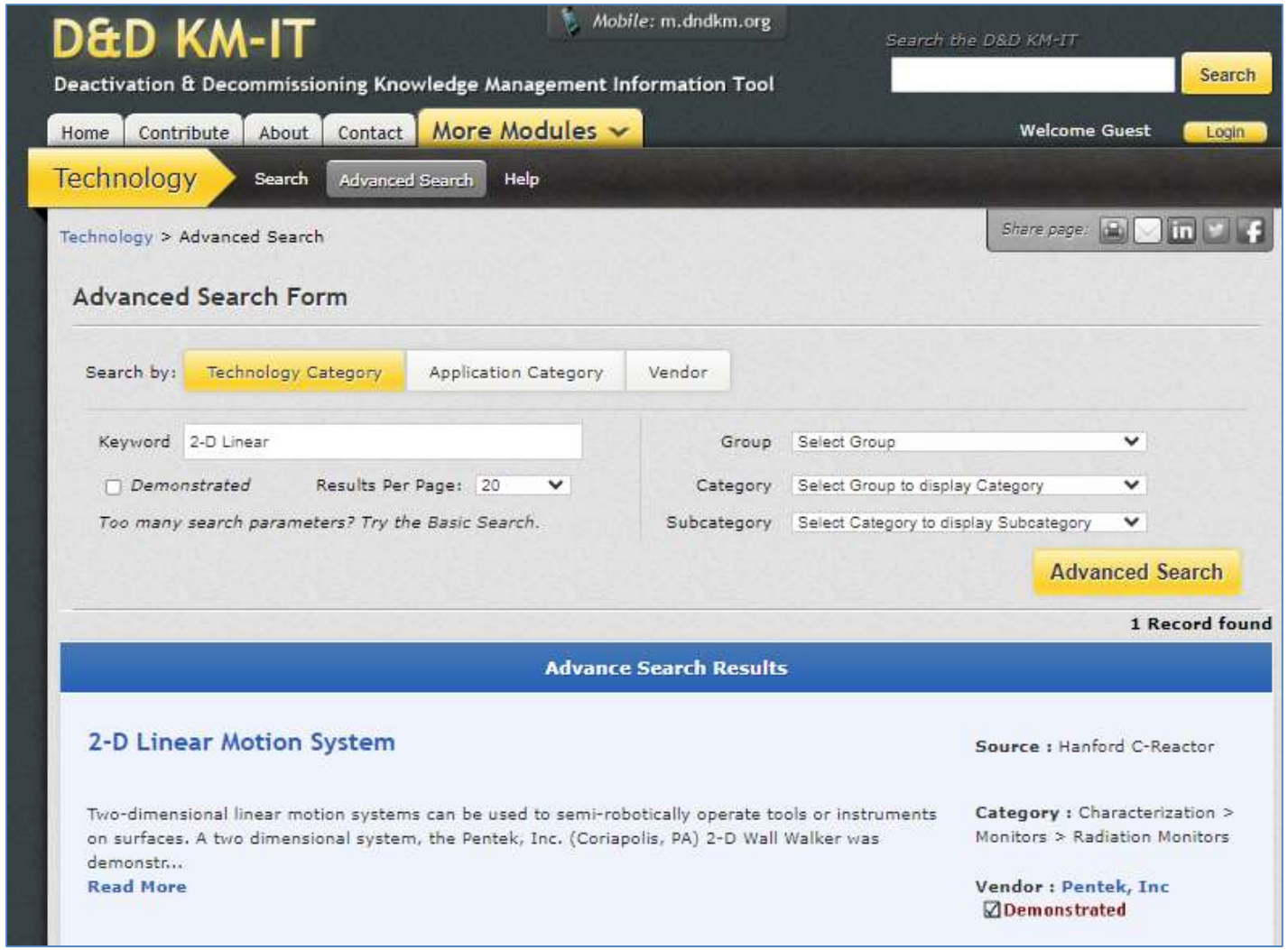
Robotic Arm Segregating the Waste

Robotic Arm Segregating Waste - Demo

