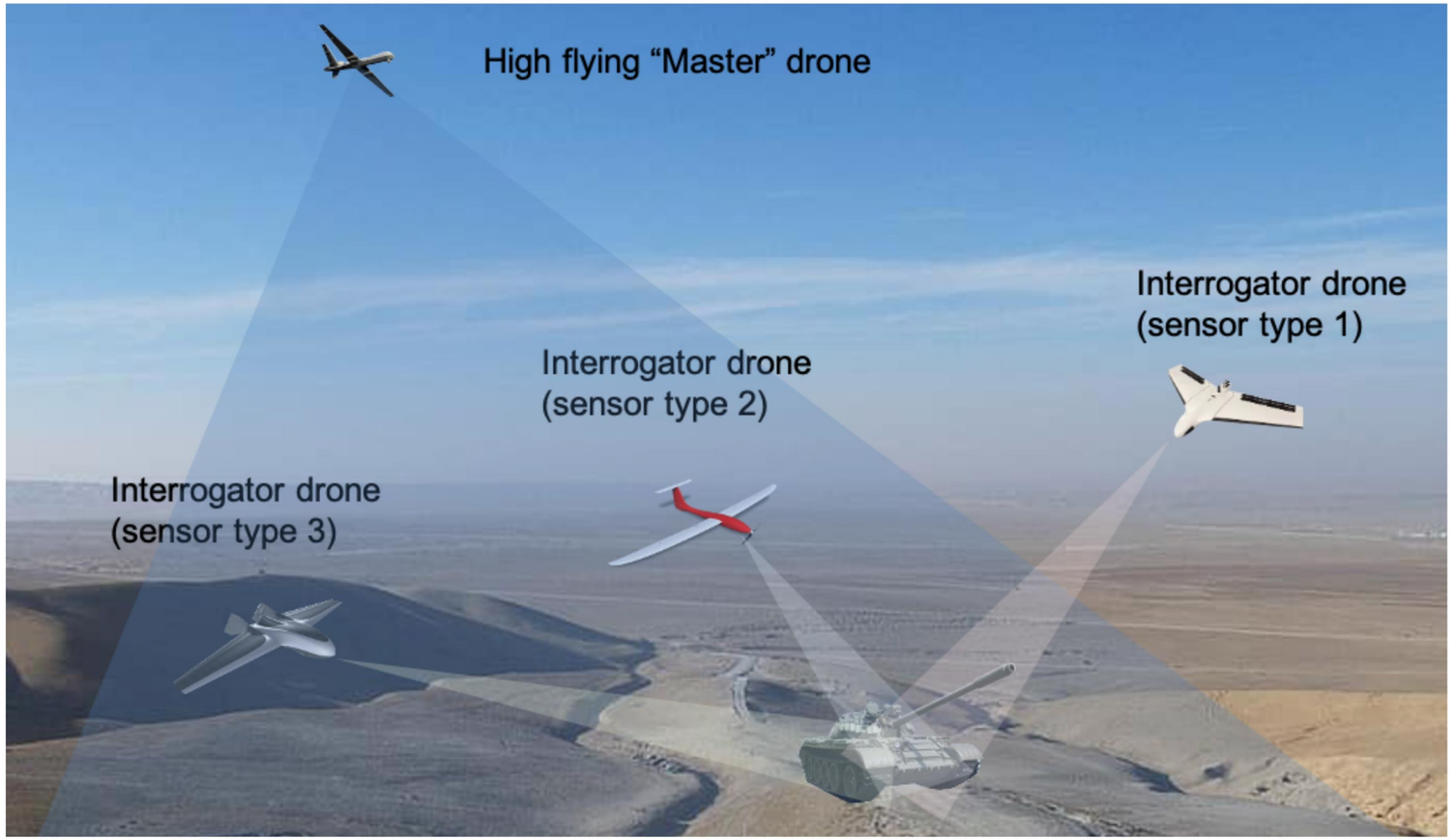
Making Sense of a Big World: Autonomous Sensing for Large Area Situational Awareness



- Multi-UAS Multi-Sensors for Intelligence, Surveillance, and Reconnaissance (ISR)
- Project Goal: Assess world state over large areas using sensors mounted on autonomous platforms. Automate data acquisition and deployment decision processes.
- Objectives/Approach: Acquire and develop a base capability of robotic and UAS platforms/sensors. Develop simulations to optimize designs/investigate deployment scenarios. Use systems to assess the state of an environment and to make decisions that may favorably affect state.

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- This project requires both military and public use applications.
- Agriculture and environmental assessment are our public use applications.
- Build a fleet of sUAS
  - Large field of view sensor finds objects of interest
  - Interrogator sUAS with different sensors examine object for additional information

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- Sensor technologies we will be investigating
  - Long wave infrared (LWIR)
  - Short wave infrared (SWIR)
  - Visible/NIR (VNIR) hyperspectral
  - Light Detection and Ranging (LIDAR)
  - Acoustic
  - Magnetic
- Developing hardware/algorithms for automated detection of objects in scenes.
- Developing advanced networking and communications to enable autonomy and situational awareness.
- Working with University of Arizona and the University of Central Florida.
- Program is currently funded at $2.7M for two years.

