CHRES

CONSORTIUM OF HYBRID RESILIENT ENERGY SYSTEMS

DE-NA0003982

Innovative Wide Area Sensing/Mitigation Technologies for CWMD

UPRM's CHRES Summer Research Program 2023

PROGRESS REPORT PRESENTATION

Minds² CREATE

RECINTO UNIVERSITARIO DE MAYAGÜEZ
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Bio, Picture, Email, Department

- My name is Brian L. Reyes Santiago, I am a 2nd year graduate student currently in the Computer Science & Engineering program, and a certified project manager by PMI.

- My work experience is centered around programming and teaching PreK-12 students. I am interested in Robotics, Computer Vision, and Machine Learning. My email is brian.reyes2@upr.edu.

Project Description

My project for this summer research program involved:

- Explore machine learning (ML) models and their applications specifically those involving unmanned systems and energy generation systems
- Experiment with the retraining of existing image classification models in ML using TensorFlow
- Write a proposal in the areas of Pattern Recognition for Robotics in Electrical Systems

Research Question?

What are the applications of ML in unmanned vehicles? How are they used in energy generation systems?

Essentially, I will be researching unmanned vehicles and their applications, particularly regarding pattern recognition in optical and hyperspectral sensors. I will also be assisting in the research of unmanned vehicles for the detection of faults in electrical systems.

Machine Learning Models

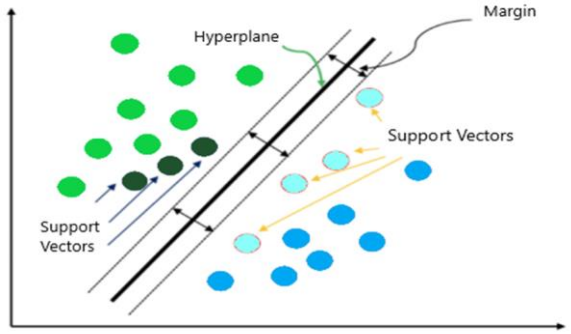
- Machine learning is the study of algorithms that improve their performance at some task with increased experience.
- Example Use Cases:
  - Knowledge cannot be explained (Speech)
  - Models need huge amounts of data or detailed customization (Medicine)
- Learning Algorithms by Task:
  - Recognizing
  - Generating
  - Classifying
  - Predicting

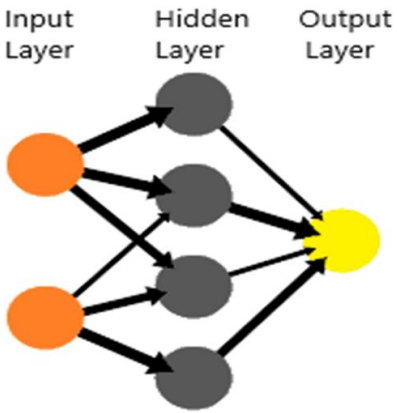
Machine Learning Models

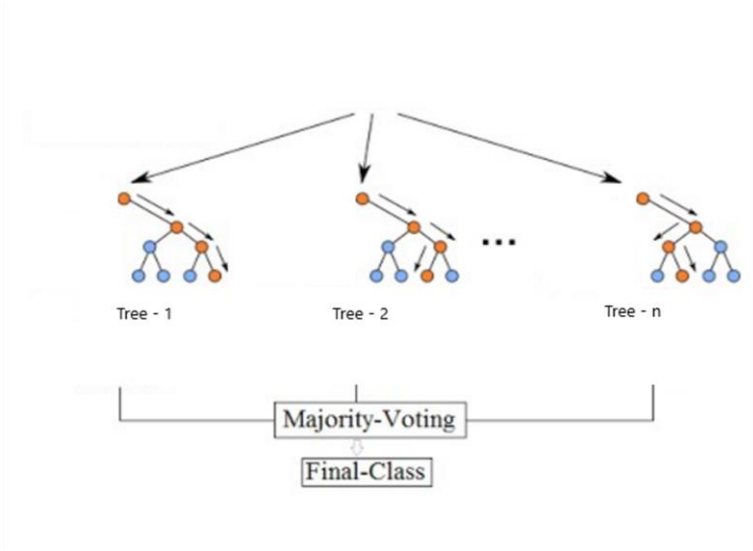
- Types of Learning:
  - Supervised – training data and desired labels are given
  - Unsupervised – training data is given but it is unlabeled
  - Semi-supervised – training data is given and only some of it is labeled
  - Reinforcement – “rewards” the system from a sequence of actions (robot in a maze games, balance, etc.)

Machine Learning Models

- Learning functions examples
  - Support Vector Machine (SVM)
  - Artificial Neural Network (ANN)
  - Random Forest (RF)







Machine Learning Models

- Error metrics
  - Mean Squared Error (MSE) – provides the average of a set of errors and how close to the regression line a set of points is located
  - Mean Absolute Error (MAE) – provides the average of the absolute value of the difference between the predicted and actual values
  - Root Mean Squared Error (RMSE) – provides the standard deviation of the errors and how far from the regression line a set of errors is located