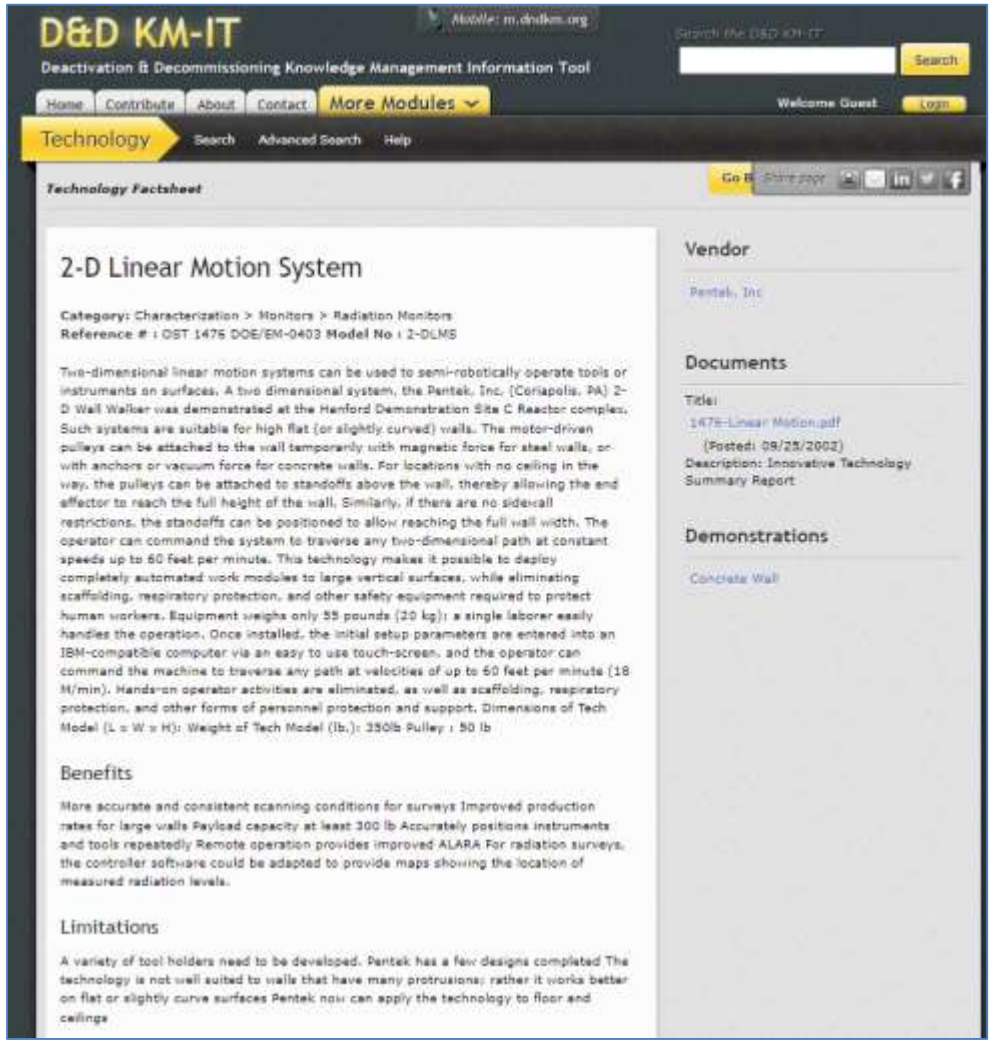
D&D Knowledge Management Information Tool (KMIT) https://dndkm.org