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Three Pillars of Development Supported by Simulation and Field Testing

Simulation

Flight Platforms/Operations
- Acquisition/development of platforms
- Development of flight procedures/missions

Sensing
- Sensor acquisition/ development
- Sensor characterization/ modeling
- Data collection/analysis

Communication/Intelligence
- Network layers development
- Algorithm development
- Integration

Field Testing

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Flight Platforms/ Operations

- Fixed wing
  - Small airplanes
    - Prop generates forward motion
    - Wing generates lift
  - Can have longer flight times
  - Can have vertical takeoff and landing (VTOL)
- Multi-Rotor
  - Most common drones
  - Useful for short flights and testing concepts.

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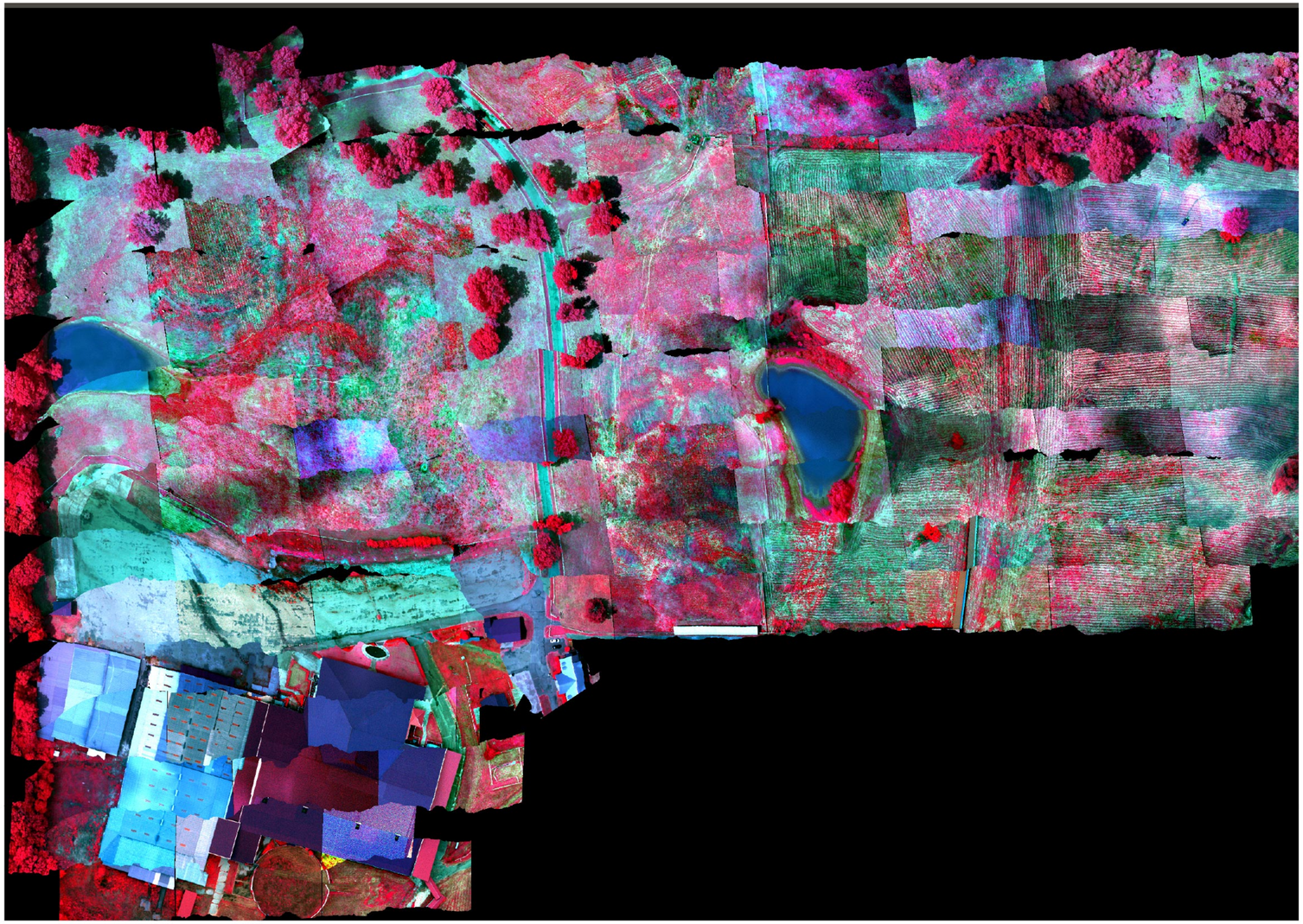
Sensing

- Hyperspectral – useful in determining crop health
- Thermal Infrared – useful in determining soil moisture
- LIDAR – useful in determining crop yield



