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Performance of DMA Fused Radar and Video

Deliberate Motion Analytics (DMA) Beyond the PIDs Fence Line

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MOTIVATION FOR DMA

Current Challenges:

- Nuclear Power generation faces increasing economic pressures
- Cost of physical security ranks high on plant operational costs
- US nuclear power plants are seeking new cost-effective physical security methods and technologies

Objective of the Work:

- Demonstrate a mathematically fused sensor system that can provide reliable detection and low nuisance alarm rates beyond the fence in an un-engineered terrain

Why Its Important for Advanced Reactors:

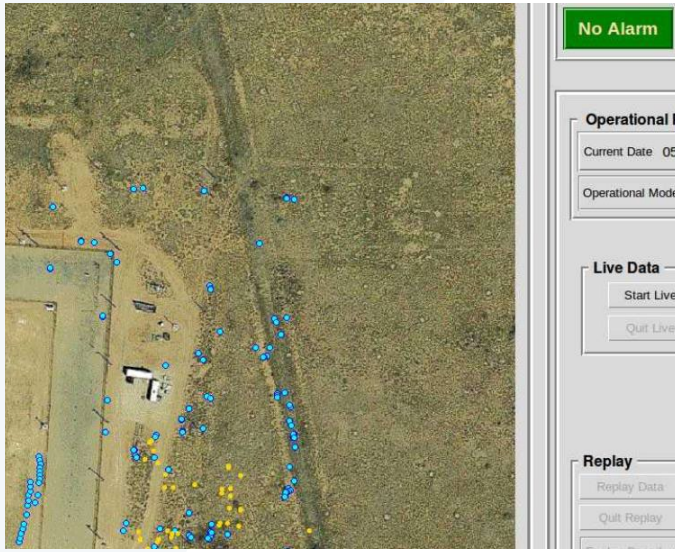
- Represents an enabling capability for new security architectures that will reduce cost; no lights needed, no fences needed for detection (may need for response or legal purposes)

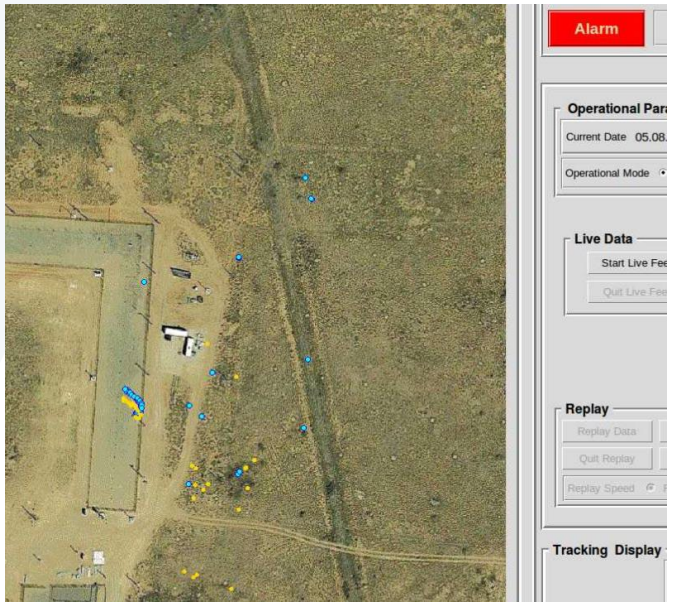
- Reliable “beyond the fence” detection will result in increased delay, giving response forces earlier notification of an impending attack

