TIALINX

Tracking, Identification, Authentication of Links

Precision Fusion: Millimeter Wave Radar with AI Imaging

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Weapon Detection at Distance

- **Space: Development of sensors (both physical and intelligence-based) specialized in detecting individuals carrying weapons.**
- **Problem: Covert identification of armed individuals within queues, even at extended distances of up to 100 meters.**
- **Results: Initial Laboratory test results indicate a probability of detection exceeding 90% for metallic objects larger than 3" x 3" at a distance of 30 meters. Through rigorous testing of diverse convolutional neural network (CNN) encoder-decoder architectures, we have achieved remarkable success in enhancing resolution for constructing silhouette images of detected individuals' motion patterns with the miniaturized hand portable Eagle70-A. Additionally, the network excels in differentiating and detailing reflective objects attached to the body.**
- **TRL = 5**

Technology

- The Eagle70-A is a cutting-edge system equipped with mmWave transmitters and receivers for data collection, a signal processing unit for initial data handling, an image processing unit for visual information refinement, and a display unit for presenting the processed data along with an integrated application software.
- The Eagle70-A is designed to sense objects within a specified range and display their silhouettes. Additionally, it has the capability to identify reflective materials in the vicinity of the detection point.
- The process involves utilizing electromagnetic simulations for multi-object detection, which serves as the data source for image processing through encoder-decoder networks comprising units of convolutional neural networks (CNNs). This approach leverages simulated electromagnetic data to inform the neural network's processing and analysis of visual information.
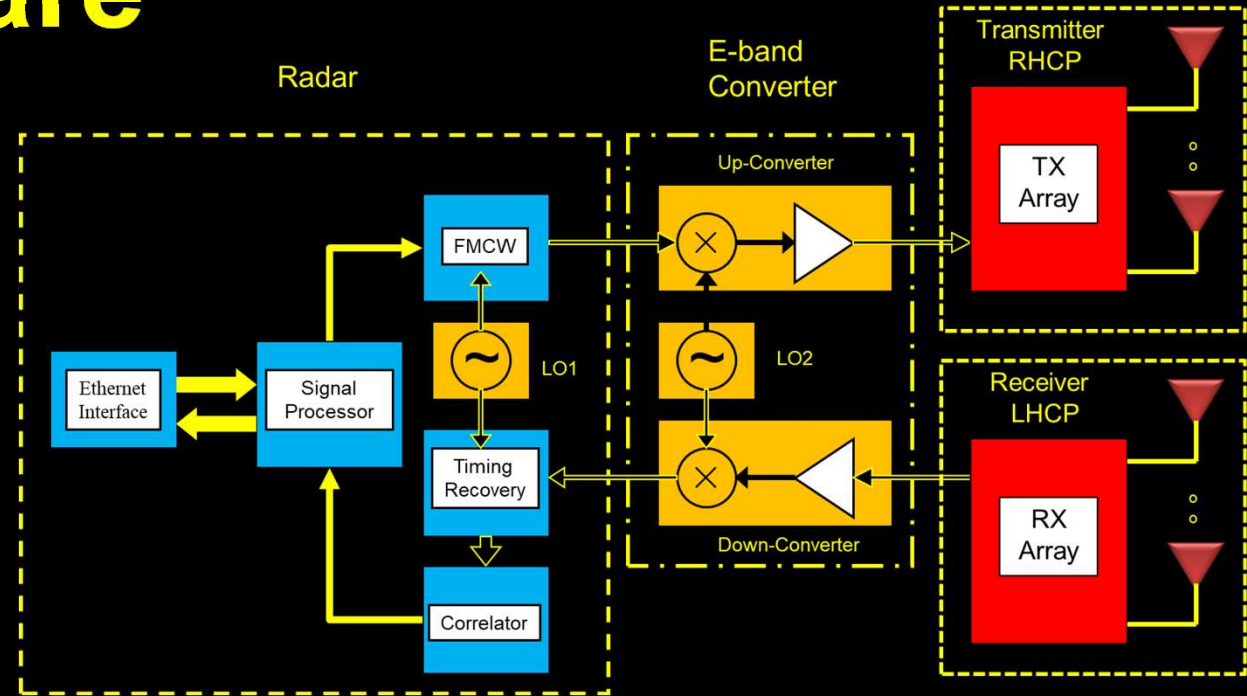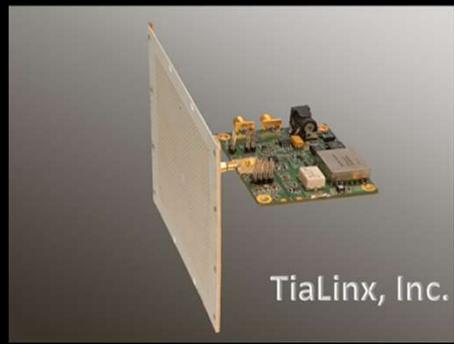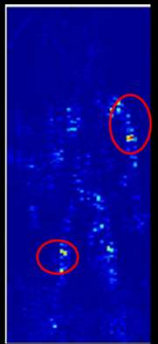
Hardware

