


L3HARRIS™

L3HARRIS INTELLIMATICS 3D VOLUMETRIC PROCESSING

P3DL CONFERENCE INTELLIMATICS BRIEFING

28 July 2021 **Bill Watkins & Glenn Boudreaux**

Agenda

- Intellimatics Introduction
- Intellimatics Construction Site and Moved Earth Monitoring Overview and Results
- Technology Status
- Summary & Q&A

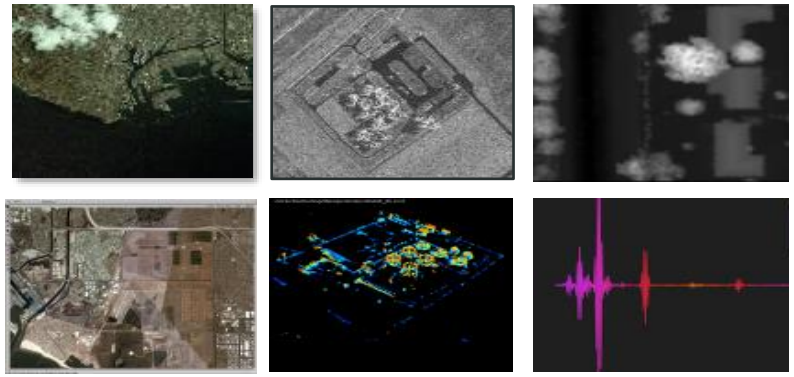
What is Intellimatics?

- **Capability:** Provides Fully Automated, Sensor Agnostic, Collection Agnostic, Near-Real-Time, EO & SAR Intelligence.

- **Impact:** Increases analytic productivity while improving quality, speed, and accuracy of sensor-agnostic automated intelligence.

- **Value Proposition:** Benefits to NGA, IC and DoD analysis, analytics and near-real-time operations.

Volumetric Processing – CRADA Construction & Moved Earth Approach/Overview



Descriptor Stack per Voxel

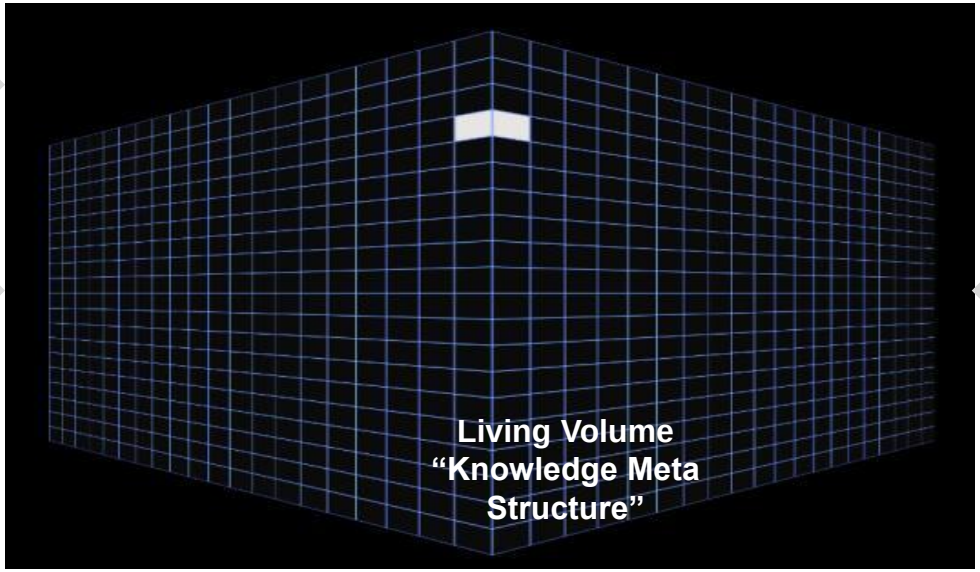
- Etc.
- Illumination / Solar Angle
- Detected Change
- Occlusion
- Phase
- Polarization
- Visibility
- Collection Parameters
- Pixel Intensity – Real And Complex

Data

Collection Parameters

Data → 3D Registration → Assemble Volume Information

Data → Feature Extraction → Features



Voxels → Applications

3D Volumetric Representation

Operational Systems

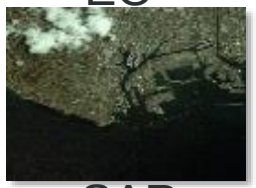
- TacDSR SAR 2019
- TacDSR EO 2020
- MAGE
- NGA CRADA 2020-Present

What is unique about our solution

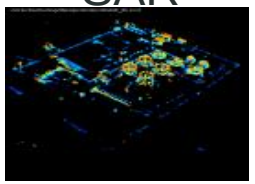
- Co-registration of all imagery in the volume (Fully automated QC)
  – Iterative Predictive Registration (IPR) ensures sub-pixel accuracy
- The system learns with each new image
- Volume is a 3D/4D representation of the real world – Not a stack of images
- Intellimatics is foundational and not an application
  – An implementation of the Autonomic Construct
- Leads to new discoveries and applications - Examples
  – Shadow Finder in SAR
  – Iterative Predictive Registration
  – Many new applications of AI
  – Etc.

Fully Automatic Monitoring Overview

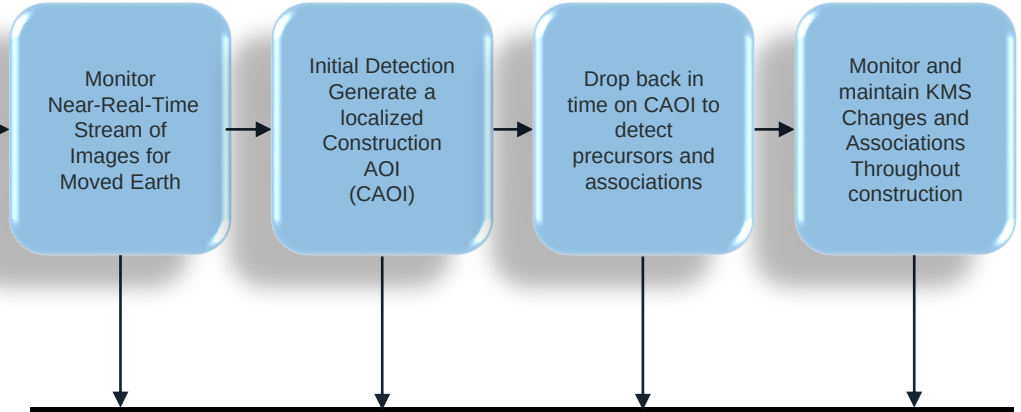
EO

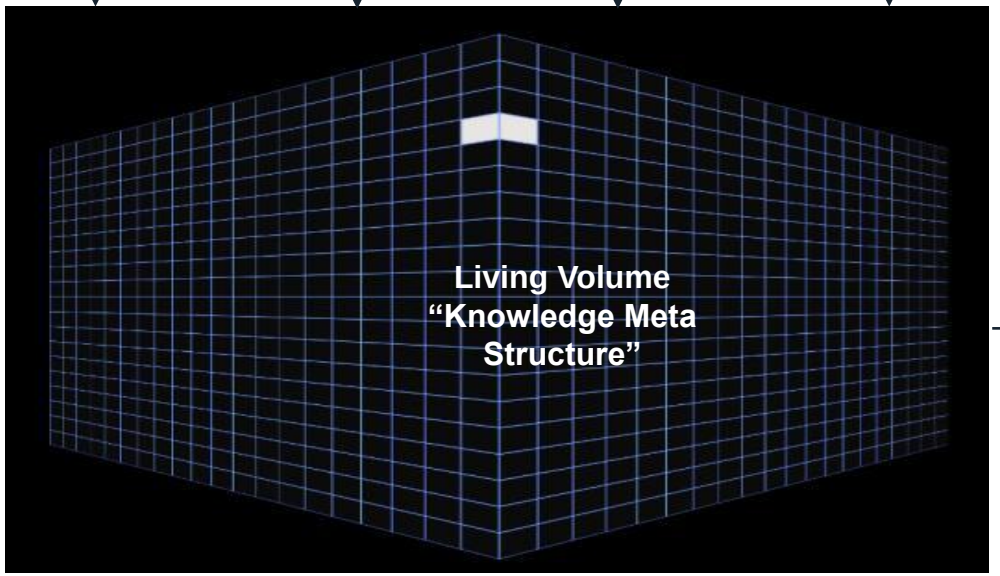


SAR



Objective: To monitor a region of construction or moved earth and provide fully automatic detections and activity monitoring





System Requirements:

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- Automated 2D/3D/4D model generation
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Agnostic with respect to type of construction
Primary focus is building construction

Specific Triggers:

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- Build Metrics of construction
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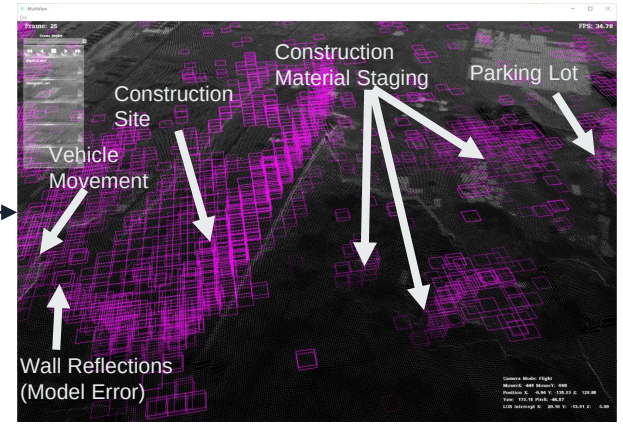
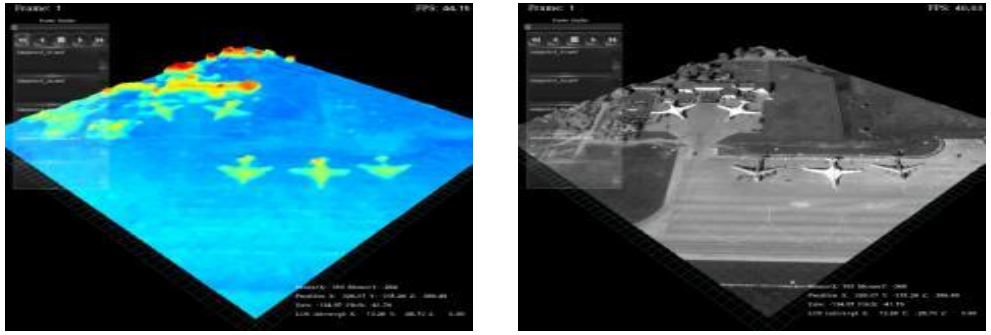
- Ex: Working on Sunday or associations with other locations