WHAT IS DELIBERATE MOTION ANALYTICS

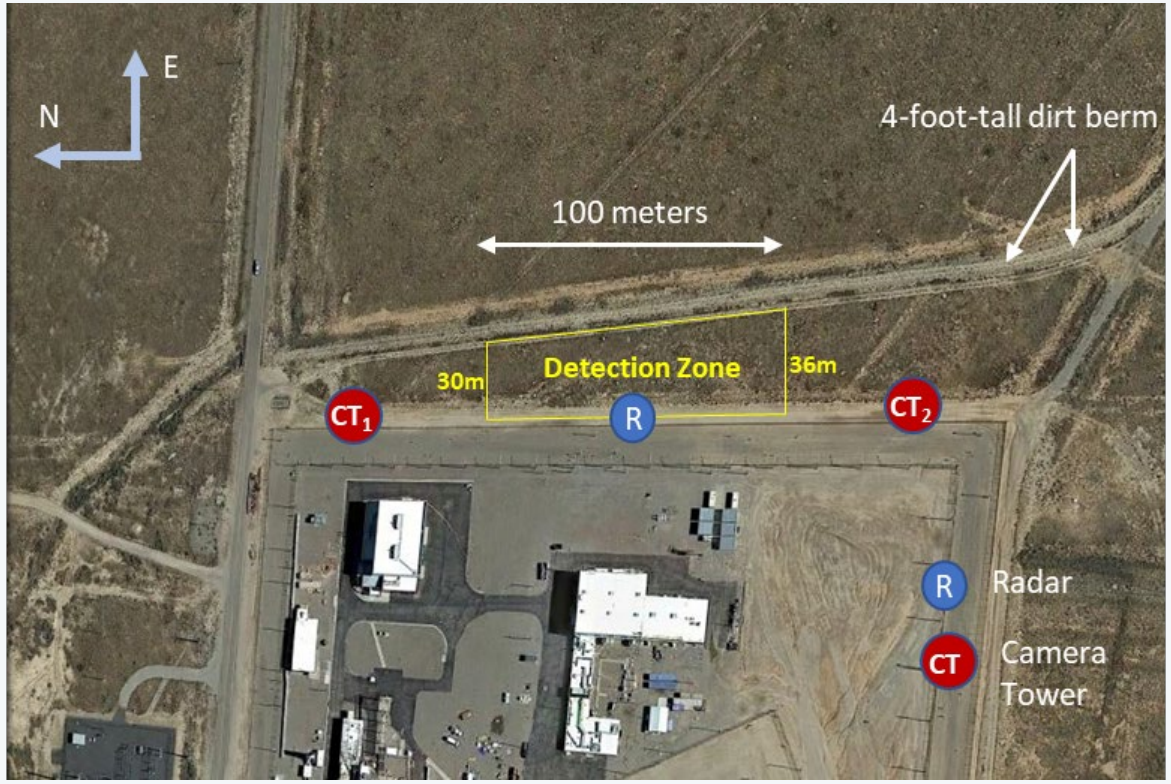
Deliberate Motion Analytics Is:

- A sensor algorithm that can fuse multiple sensor outputs to create a multi-physics sensor system, allowing explicit implementation of complementary sensors
- It uses deliberate motion to differentiate intruder alarms from nuisance alarm sources, including weather, moving fences, and foliage
- Incorporates a 2-layer nuisance alarm suppression strategy
- A Multi-Intelligence Fusion Algorithm – uses machine learning, probabilistic techniques, Multi-Hypothesis Tracking, and Dynamic Bayesian Networks
- It decides when to “and” and when to “or” filtered alarm outputs from each sensor





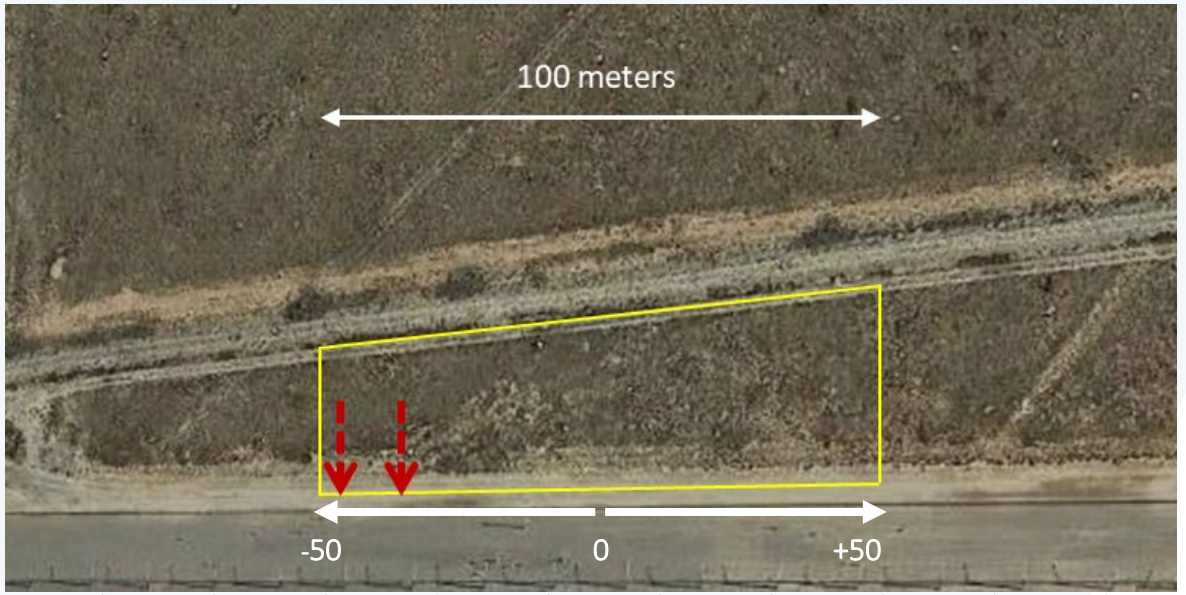
DESCRIPTION OF DEMONSTRATION ENVIRONMENT