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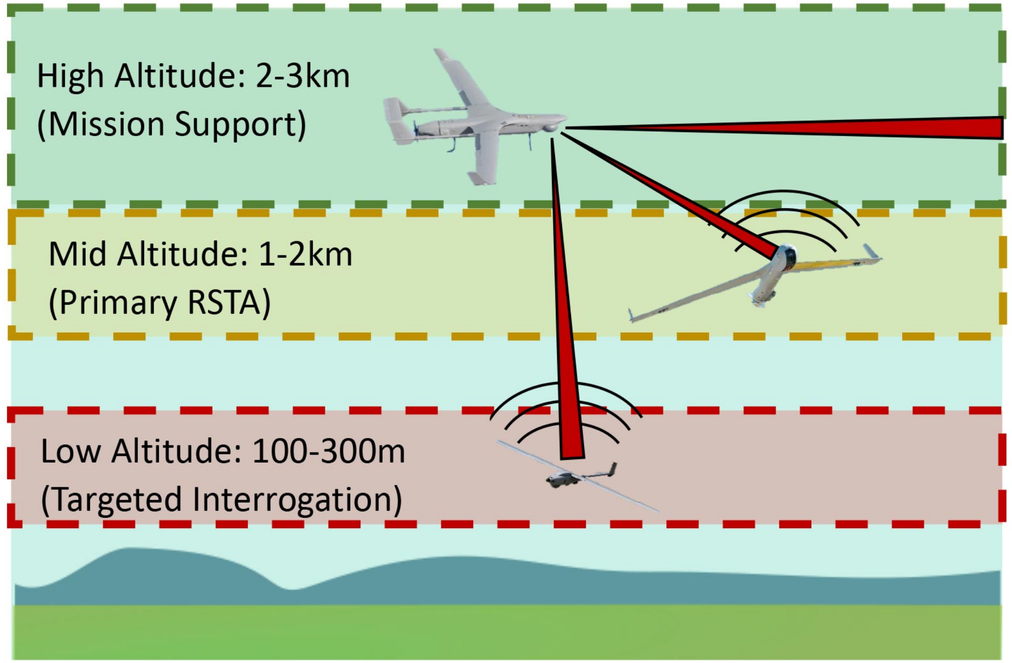
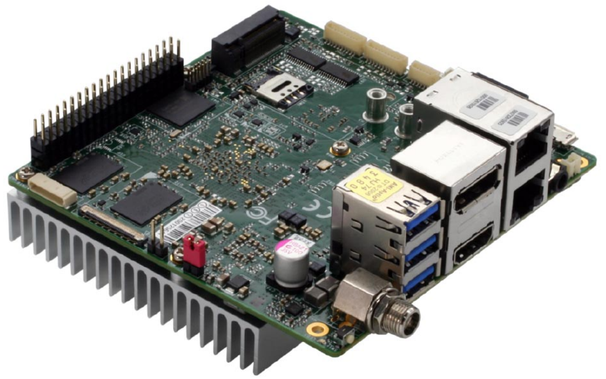
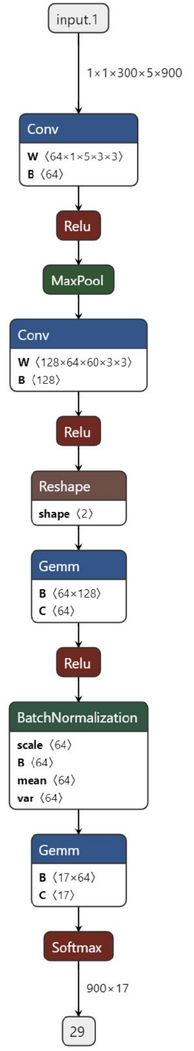
Communication/Intelligence

- High bandwidth optical wireless communications (OWC)
- Advanced Named Data Networking (NDN)
- Deep learning/AI algorithm development for deriving actionable information quickly
- Processing data onboard the sUAS through optimized algorithms/hardware







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Simulation

- Using detailed models of an environment, we can use imaging simulation to generate realistic images of that environment.
- These images can be used for planning or training algorithms.

Satellite view
Of
Agricenter

Simulation
Of
Agricenter

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Field Testing

- Taking sensors and sUAS to the remote sites and collecting data.
  - Eglin Air Force Base
  - Agricenter, International
  - University of Arizona Santa Rita Experiment Station
- Data can be used to …
  - Train and test algorithms
  - Compare with simulations
  - Assess a sensor technology

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- Student Experiences:
  - Introduction to the concepts of remote sensing and sensing technologies.
  - Using and developing Geographic Information Systems and Navigation/GPS
  - Using models and simulations to design and analyze remote sensing scenarios
  - Collecting remotely sensed data for agricultural, environmental, or military applications using sensors on small uncrewed arial systems (sUAS) aka drones.
  - Development of deep learning and machine learning algorithms for automatic analysis of data.