Predictive Change Detection Products



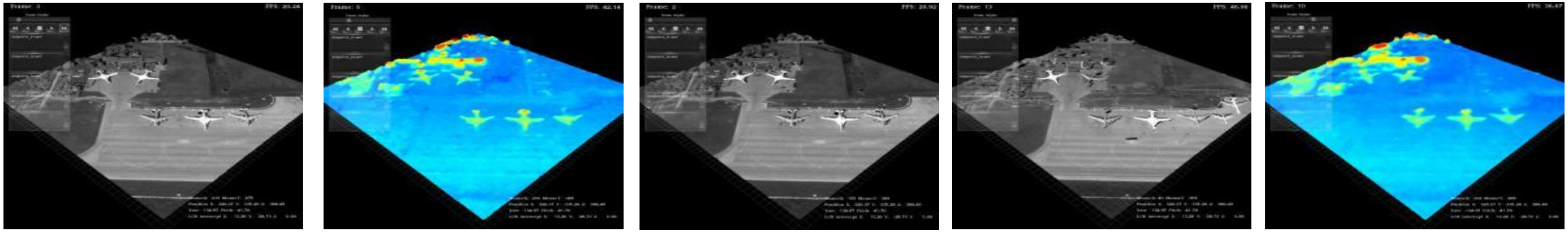
Growing the Volume

- Base Volume Formation
  - Initial Volume is formed with one surface and one image
    - Surface is created by L3Harris 2.5D Topo3 processing using multiple images
    - Image is projected onto surface with sensor model
    - Image header information added to voxel structure
    - Differing sensors handled automatically
- Growing the volume
  - Flexible volumetric data structure allows additional surfaces and images to be added in any order



Base Volume Creation

Grown Volume with 4 Surfaces and 14 Images from 3 Sensors

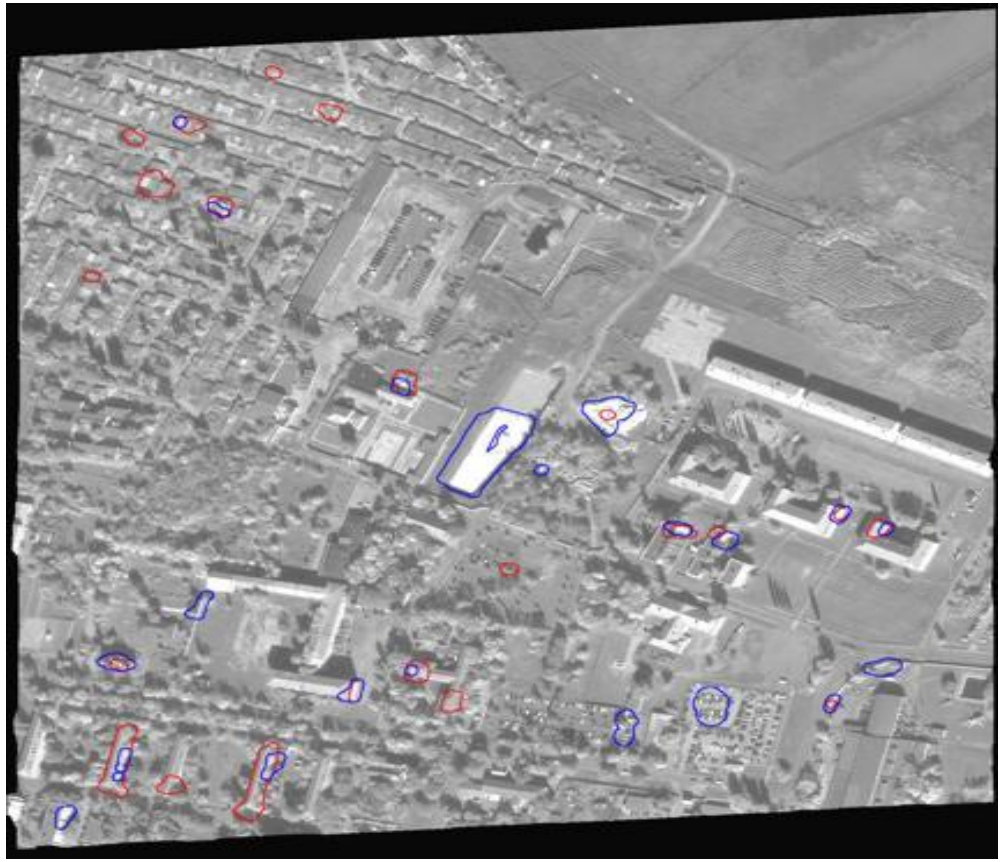


Adding Additional Surfaces and Images

Construction – Change Detection

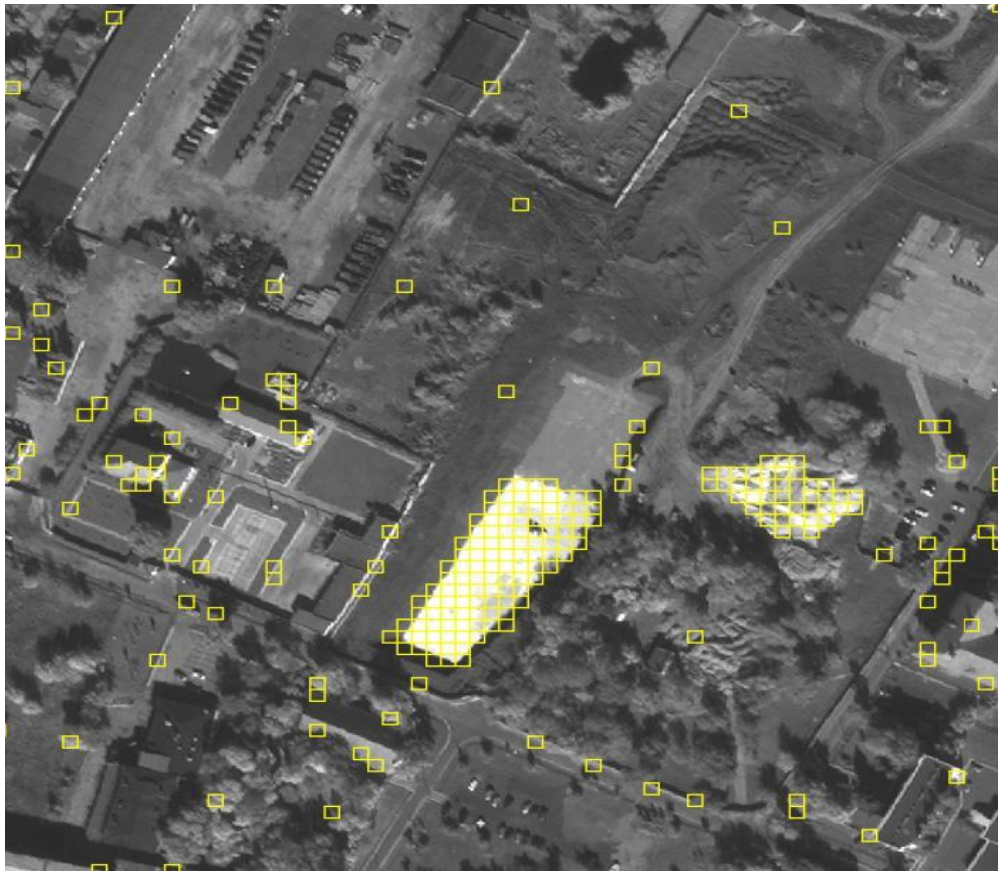
Predictive Change Detection

Produces a prediction of a new collection and then allows change detection for the new image vs the predicted image