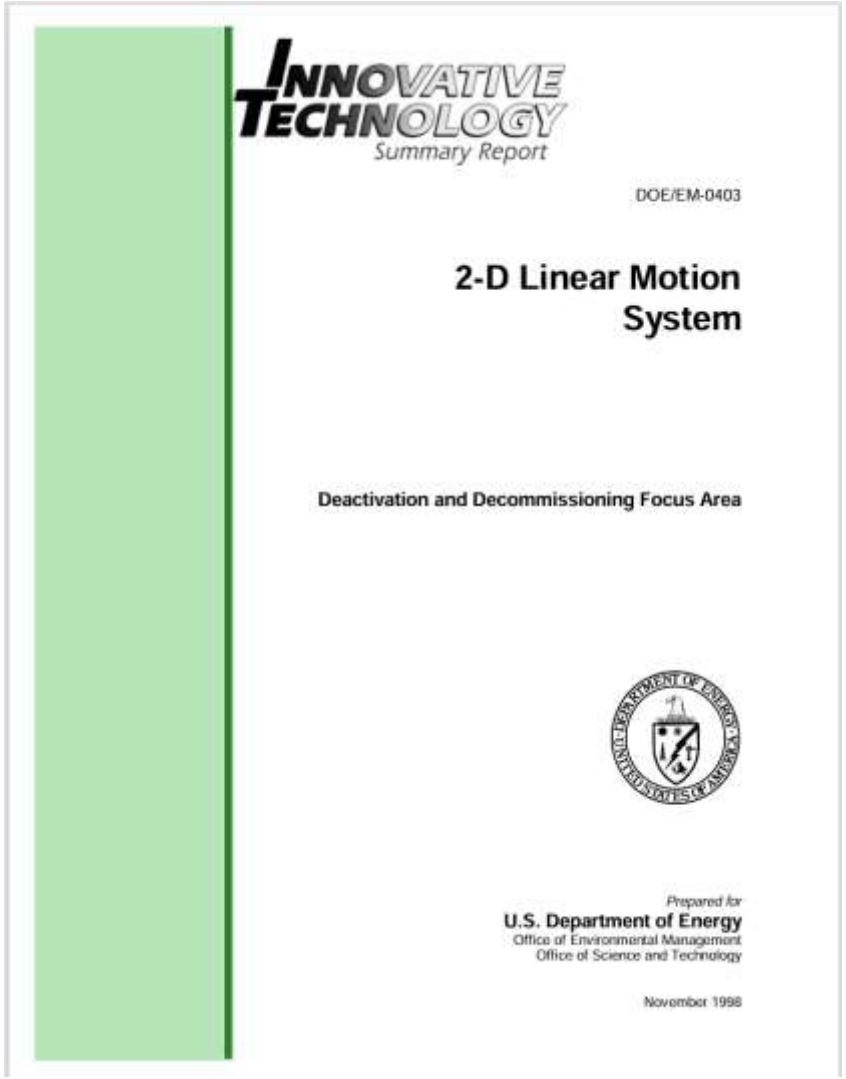
KM-IT Technology Module



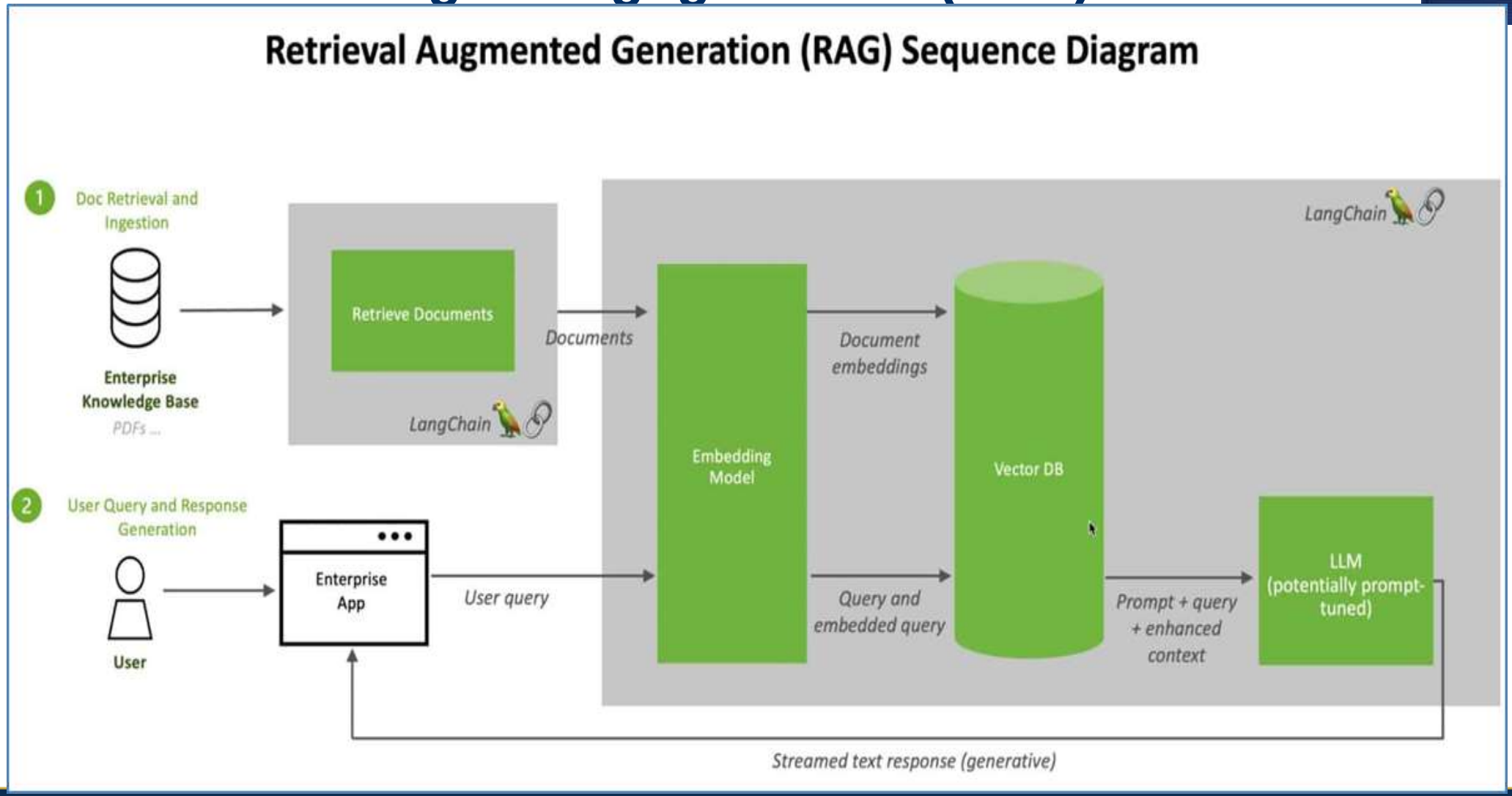