MSE

$$\frac{1}{n} * \sum (actual - prediction)^2$$

MAE

$$\frac{1}{n} * \sum |actual - prediction|$$

RMSE

$$\sqrt{\frac{\sum (actual - prediction)^2}{n}}$$

Machine Learning Models

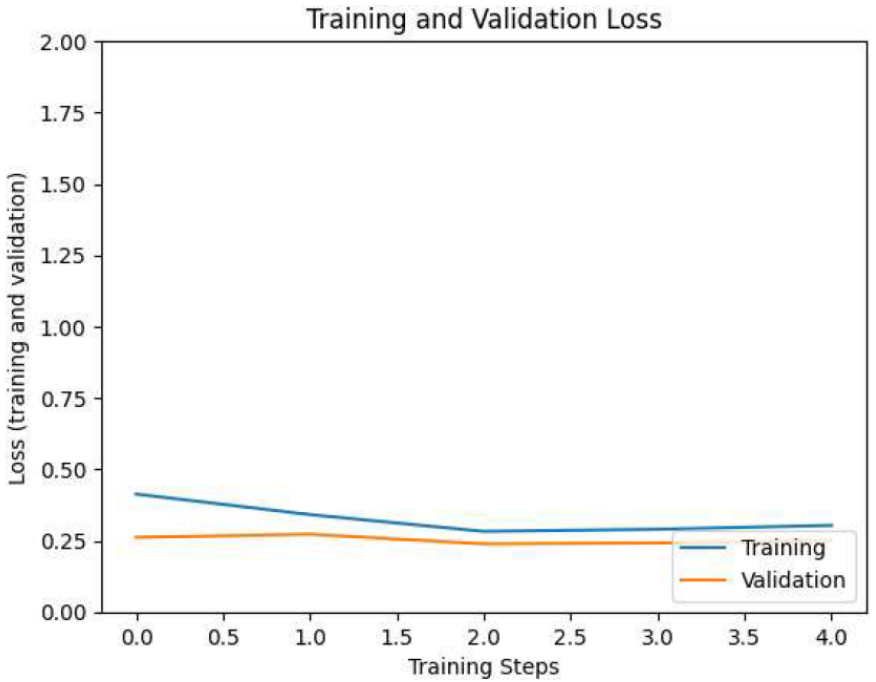
- Results on Energy Use Prediction

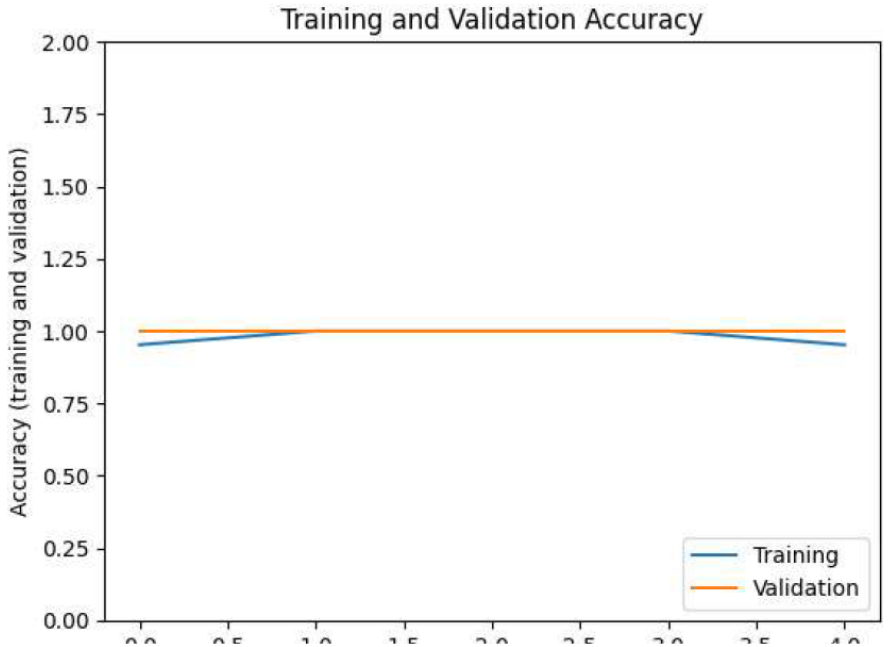
S/N	ALGORITHM	RMSE
1	CATBOOST	1.377
2	LIGHTGBM	1.119
3	ADABOOST	1.993

Method	RMSE [kWh]	NRMSE [%]	MAPE [%]	PCC
Linear Regression	5434.89	25.81	7.39	0.90
Multiple linear regression	22566.99	94.15	29.86	0.57
SVR (RBF)	22452.64	87.08	30.63	0.78
SVR (polynomial)	10617.40	40.94	13.87	0.88
SVR (linear)	4443.11	23.63	6.34	0.91
Regression tree	14140.10	74.39	18.84	0.71
Ensemble regression tree	12791.76	67.53	17.42	0.75
Ensemble Tree LS Boost	12791.76	67.53	17.42	0.75
Ensemble Tree Bag	10285.76	52.50	14.60	0.81
Gaussian process (linear)	5529.98	27.13	7.54	0.87
Gaussian process	4326.72	18.85	5.35	0.93
Multilayer perceptron	2376.38	12.45	3.40	0.96

Machine Learning Models

- Retrained Classifier at UPRM





Results

- A basic model for image classification (MobilNet) has been retrained using a plant specific dataset. Further refinement of the data is necessary in order to measure the Recall, Precision, and F1-score of the model.

Next Steps

- Refining the dataset for the ML model to measure its accuracy
- Create a ROS application for the Husky A200 to map a room and maneuver within it
- Write a proposal in the areas of Pattern Recognition for Robotics in Electrical Systems

References

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