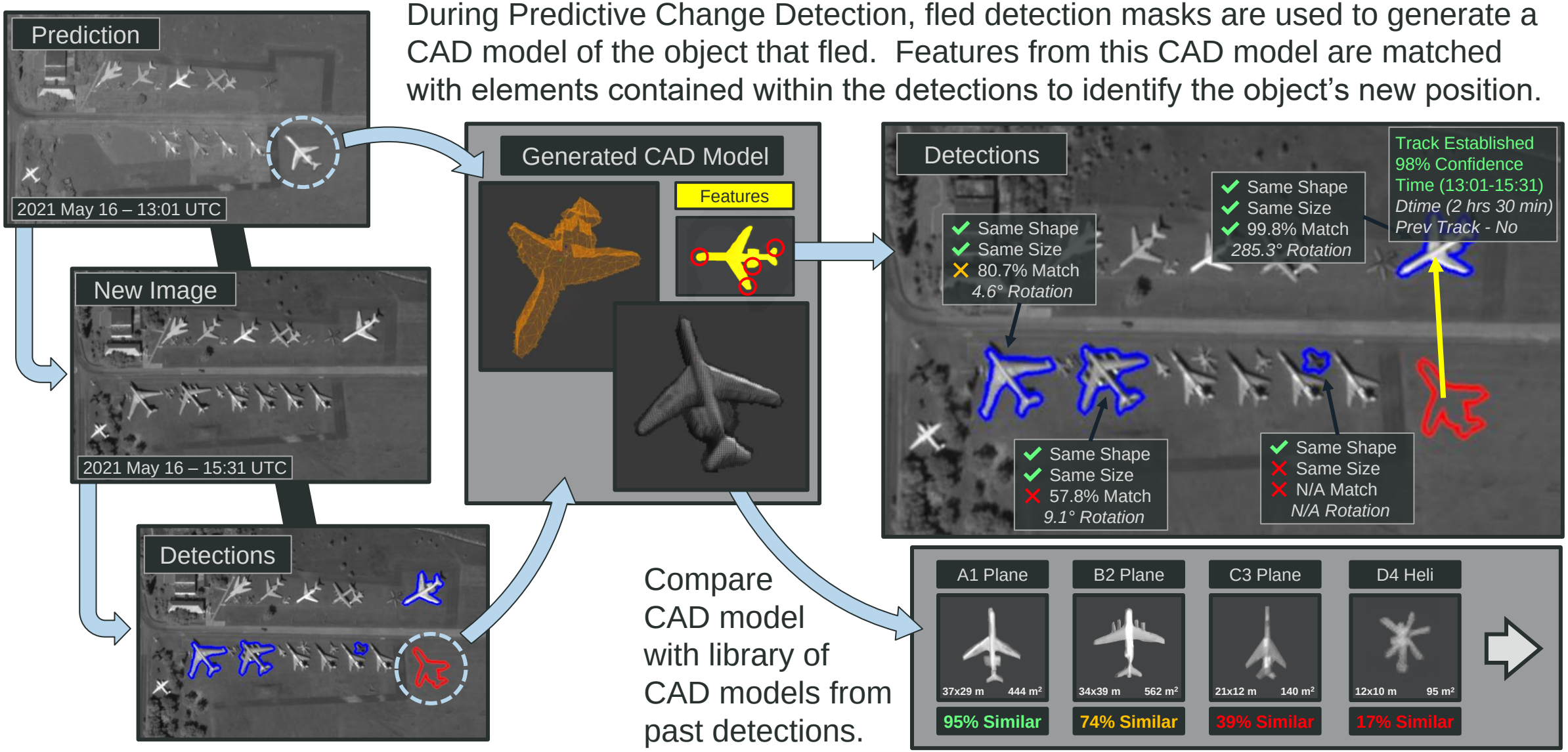
Volumetric Change Detection

When we put a new image in the volume, we look for statical changes in intensity and surface height in the volume



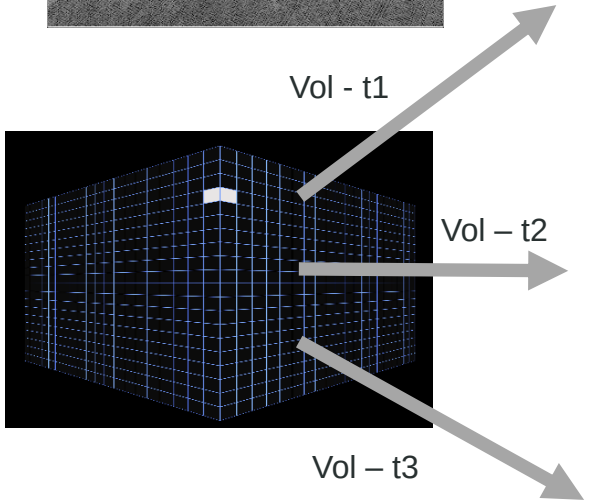
Automatic Detection of Objects Moving Within a Scene (Base Concept)

During Predictive Change Detection, fled detection masks are used to generate a CAD model of the object that fled. Features from this CAD model are matched with elements contained within the detections to identify the object's new position.



Engels Airfield: Predictive Change Detection - EO

Volumetric Representation

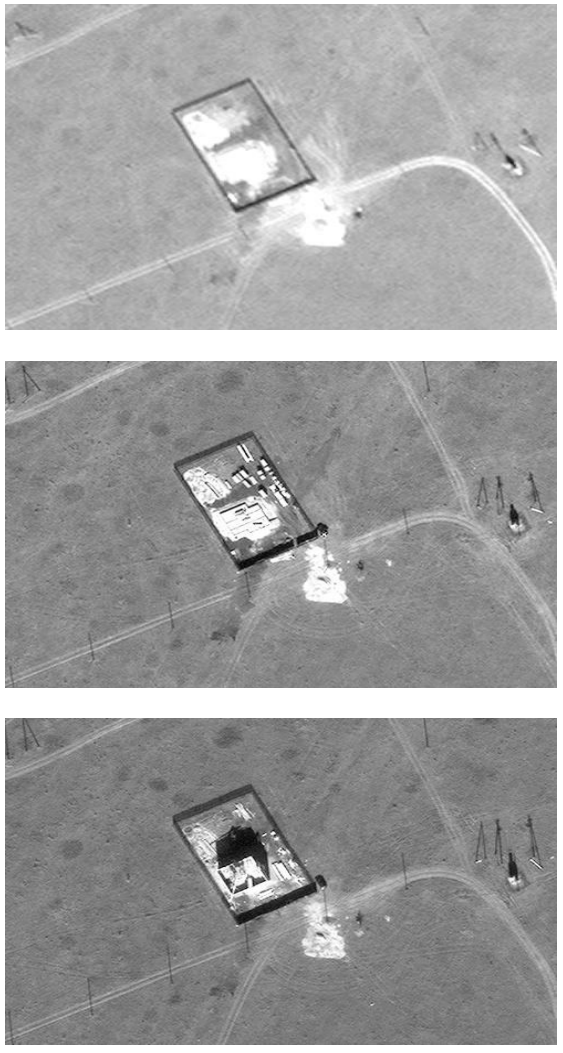


Volumetric image representation is used to create image predictions with the same parameters as actual image collections.

