

1. **Research Title:** Improving Multi-Task Foundation Models for Dynamic Signal Processing for Intelligence, Surveillance, and Reconnaissance (ISR) Missions
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**

Computer, electrical, industrial, mechanical, and related engineering disciplines (MS or PhD level)
Computer science and related disciplines (MS or PhD level)
Mathematics, statistics, and related disciplines (MS or PhD level)

4. **Objectives:**

- a. Investigate and develop a reparametrized multi-path encoder architecture to simultaneously capture fine texture and global context in highly noisy, scatter-prone environments with dynamic signals
 - b. Develop soft parameter sharing techniques, specifically probabilistic task balancing via homoscedastic uncertainty weighting, to mathematically balance loss gradients across concurrent subtask
5. **Description:** Grayscale-based imaging is inherently rich in data but highly susceptible to severe speckle noise and shadow artifacts. As machine learning models transition toward highly parameterized foundation models capable of simultaneous classification, segmentation, detection, and regression subtasks, these networks frequently encounter a phenomenon where competing tasks degrade overall model performance.

To address this issue, this project will develop a novel multi-path encoder and soft parameter sharing techniques to improve overall model task performance. By dynamically balancing the optimization process across various subtasks, the network can stabilize itself without relying on manual tuning. Ultimately, this approach will lead to better extracted Intelligence, Surveillance, and Reconnaissance (ISR) features.

6. **Research Classification/Restrictions:** Unclassified
7. **Eligible Research Institutions:** Any university in the State of Ohio

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