Figure 1: The Eagle70-A Transmitter-Receiver Block Diagram

2016 - AR60   (7' H, 4' W, 2' D)   Transmitter Array   2024 – Eagle70-A (6" H, 6" W, 2" D)

Figure 2: Transition from AR60 to Eagle70-A

Software

- **2024 Observations**
- **33 Classes**
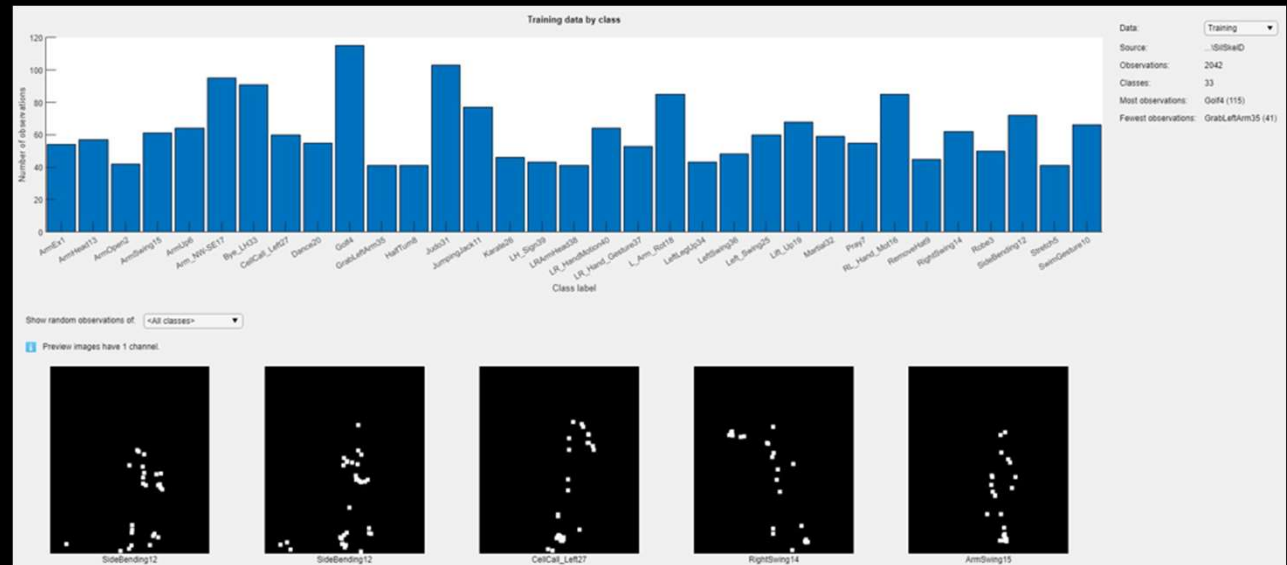- **4-Stage Encoder-Decoder**
- **Regression Layer**