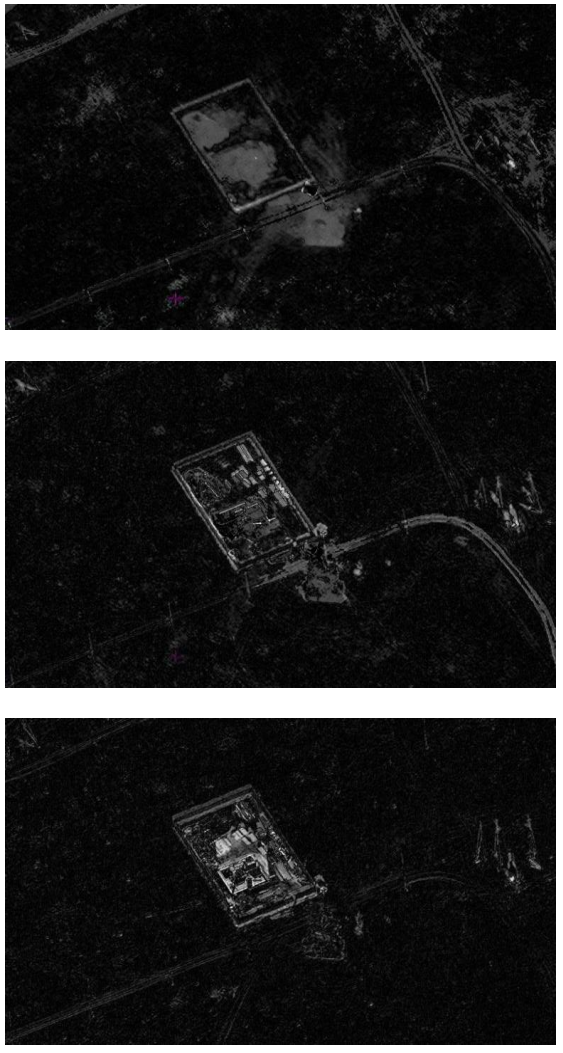
Change Detection is Inherent

Predicted Digital Globe Image

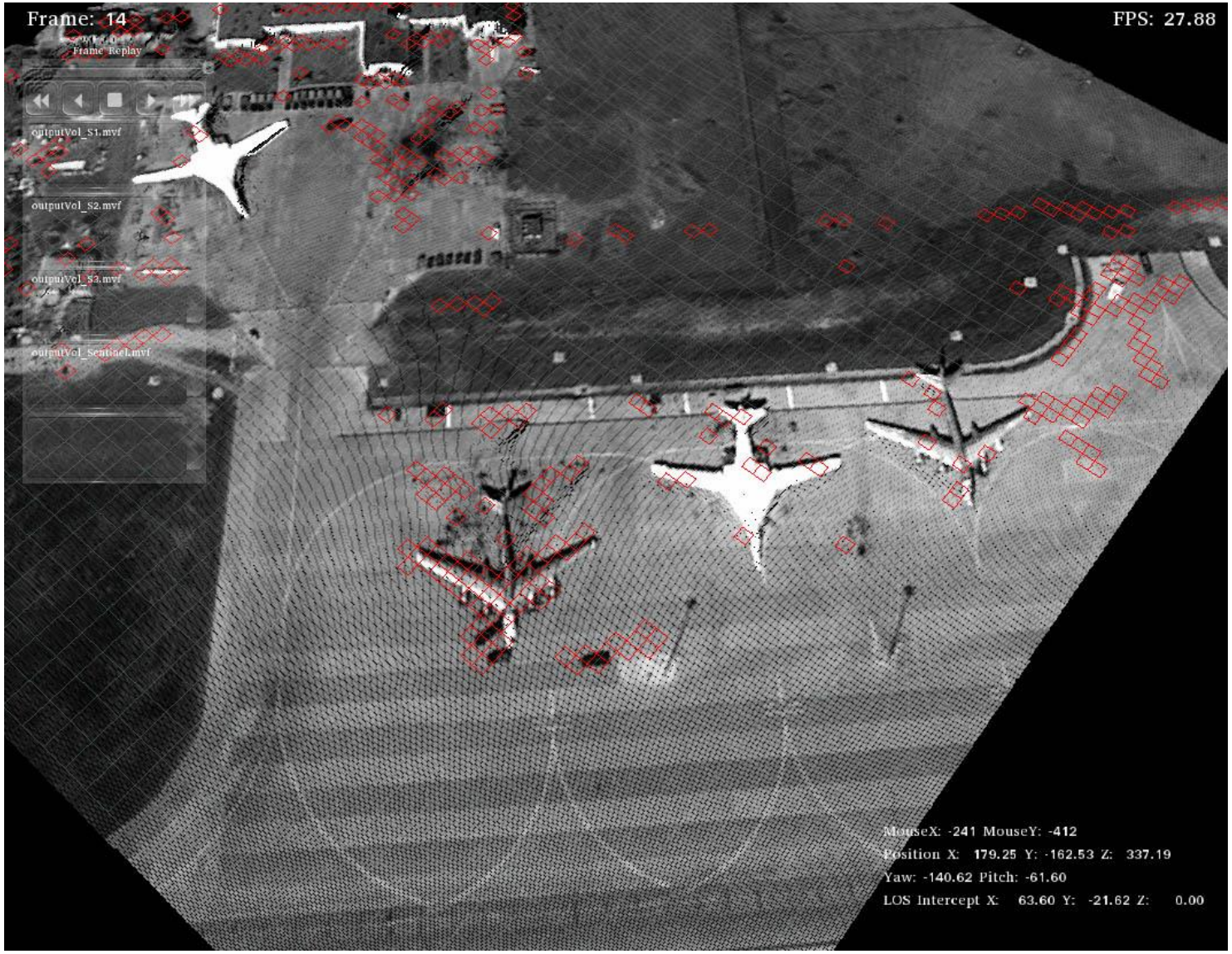
Actual Digital Globe Image



Difference Image



Volumetric Change Detection



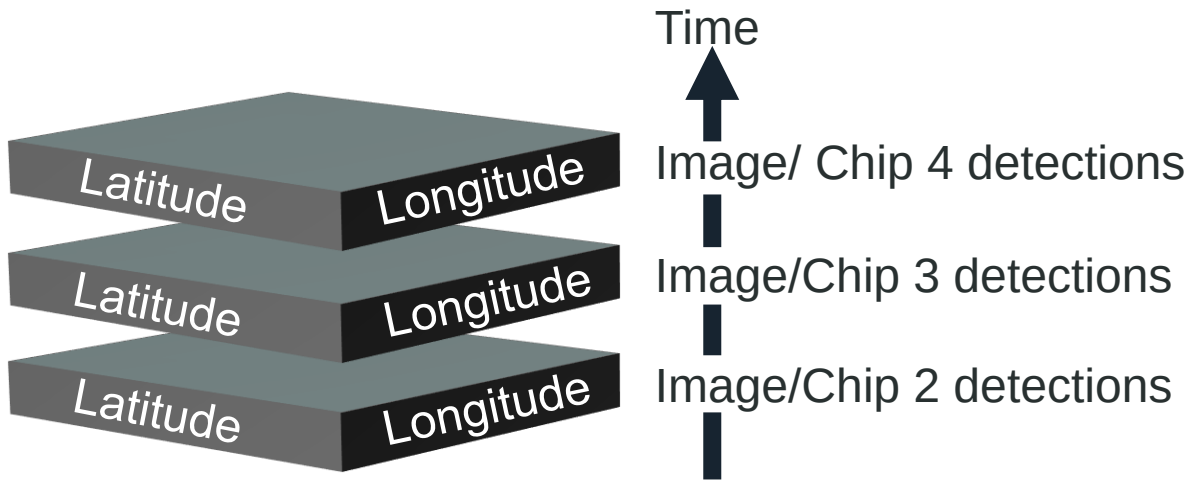
CRADA Predictive Change Detection Images Over Engels Airfield

- A series of predictive and actual image chips are used such that chips 2, 3, 4…. N are in chronological order.
- Prediction is created by projecting the 3D Volumetric Knowledge to 2D Image plane.
  - It is the “Expected Value” based on the geometry and parameters of the system (Sensor Model)
  - Applicable across multiple sensors (Ex: WV and Pleiades) and INTs (Ex: EO-SAR)
- Detections are differences between the Prediction and the Actual Image

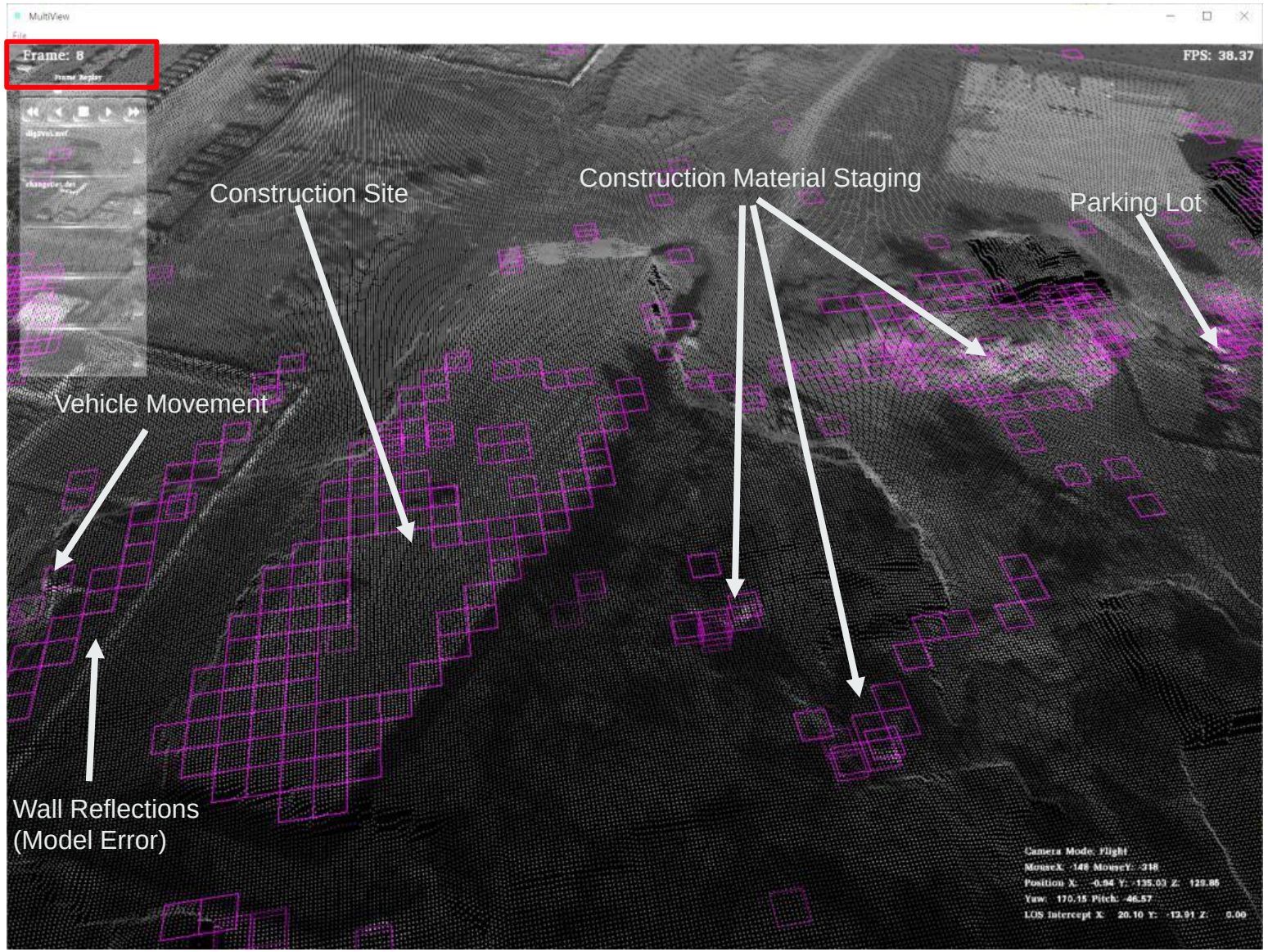
August 12, 2018 (chip 2)	August 28, 2018 (chip 3)	September 23, 2018 (chip 4)
 Prediction	 Prediction	 Prediction
 Actual Image	 Actual Image	 Actual Image

Volumetric and predictive change detections over time

- Since a series of original and predictive image chips are generated in chronological order, we can “stack” the plots of detections from each chip over time
- This creates a 3D Map of position and time: latitude (x), longitude (y), time (z)
- This allows us to visually analyze detections over time, and easily identify and isolate different phases of construction: Moved Earth, start of construction, etc.



3D Accumulation Map (Volumetric Change Detection)



