

# Branch Project Based on Building Smart Power Grid

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## 1 Project Proposal

### 1.1 Abstract

With the continuous development of the power system and the application of a large number of distributed generators, various non-linear loads were generating various power quality disturbance. However, various electrical equipment has higher requirements for power quality standards and the power quality disturbance will affect the safety and lifetime of smart power grid networks. Therefore, identifying and classifying the power quality disturbance signals is a prerequisite to maintain a stable, safe, and efficient smart modern power grid. In order to address the problem, convolutional neural networks (CNN) are used in our summer team project due to its fast and accurate feature extraction and classification. Python is the basic tool to implement CNN and train synthetic data because of its open sources and diverse libraries to solve problems. Although, our summer team project has finished most requirements mentioned by clients, there are various features can develop further from machine learning part to dashboard interface, based on the discussion of team members and the requirements of team project client.

**Keywords:** Machine learning, Deep learning, vision, user interface

### 1.2 Introduction

As mentioned before, we have created some basic machine learning models to classify power quality disturbance signals. After that, a visualization web interface to display different disturbance events and their phase diagrams for further investigations by users is also constructed. However, the implementation of the convolutional neural network structures using Python are simple and general with basic classification functions because of the limited project period. So it is possible to improve the efficiency and accuracy of existed CNN models and web dashboard interface. On the other hand, transfer learning can be applied

to machine learning part because we can get high-performing models trained by larger datasets than the synthetic datasets generated by our team members and it is also the optional requirements referred to Tometics clients. In addition, clients also mentioned some expected web features that we didn't realize because of the tight project timeline. As a result, the individual branch project can research these parts and add more flexible features while researching. The process to solve these problems is a good practice to understand deeply what we have learned during this year. Moreover, it will improve the design of our products so that contribute to get better user experience.

### **1.3 Related Work by Summer Team**

The complete workflow of our summer team project can be divided into five steps. First, we followed IEEE standards to create required synthetic signals of power quality disturbances by Python. Then we converted the 1D time-series voltage signals to 2D images, which used to train CNN models. After that, clustering and dimensionality reduction functions were applied to the results predicted by CNN models. In the final step, our team visualized the results on a web interface and wrote the documentation for our project.

### **1.4 Implementation Section**

Based on the previous related work. There are three general directions can be developed in the my individual branch project as follows. More specific research contents can be added while researching.

#### **1.4.1 Transfer Learning**

The reason why I'd like to research transfer learning is that clients have told us to add transfer learning to our project before in the clients meeting. Moreover, since computer vision and image recognition are huge area, many massive and very accurate models have been pre-trained on image datasets to solve general image problems. For example, some models are trained using large datasets like ImageNet, so we can get high- performing models from this. Using transfer learning, it may give better results than the models we constructed from the recommended paper in the summer team project.

There are three steps I'd like to first research, which are feature extraction, fine tuning and scaling up. I'll also modify the structure of existed model constructed this summer by our team, then comparing the performance and accuracy between these models.

#### **1.4.2 Multiple Events Selection in Dashboard**

As for the web dashboard, there is also an important unfinished feature. After we draw the scatter-plot of power quality disturbance events in the dashboard. Clients prefer to choose either an event, or numerous events to see the details of

each selection event. But they can only choose one event now because the python libraries we use to build our dashboard only support to select one event at a time. So I guess it is also a good research aspect to research in my individual project. I prepare to add multiple events selection using different libraries, structure, or layout .

### 1.4.3 Efficiency and Accuracy of Project

Except transfer learning, I prepare to spend some time on improving the efficiency and accuracy of CNN models and dashboard. As for our CNN model, I will mainly construct and modify models from data preprocessing, regression, classification, to clustering. Then I may get a more efficient and accurate model to classify power quality disturbance.

In regard to dashboard, I can also optimize some structures and functions. For example, using asynchronous functions, applications can do multiple tasks at the same time such as processing user input, making I/O requests or running long running calculations. We didn't research more on these methods before, but it will definitely improve the performance of our dashboard.

## 2 Time Plan

Now I'm focus on reviewing the machine learning part of our project, from the videos we found and codes we wrote before. It is because I'm mainly responsible for dashboard in the summer team project. So it will take more time to take over machine learning part than dashboard.

In the first month I will spend two weeks on learning machine learning part in our project and using transfer learning to classify power quality disturbance. Then I will compare the performance and accuracy of transfer learning models to previous models constructed by recommended paper in the next one week. After that I'll modify the structure and code of dashboard in order to support multiple events selection.

In the second month, improving the efficiency and accuracy of my project is the primary tasks. It will also take some time to collect feedback from users so that I can improve my products. Besides, if I encounter some problems and new ideas, I will spend some time on it after I finish the above tasks.

Then, It's time to complete individual report and presentation in the last month.