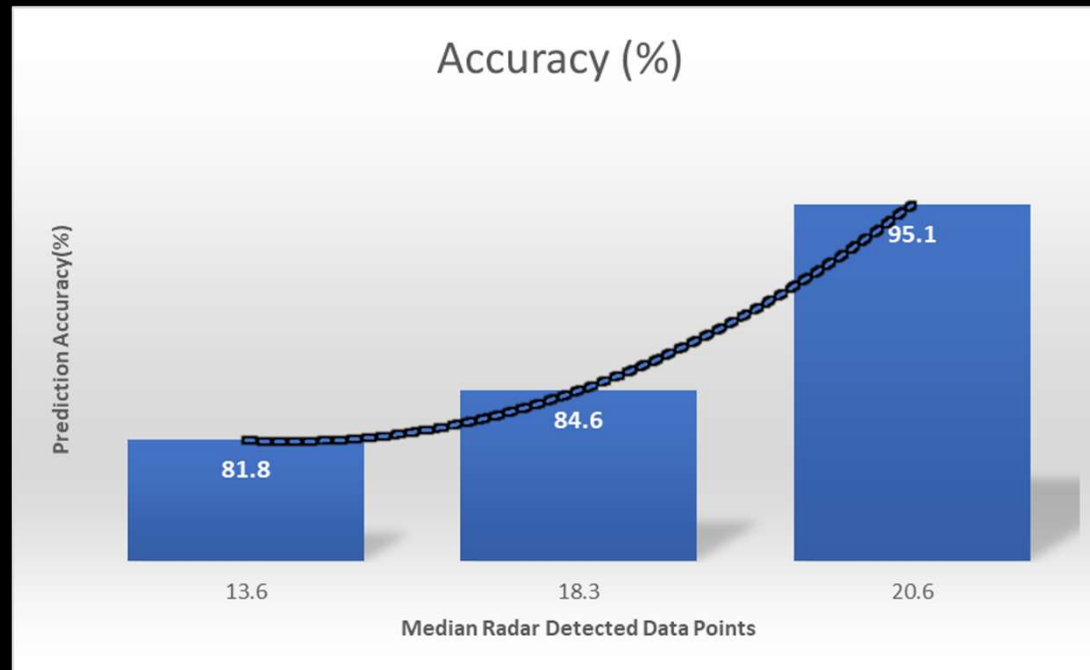**Figure 3: Observations and Classes**

Figure 4: Predication Accuracy
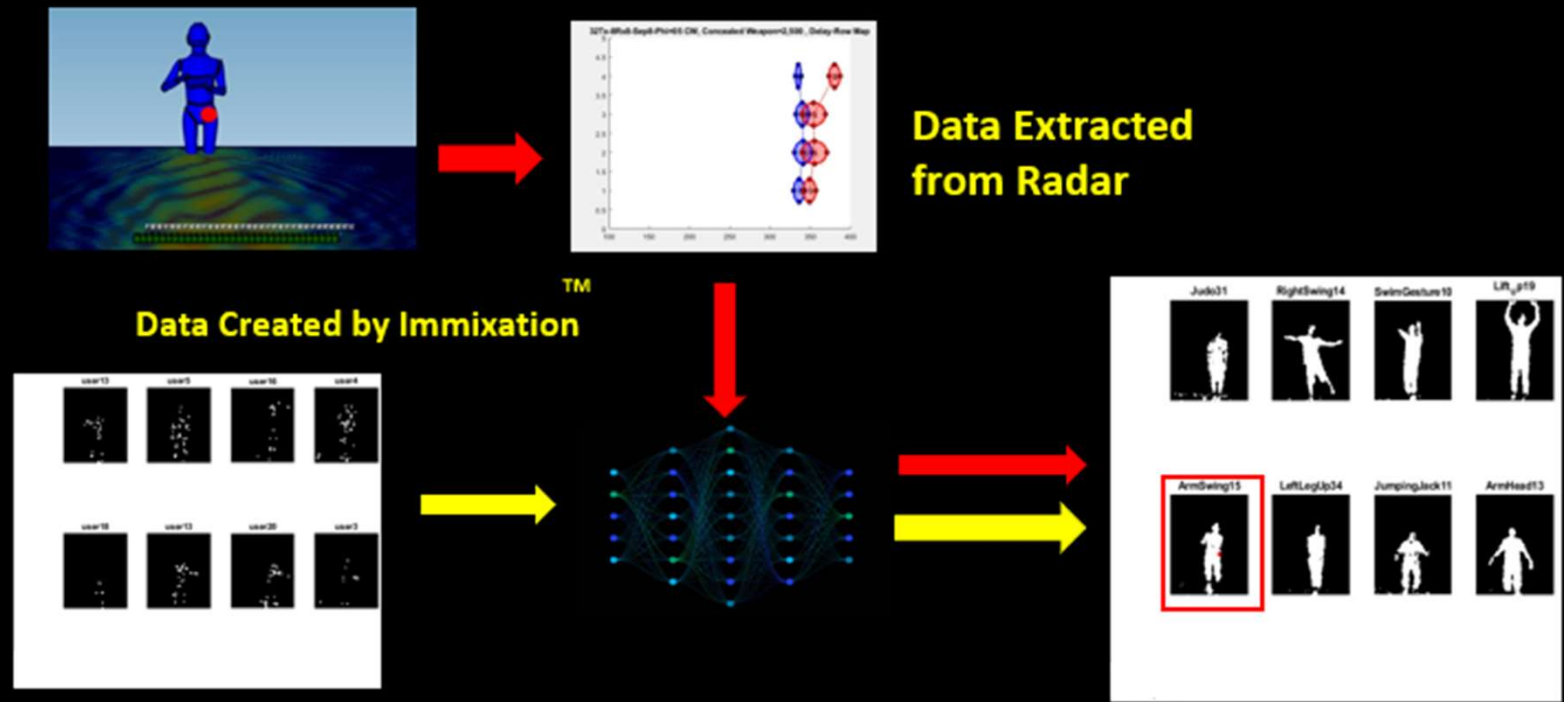
Detection, Processing and Presentation

Figure 5: Predication Process

Within the Immixation process, the neural network assimilates sparse radar data retrieved from reflections off a subject's body. Pre-trained with sub-sampled images, the network processes this limited information. Subsequently, it extracts pertinent features critical for precise assessments. These extracted features serve as the foundation for predicting both spatial and temporal facets of the observed motion. Through this methodical approach, Immixation ensures an accurate and insightful evaluation of movement dynamics based on the radar-derived data.

Product

- **The Eagle70-A demonstrates versatile applicability, finding deployment in security and surveillance, search and rescue operations in degraded vision environments, and collision avoidance scenarios.**
- **Activation is streamlined, featuring user-friendly controls that facilitate the effortless definition of the area of interest. The device excels in data collection and processing, adeptly presenting object silhouettes while seamlessly identifying reflective materials.**
- **The legacy device AR60 is at TRL7, the proposed Eagle70-A is at TRL5.**
- **Upon successful completion of hardware development and integration with AI imaging capabilities, we anticipate the product launch to take place in late 2024.**