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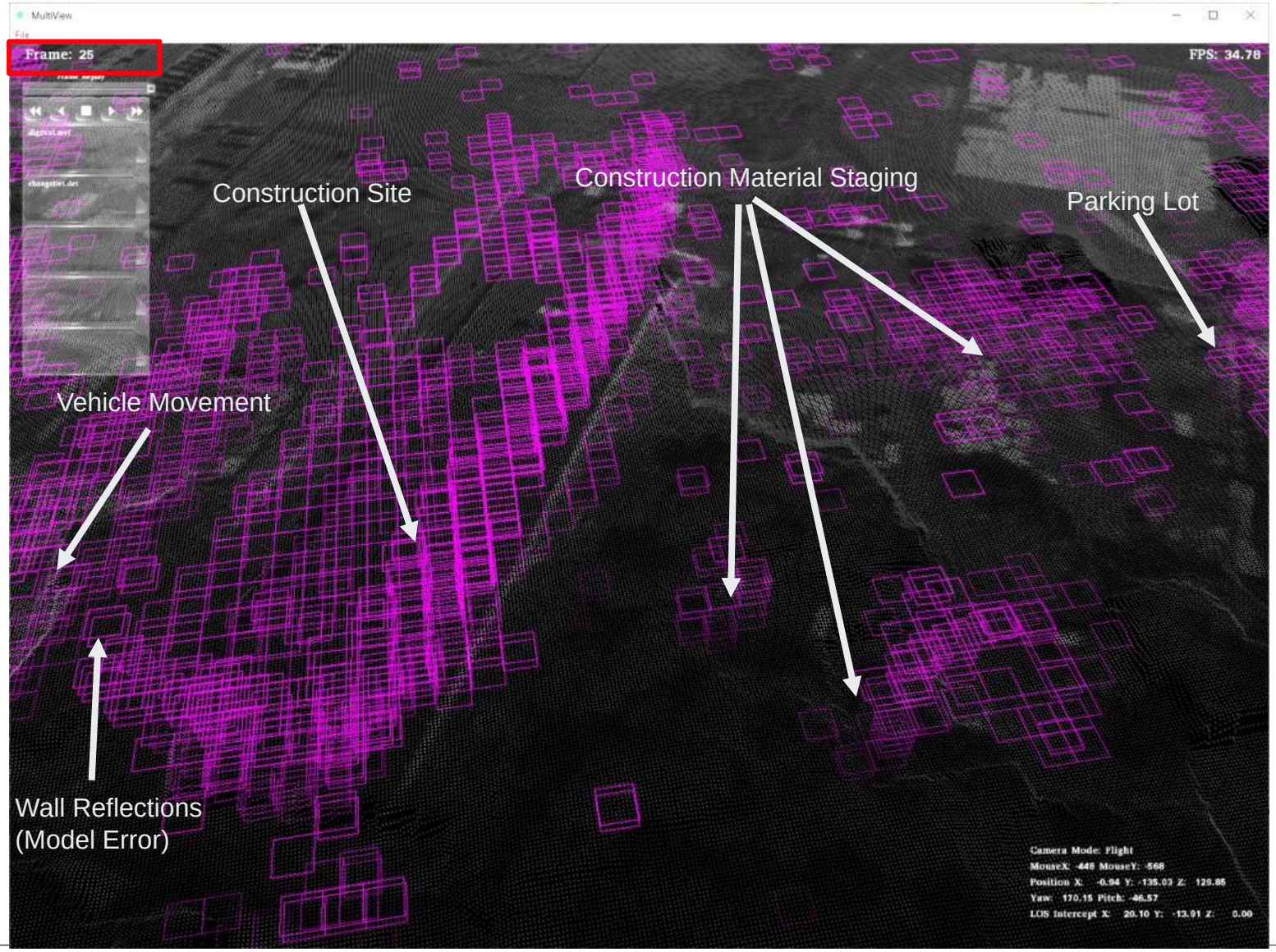
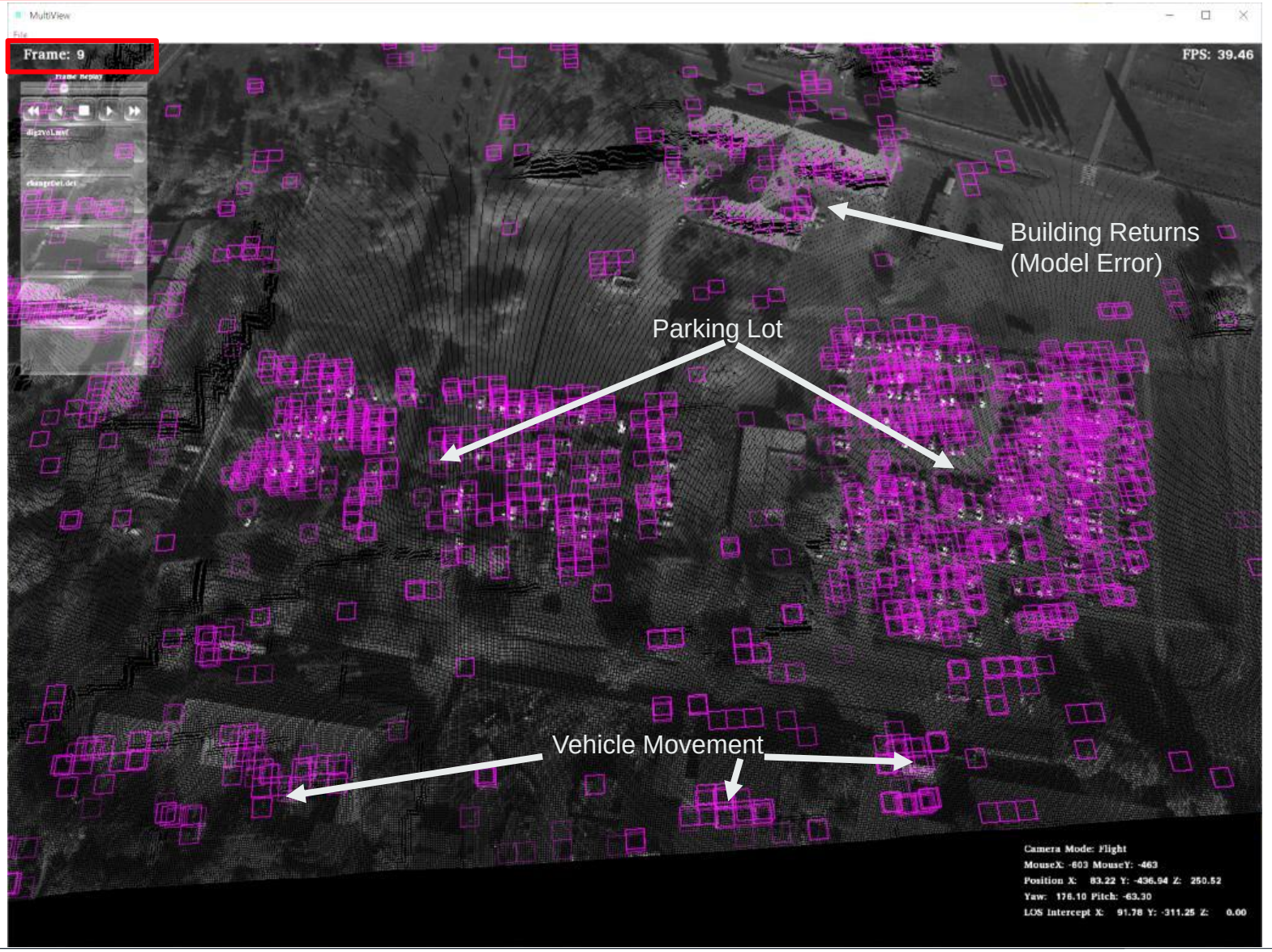


3D Accumulation Map – Parking Lot Construction



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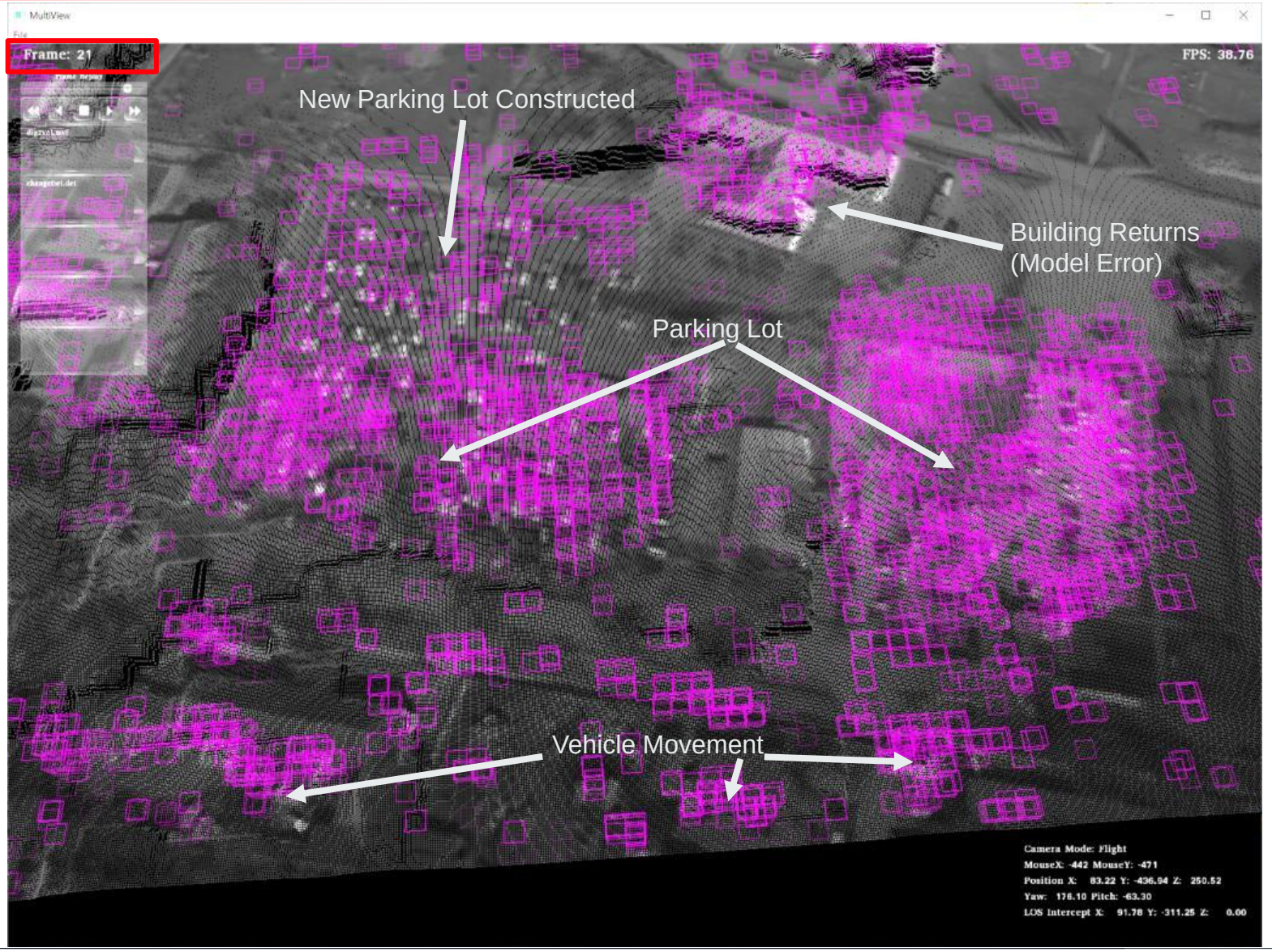