TEST STRATEGY

35 Tests Per Intruder Type

35 Hits Results in Probability of 92% with 95% Lower Confidence Level



Indicates a Notional Intrusion Path

Location (m)	-50	-48	-45	. . .	-6	-3	0	3	6	. . .	45	48	50	Hits	Misses
Walker 1 ft/sec															
Run At 10 ft/sec															
Hands and Knees Crawler															
Belly Crawl															

TEST RESULTS (INTRUSION TESTS)

Threat	Total Attempts	Total Hits	Total Misses	P_S at 95% CL
Walker 1 ft/sec	35	35	0	92
Run At 10 ft/sec (+)	35	35	0	92
Hands and Knees Crawler	35	35	0	92
Belly Crawl	35	35	0	92

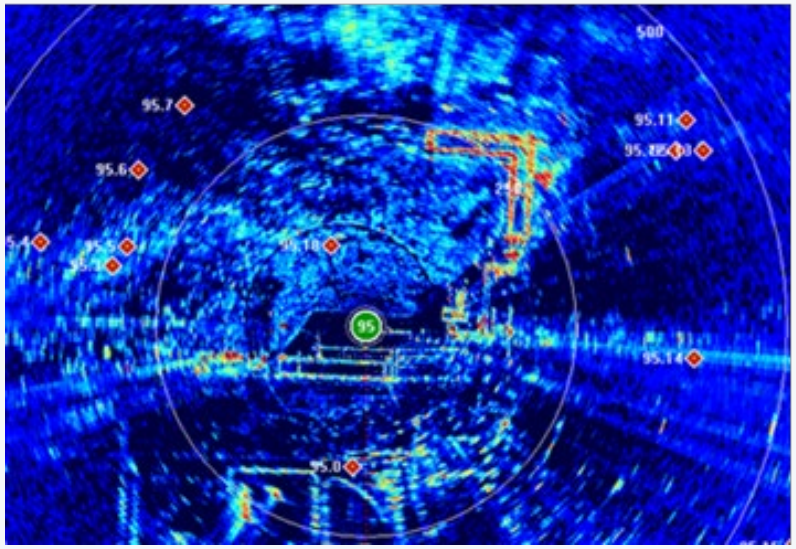
TEST RESULTS NUISANCE ALARM COLLECTION

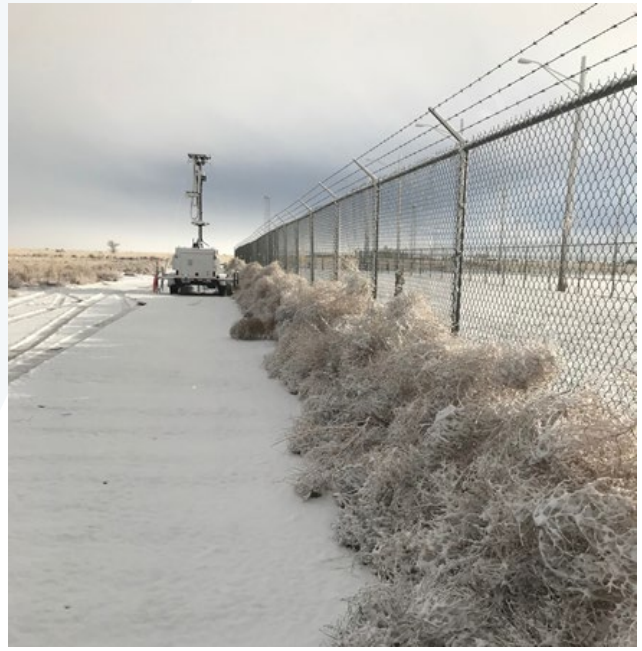
	Number of Nuisance Alarms	Weather	Wildlife	Average NAR Alarms/Day
Radar	15,388	14,618	770	13,190
Video Analytics	143,211	136,050	7,161	122,752
DMA	0	0	0	0