KM-IT Technology Module



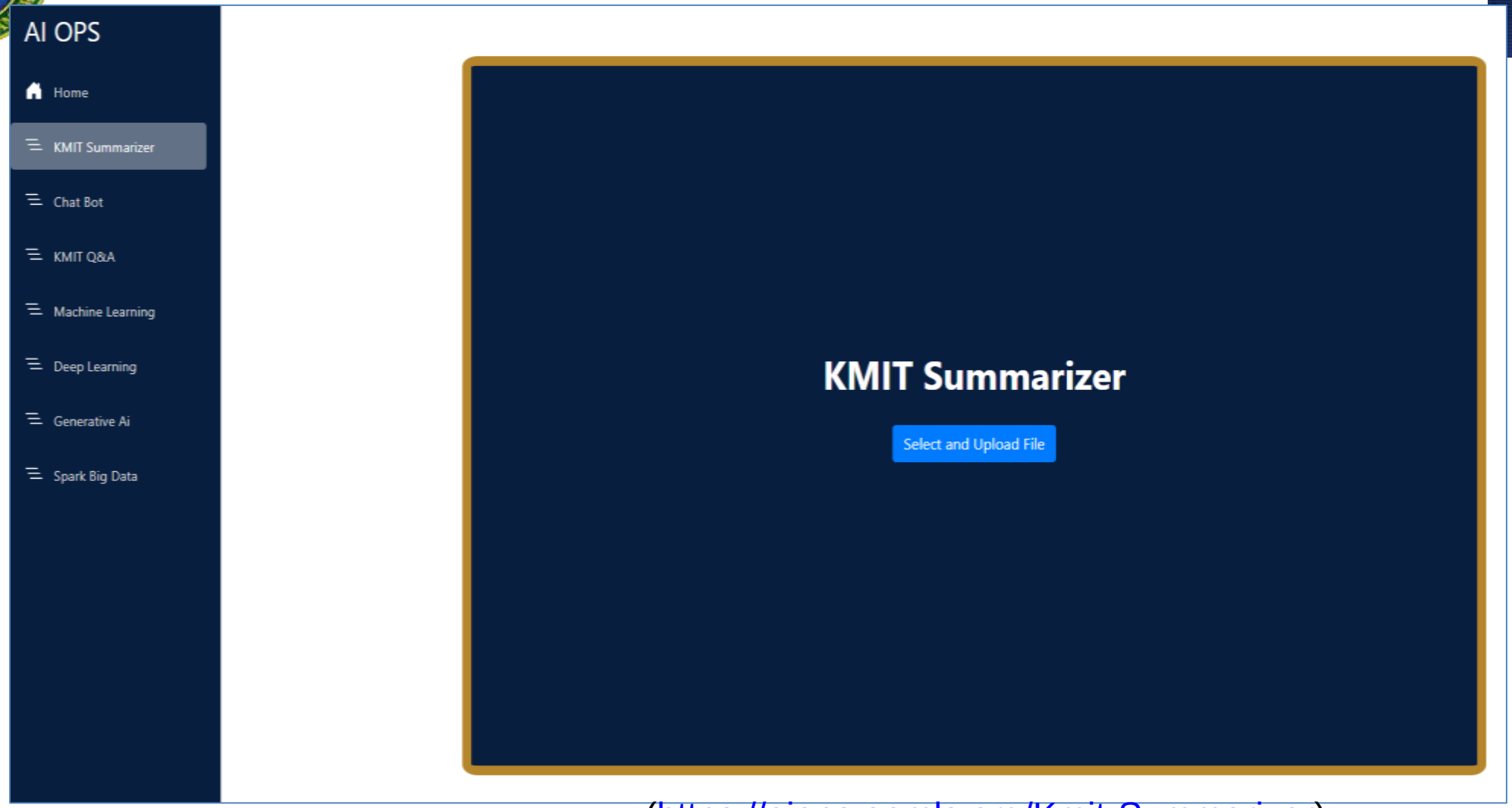
Innovative Technology Summary Reports (ITSRs)