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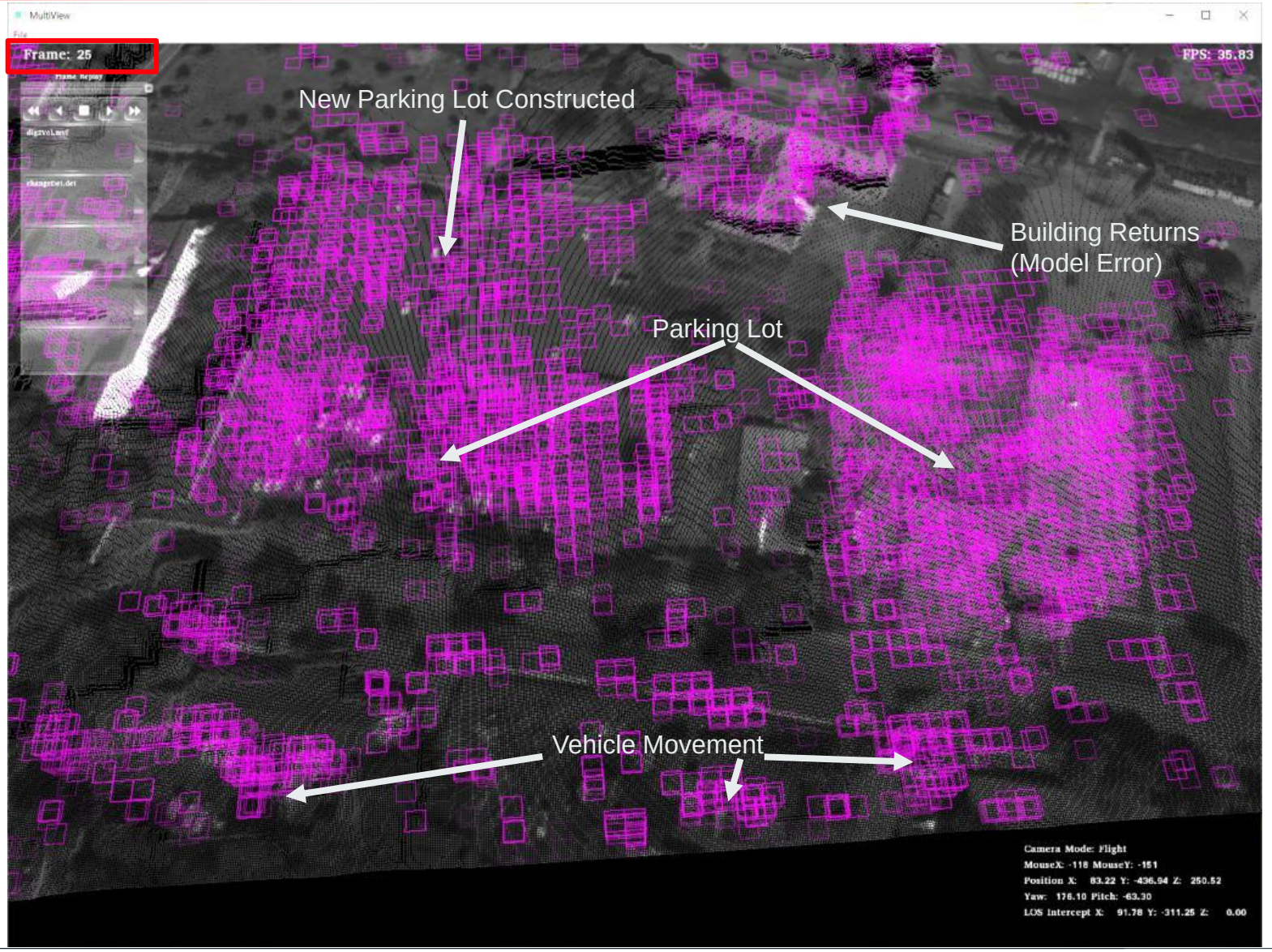
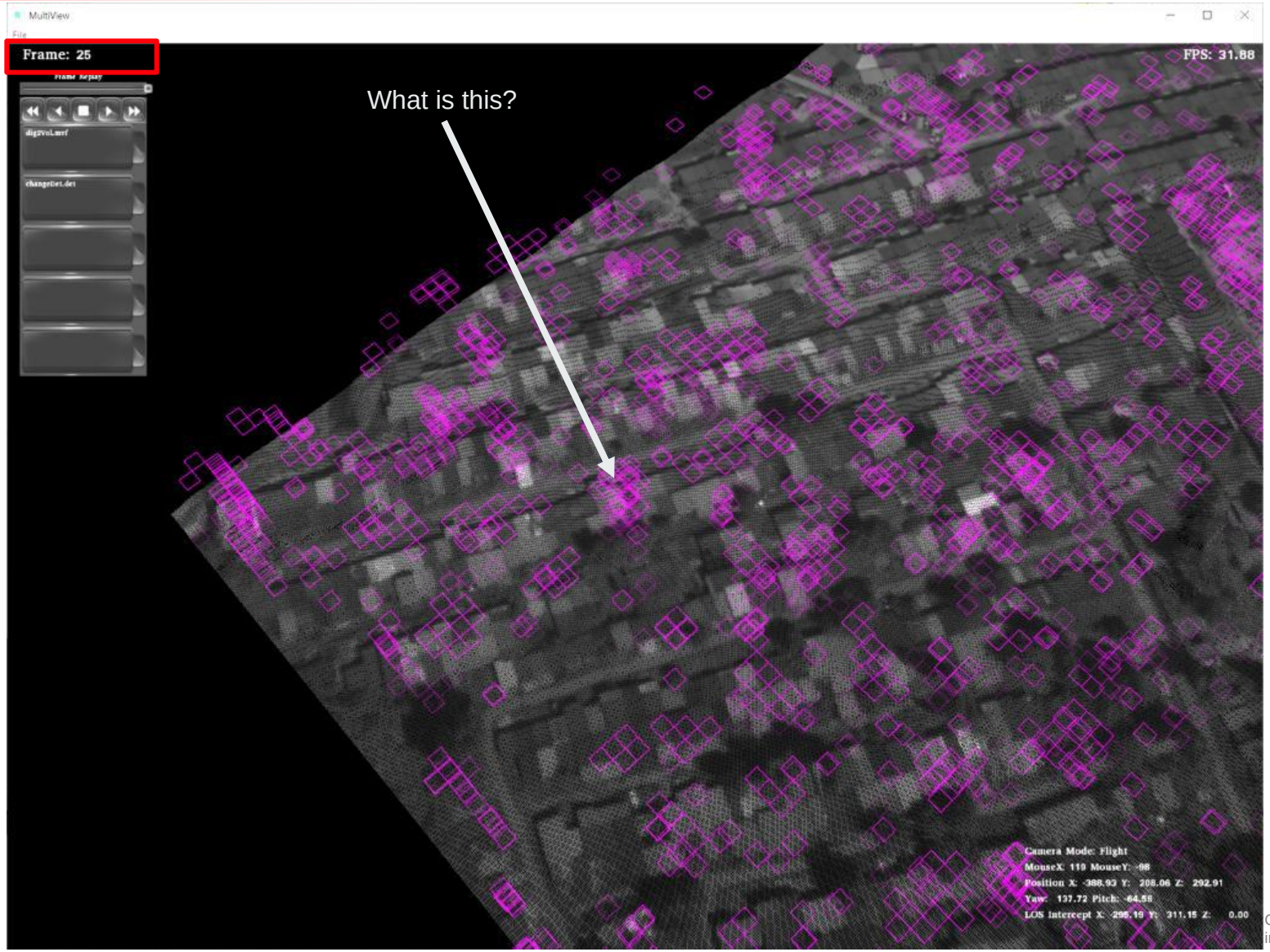
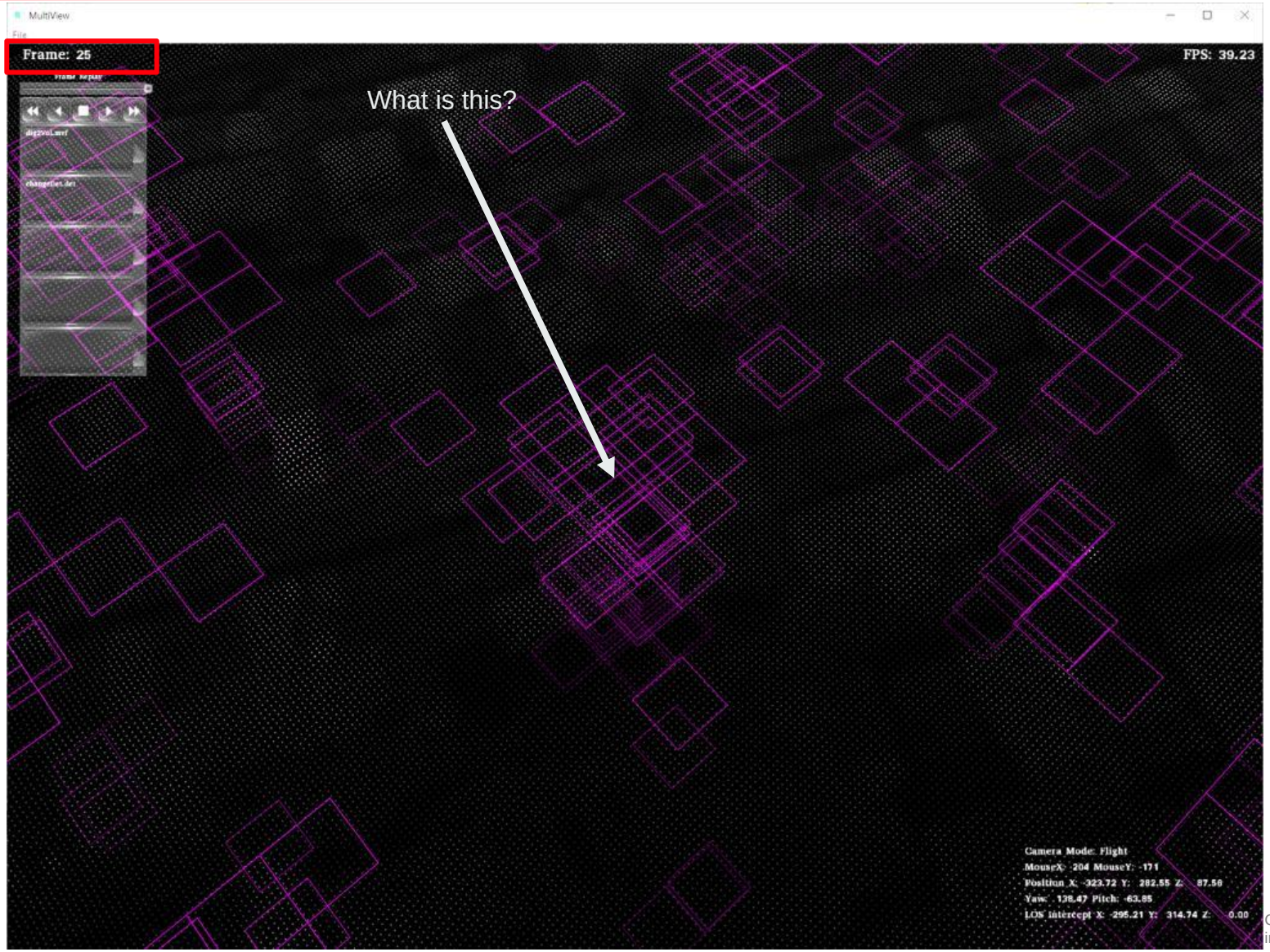