Only 28 hours of NAR data

Premature to specify NAR performance

Hardware and Nuisance Alarm Processing Challenges

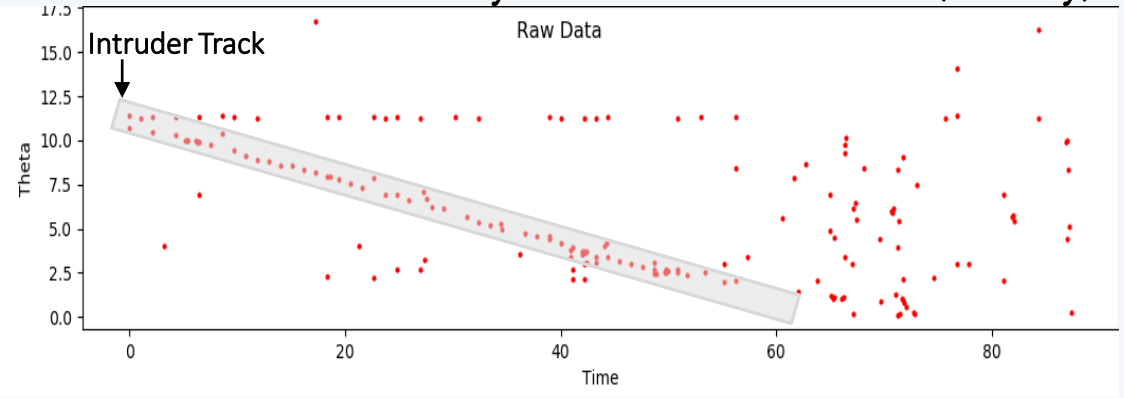




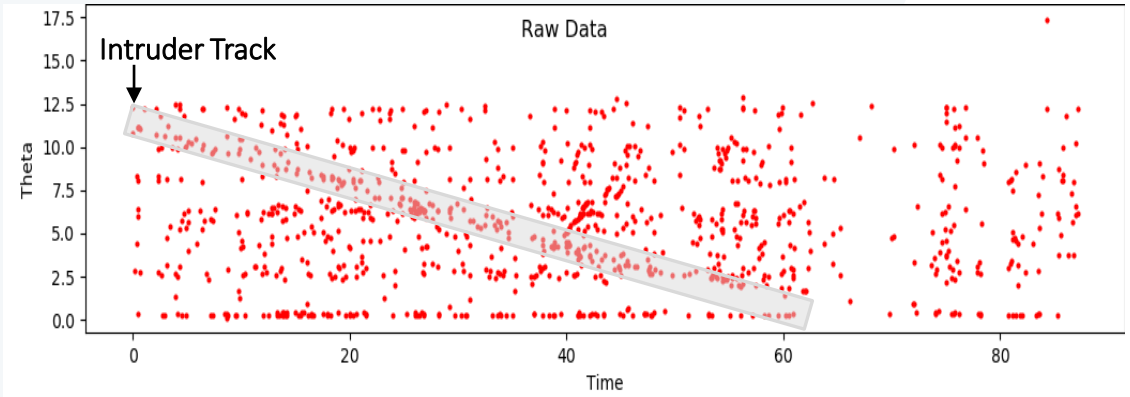
TEST RESULTS NUISANCE ALARM COLLECTION

NAR PROCESSING CHALLENGES

Cam 1- Raw Video Analytic Alarm Data – Low NAR (.1M/Day)



Cam 2- Raw Video Analytic Alarm Data – High NAR (1M/Day)



- We believe we have a bad PTZ camera and/or unstable camera tower – very high nuisance alarm rates (plot on the right)
- During wind, camera is moving, creating a “sea of nuisance alarms” for video analytics
- We can still detect the intruder and not declare a nuisance alarm – “gray box in plots”
- Size of the Nuisance Alarm Data exceeded the processing capability of our numerical analysis library
- We can fix this – but not in time for the release of this briefing
- To Date – cannot conclude what long term NAR performance is

POSSIBLE APPLICATIONS OF DMA

1. Beyond the Fence Detection 20m, 100m, 300m
2. Use existing cameras in PIDs, add video analytics, possibly fuse with existing sensors
3. Use DMA, radar, video analytics for problem locations
4. Fused sensor system for UAVs
5. Possibly Dual Use, 1 and 4 with the same sensors

KEY TAKE-AWAYS

- DMA has demonstrated reliable detection fusing radar and video
- Probability of Detection $P_D > 90\%$
- Limited NAR Results -- Suggest Very Low NAR but need to analyze more data
- Performance in an un-engineered terrain, beyond the fence
- This technology could eliminate the need for PIDS – as we currently know it

View of Radar and Weeds

Radar Blocked by Rocks

Crawl Path Towards Fence

FUTURE WORK

- Possible demonstration of DMA fused radar/video at a commercial reactor site
- Demonstrate Fused Counter UAS detection system
  - Fuse COTs Radar and Passive RF
  - Scheduled Completion Date: Sept 2021
- Air Force to Integrate DMA into their Security of the Future (PICARD) – starting this FY
- Identify a more modern and less expensive radar
- Incorporate LIDAR into DMA

10 years old
$ 60K