D&D KMIT Document Summarizer
Large Langage Model (LLM)

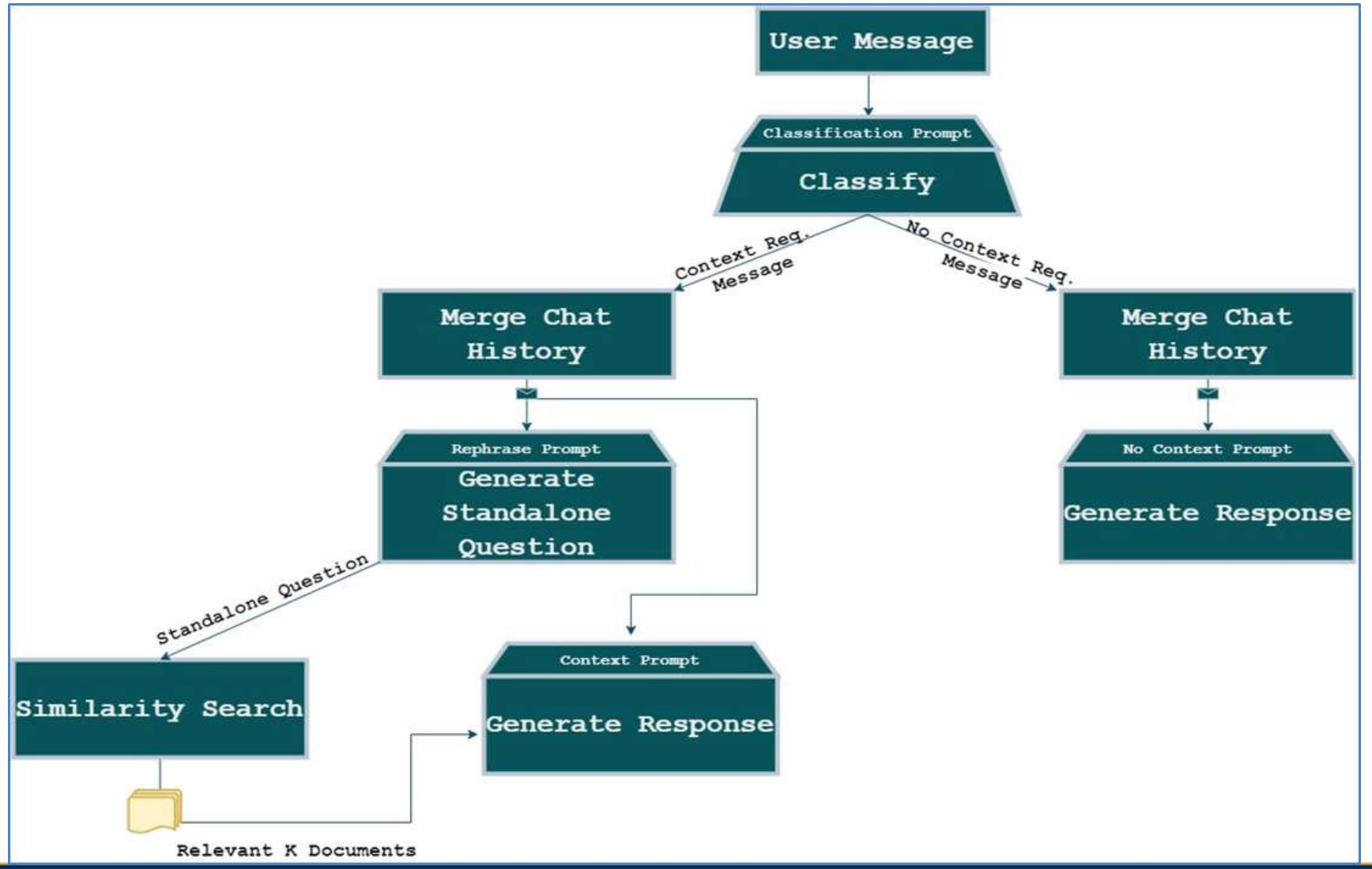


KM-IT Summarizer Module

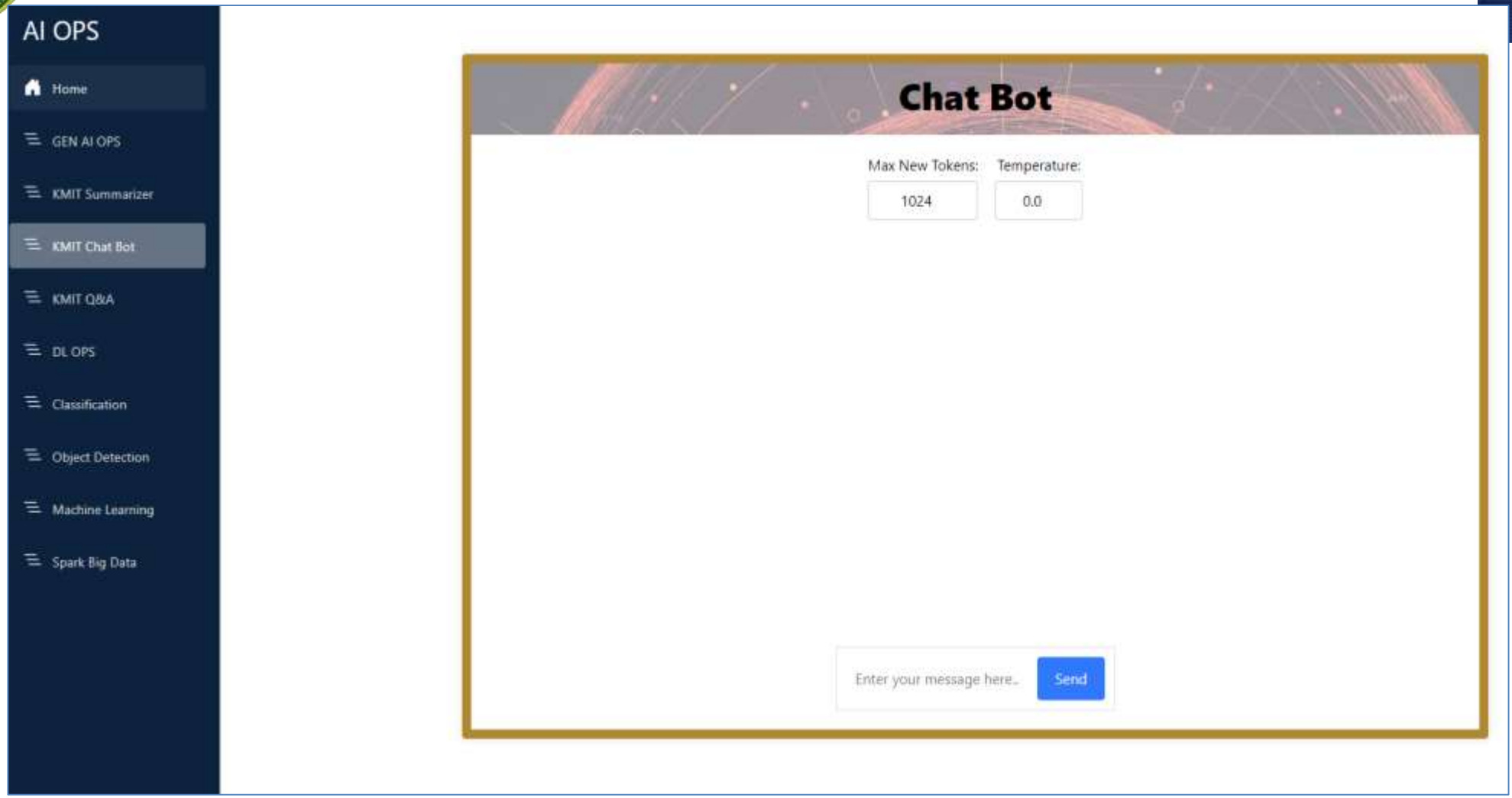


(https://aiops.aamls.org/Kmit-Summarizer)

KM-IT ChatBot: RAG and LLM Memory



KM-IT ChatBot Module



(https://aiops.aamls.org/Chat-Bot)

Q & A

Thank You