3D Accumulation Map – Discovery



This change represents intensity and height changes over time

3D Accumulation Map – Discovery



3D Accumulation Map – House Construction

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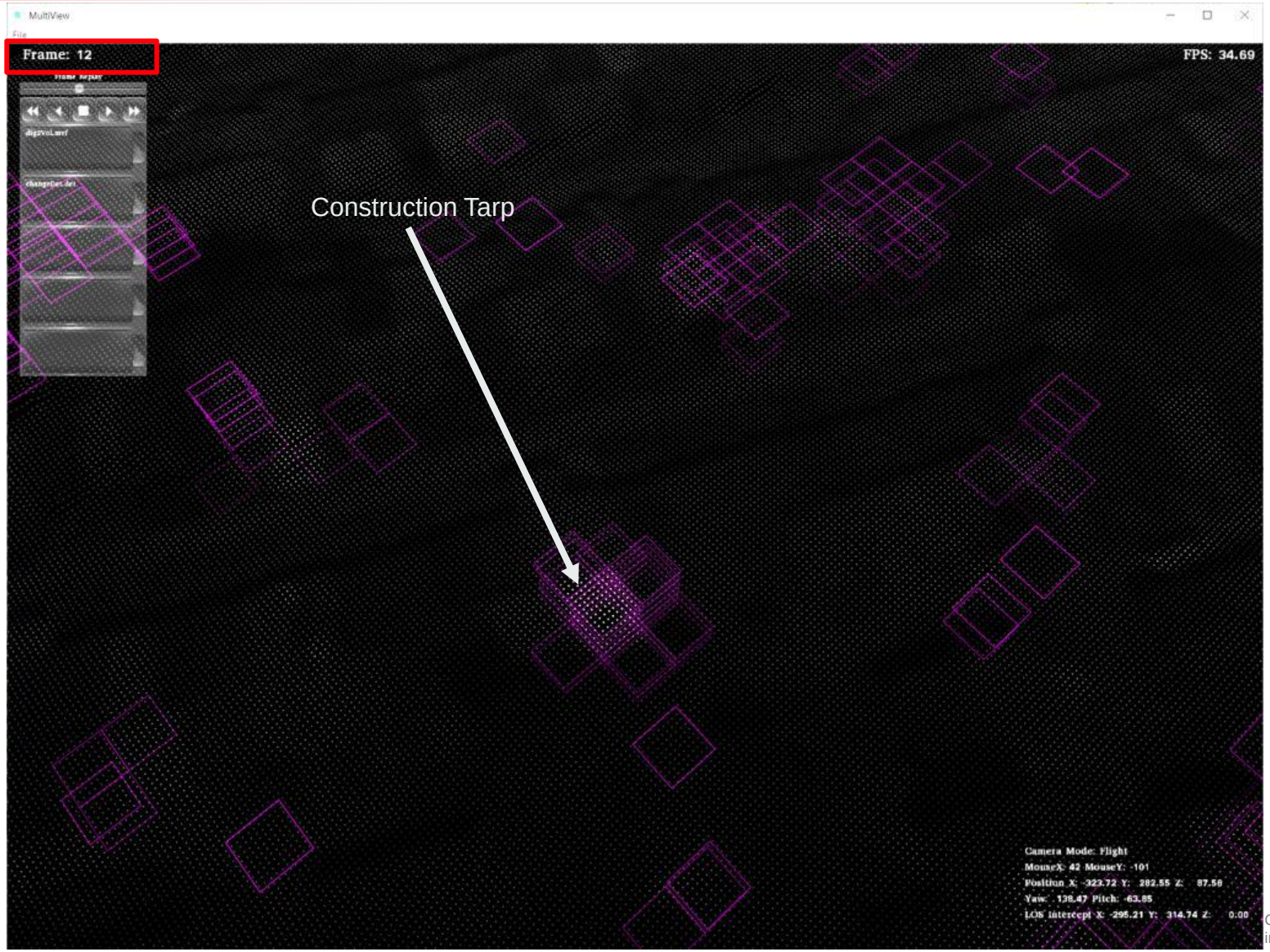

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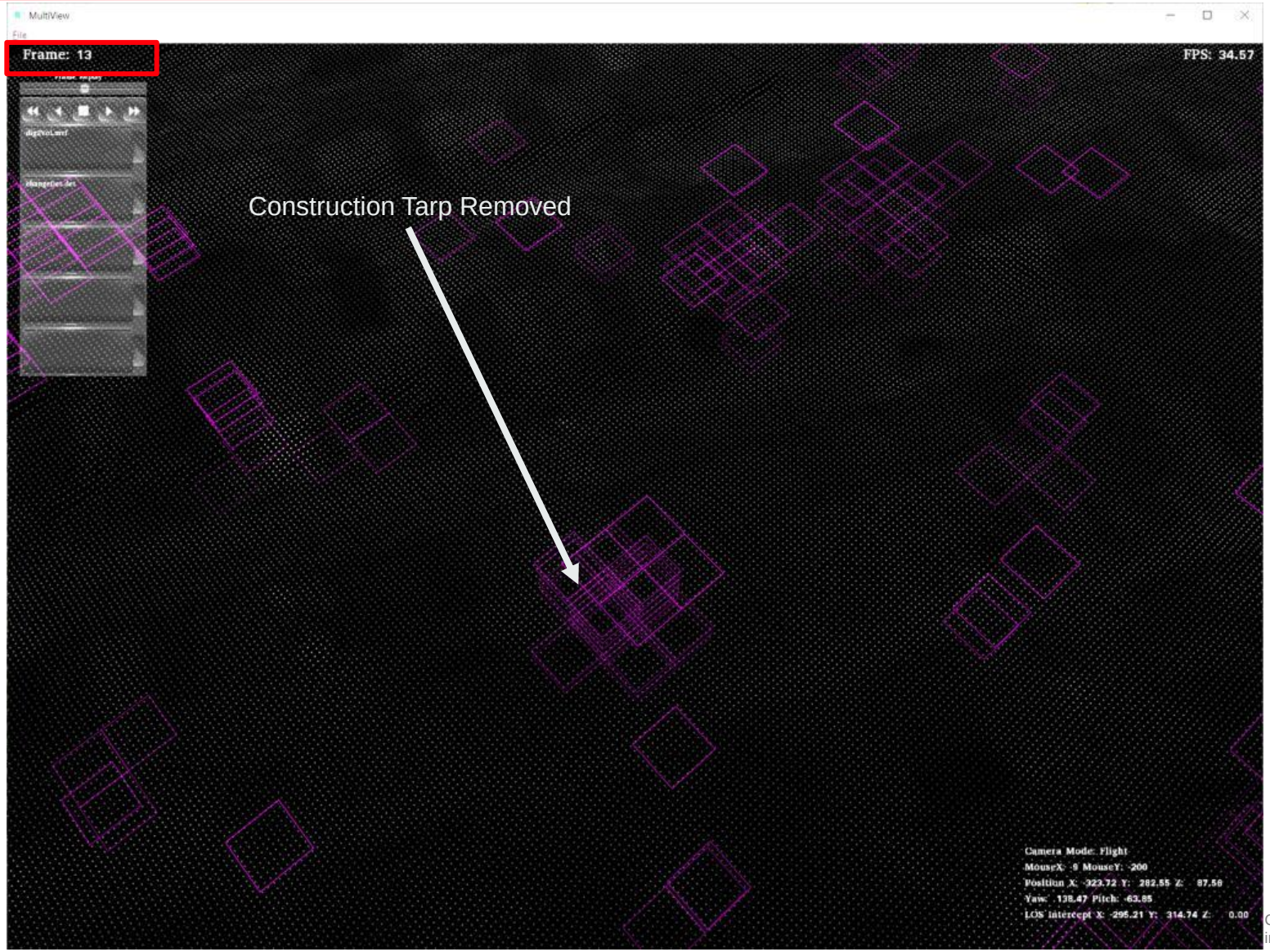
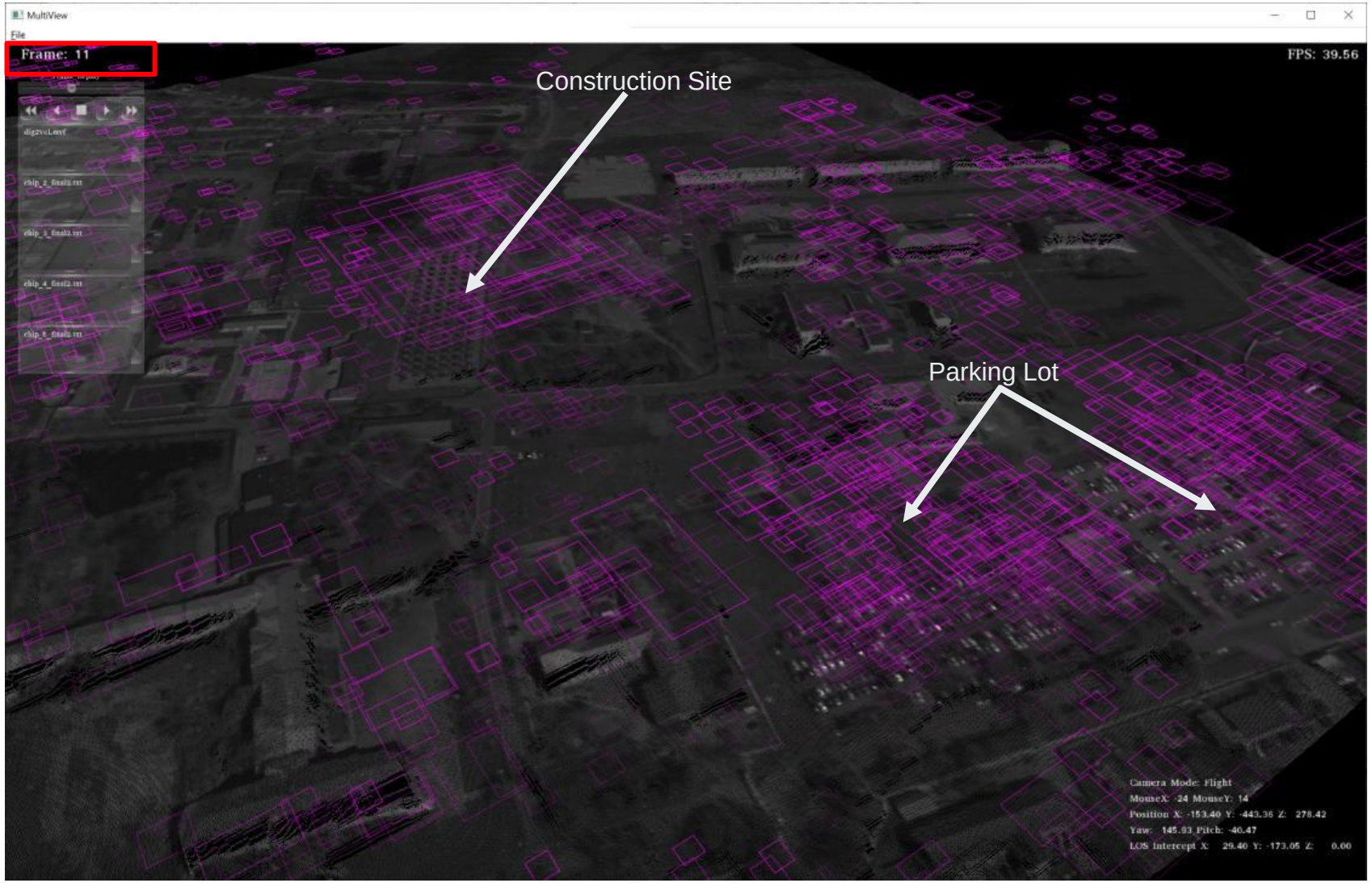
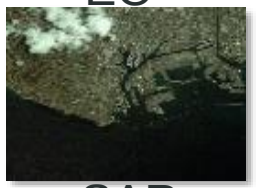


