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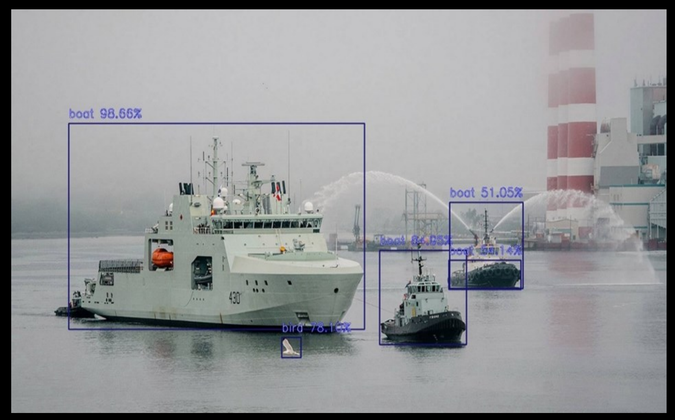
Generate Image Recognition Software for Naval Ships

Scope of Project

- Design an Image Recognition algorithm for LMC to detect and classify naval ships with a degree of confidence
- Detect and identify desired objects within an image input
- Provide an XML output file corresponding to relevant data
- Provide multiple predictions for each object detected within the image inputs
- Maintain LMC Intellectual Property standards (open-source)



Machine Learning

- Machine learning programs are trained to find patterns within a large data set and be modified to understand what each singular class represents. By using machine learning, the team met the project requirements proposed by Lockheed Martin
- Although Artificial Neural Network (ANN) and Recurrent Neural Network (RNN) are useful, Convolutional Neural Network (CNN) was used in conjunction with Python (CNN is industry standard)

ImageAI and Graphical Dependencies

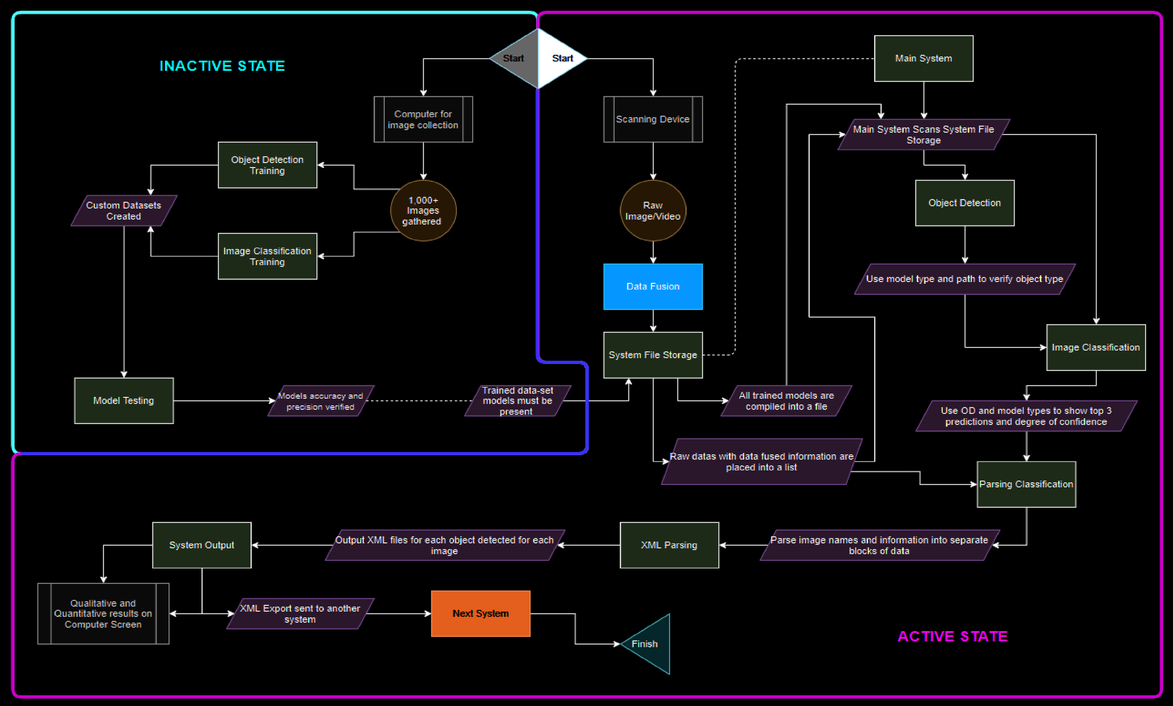
- ImageAI is an open-source python library used to develop the system architecture of this project. With ImageAI being a computer vision python library, Python was the coding language used.
- CUDA and cuDNN (GPU Acceleration) were utilized in the project to speed up the process of training and execution. They accelerated the computation of the GPU and deep learning frameworks (Tensorflow)

Design Process

- The operational state of the system has two processes, active and inactive. The active component of the system represents the state of actively classifying objects and being operated by a user. The inactive component of the system is referred to when training and modifications are made when the entire system is offline and not under operation
- Device (i.e., infrared, UAV, camera, video, etc.) captures the unidentified image and feeds it into the data fusion system. The parsed images are then placed into the system storage
- Object detection would detect the parent object (i.e., ship, car, plane, etc.) before handing the information to image classification. The image classification would take the variables from object detection and categorize the detected class into three specific subclasses (with degree of confidence)
- The classified objects have their information sent to the parsing system to record each variable of the image. The variables are sent to the XML subsystem to export all crucial data into an XML file
- The system output would allow the XML export to travel to the next independent system that LMC desires and present the results qualitatively and quantitively to the operator

Testing Process

- Image classification training is used for classifying a generic input object into a more specific subset. Our classifier was custom trained to distinguish between three different classes of ships (i.e., Aircraft Carrier, Frigate, and Cruiser)
- To train the AI model, hundreds to thousands of images of desired objects should be parsed & compiled to ensure quality. The images are then fed into the model trainer algorithm
- The model is trained for a user specified number of EPOCHs where each image is examined, and relevant parameters are compiled to help the model make a prediction for subsequent inputs
- Our training process was completed using Google Collab GPU as our data set was too large to train on our personal computers (~3000 images)



Results

- The system was able detect the parent object (ship) and predict the given child classes (aircraft carrier, cruiser, and frigate) successfully
- Using 100 images of each class, the system was able to predict the correct image with an accuracy above 80%
- Inaccuracies between the classes come from using low-resolution images, as well as certain ships having more distinguishable features than others

300 Image sample					
Input	Aircraft Carrier	95	4	1	0.95
	Cruiser	16	84	0	0.84
	Frigate	16	15	69	0.69
		Aircraft Carrier	Cruiser	Frigate	82.67%
		Predicted as			Percentage Accuracy

Conclusion and Recommendations

Our team was able to achieve an 82.67% success rate after testing. LMC will improve this by:

- Using a dataset with higher resolution images. Our team simply used images directly from Google Images, where some images are low resolution
- Producing a dataset with more images will result in more accurate and efficient predictions
- Training the model with more EPOCHs and increasing the batch size to decrease the loss variable during testing

References

Analytics Vidhya. (2020). *CNN vs. RNN vs. ANN – Analyzing 3 Types of Neural Networks in Deep Learning.* Retrieved from https://www.analyticsvidhya.com/blog/2020/02/cnn-vs-rnn-vs-mlp-analyzing-3-types-of-neural-networks-in-deep-learning/