3D Accumulation Map – Predictive Change Detection Map

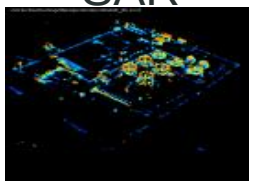


Fully Automatic Monitoring Overview

EO



SAR



Objective: To monitor a region of construction or moved earth and provide fully automatic detections and activity monitoring

Monitor Near-Real-Time Stream of Images for Moved Earth

Initial Detection Generate a localized Construction AOI (CAOI)

Drop back in time on CAOI to detect precursors and associations

Monitor and maintain KMS Changes and Associations Throughout construction

System Requirements:

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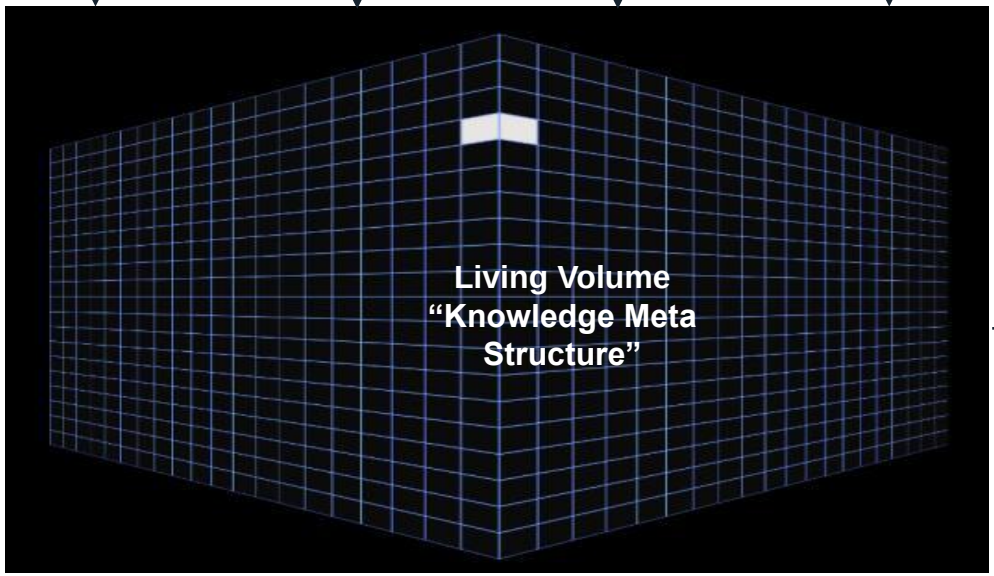

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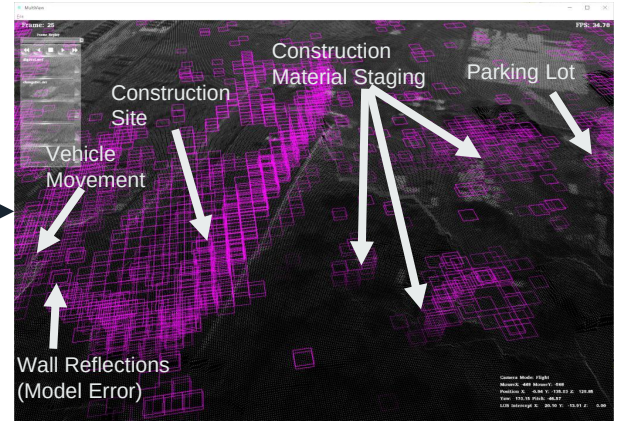


Intellimatics Technology Status

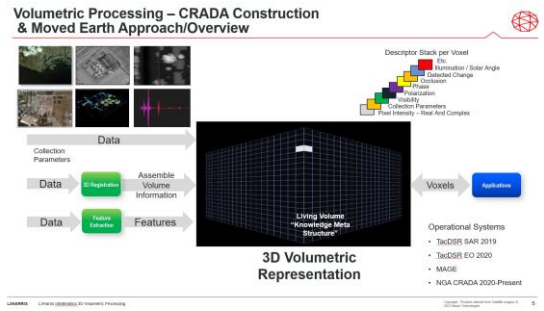
★ Includes AI/ML application(s)

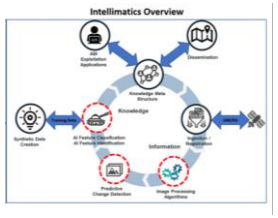
Intellimatics Technology Path

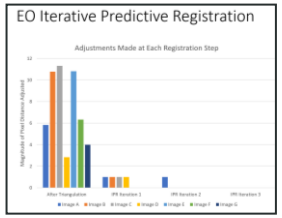
Volumetric EO & SAR Processing	Volumetric SAR-EO Co-Processing	Imagery Based Knowledge Exploitation	Automated Activity Based Intelligence (AABI)	Non-Image Knowledge Extraction	Machine to Machine Knowledgebase Cooperation
Optimal Regression Height Estimation ★	Optimization using Cooperative GANs ★	AI Assisted Tracking of Volumetric Chg ★	Automatic Movement Detection, Custody and Tracking ★		
Topo3 Height Seed Initialization ★	Volumetric labeling of 3D EO with SAR response function ★	Inpainting Voids Using Cross Modality GANs ★	A-ATR Training and Search ★		
A Priori 3D Assisted SAR Interferometry	Volumetric Cross mapping SAR-EO Image Geometries	Optimal Collect for Multi-Source Mtrl Classification ★			
Predictive Registration ★	Optimizing Predictive ML Registration ★	High Res SAR Speckle Reduction from Multi-Source Vol Knwldg Base			
Iterative Predictive Registration ★	Optimal Cross-modality deep learning classification/detection ★	System and Sensor Resource Management ★			
		Precision Targeting Improvement			
		VAE for Change Detection ★			
		Spinning Cross-Correlation Hessian for SAR ATR			

Technologies Maturing

Improving Fully Automated Intelligence





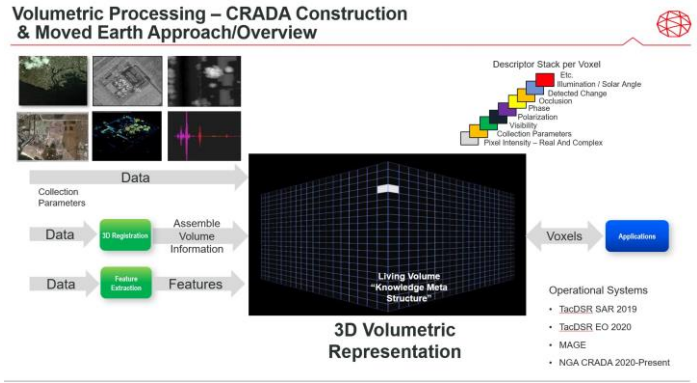


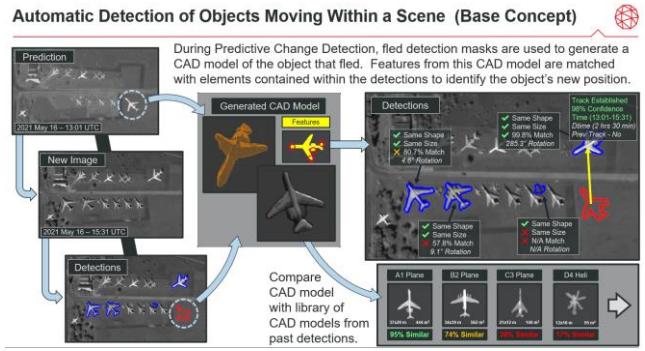
Legend

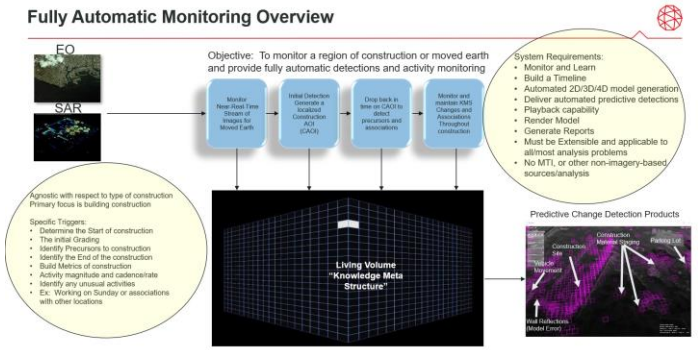
- Demonstrated
- Base Concept in Work

Summary

- Accurate 3D/4D Knowledgebase that Learns
- Applicable to a multitude of problems
- Demonstrated Objectives







Questions?

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