Abdallah Abu-Ghazaleh

Exporting data from PSSE to Matlab for Power Flow calculations

The goal of the project is to employ some older Matlab code to extract PSSE raw files into Matlab m format and use that to calculate the power flow and compare that with PSSE. In the process the goal would be to optimize the process and make improvements. Potential improvements include: being able to transfer Matlab m format files into PSSE (under certain format and data structures). Analyze and improve the already written Matlab code.

GOALS: Make the code accept the latest version of PSS/E raw files and produce .mat binary files for input to Matlab programs. Create input program in Matlab that can select to read .mat files or spreadsheet files.

Rulin Dong

Sparsity and Optimal Power Flow, LPOPF algorithm

In this project I will work on the existed matlab code which is using linear programming to solve the optimal power flow problem. My job is to transfer the large matrix in the code to sparse matrix and compare how is the performance will be improved. The result comparison will be based on the time, memory usage corresponding to different buses the power system have. This part is almost finished right now and the second step will be trying to add more constrains to the power system: add the ability to constrain of P flows of a group of lines. After this second part is finished we can go ahead and do the comparison in the first part again to see how is the sparse matrix working based on different constrains.

GOALS: Extend existing LPOPF code to work with large sparse matrices, include MVA constraints on transmission lines.

Swaroop Srinivasrao Guggilam

Adaptive Localized Method for fast real-time ac security analysis

In today's world, with electric grid operating at its limits, power system security is one of the main concern. Real-time contingency analysis is performed to analyze the ability of power system to withstand contingencies and remain secured. For practical use, this analysis should be quick and accurate, as it is performed frequently. A modified fast decoupled power flow (FDPF) algorithm for fast real-time ac security analysis is presented in this project, which can also be called as adaptive localized method (ALM). Main idea of this method is built upon the fact that, influence of most of the contingencies in power system security analysis is limited to "localized" regions (set of buses) of the network. In every iteration, adaptively a localized region in the form of set of buses is identified where limits are being violated. Sparse vector methods are then used to solve for voltage magnitude and angle corrections at these buses for localized solutions. Test results for few practical systems along with a brief overview of traditional methods will be presented and it will be shown that this proposed ALM method is faster than earlier conventions maintaining same amount of accuracy.

GOALS: Get the Adaptive Localization method working and have it able to use either the .mat input files or the spreadsheet files.

Michelle Hunt

Solving Unit Commitment by Integer Programming

My project is to implement a version of the unit commitment problem using Matlab's intlinprog command. I plan to try it with both linearized versions of the the test systems used in the lambda

relaxation programs for a comparison and because there are known answers. If there is time I will use the IEEE RTS as it has all of the
For the related research, I will explain why unit commitment is a non convex optimization problem - citing Boyd and Vanberghe's Convex optimization. For problem formulation, I will describe from literature how to enter the problem as a linear program.

GOALS: Build a working Unit Commitment program that uses Integer Programming. Solve large 168 hour unit commitment via both Lagrange Relaxation and Integer Programming and compare results.

Tanhee Miller

Contingency Ranking Comparison

Compare the contingency ranking algorithm utilized by the PSSE activity RANK, from the Mikolinnas/Wollenberg paper "An Advanced Contingency Selection Algorithm," to the contingency selection process identified in the Ejebe/Wollenberg paper "Automatic Contingency Selection" by developing a test project and comparing each method. The Mikolinnas/Wollenberg method would be performed using PSSE and the Ejebe/Wollenberg method would be performed using Matlab.

GOALS: Compare ranking results for both real power flow and well as Q/V cases using the Ejebe/Wollenberg and the Mikolinnas/Wollenberg methods and compare results.

Brian Monson

EE 8725 Zero Mismatch Power Flow Project Summary

My project will be to develop a MATLAB program to run a zero-mismatch power flow, using the process outlined by R. Bacher and W. F. Tinney in “Faster Local Power Flow Solutions: The Zero Mismatch Approach”. This MATLAB program will use .mat binary files from solved PSS/E cases that contain power flow data as input, and will output a solved zero mismatch power flow for a single outage and will report the total computation time. The total computation time for these cases can be compared with the total computation times for similar analysis using the full Newton power flow, and the fast decoupled Newton power flow. This project will leverage malfunctioning code written by a previous graduate student as the basis from which the code will be developed.

GOALS: Build zero mismatch power flow code and compare run time to standard Newton Power Flow run time.

Vamsi Paruchuri

Efficient and Complete Bounding Methods for Contingency Analysis

Real-time security analysis requires to analyze the effects of hundreds of outages on line flows and bus voltages and this increases the demand for computational speed and adaptability of solution methods. Ideally an AC power flow should be solve for each contingency followed by a check for branch thermal ratings and bus voltage limit violations and major shifts from the initial system condition. This analysis is computationally intensive and not practical in real-time environment. To address these issues and to cope up with the computational barrier various approximate methods have been developed based on the idea that vast majority of outages does not cause major shifts or violations. The explicit methods (ranking methods) that quantify the severity of outage by scalar index are prone to masking errors, but implicit methods (screening methods) which are computationally intensive that identify actual violations and major shifts and therefore avoid masking errors. The scope of this project is to research and implement Efficient and Complete Bounding contingency screening methods which are flexible and fast. This method is based upon the incremental angle criterion and the fast decoupled power flow and uses (a) a bounding criterion which reduces the number of branch flow computations and limits checking and (b) from a bounding criterion which reduces the number of buses for which Q-mismatch has to be calculated.

GOALS: Create bounding algorithm method to do contingency analysis and compare run time to standard DC power flow method.

Victor Purba

Dynamic Equivalents

This project is based on recent development of power system dynamic equivalent. An algorithm proposed in a journal paper, titled “Right-Sized Power System Dynamic Equivalents for Power System Operation,” will be implemented here. The first step in developing dynamic equivalents is to determine an area of interest, called the study area, and the external area. There might be some generators in the external area that are critical to the study area; they can be identified using power transfer distribution factor (PTDF). After those generators have been determined, the original boundary between the two areas is altered in order to include them into the study area. The next step is to determine dynamic of the generator system that is suitable for large-scale power system. In order to simplify the dynamic, slow coherency of the generators is considered here. Under this condition, the linearized swing equation is used as the dynamic of the generator system with the states to be the generator rotor angle deviation and generator speed deviation. A change in generation/load, or line outage/addition affects the state matrix of the system. By leveraging linear algebra techniques, the state matrix after the change can be updated without finding the whole matrix from scratch. After the new state matrix and critical external generators have been obtained, the equivalent system is formed using DYNRED software. The algorithm in the paper will be tested on a portion of the WECC system or other large power system that could be found. Plots of transient responses of the full and equivalent systems due to changes listed above will be presented. The MATLAB codes of this project will be provided in the end.

GOALS: Build dynamic equivalent circuits from real test cases such as WECC model and compare results to cases without an equivalent to determine accuracy.

Pei Xu

Power System Observability Assessment

Power systems' secure operation demands a comprehensive and detailed monitoring system to guarantee systems' observability. However, redundant measurements would cause problems in control, management and cost. The optimal Phasor Measurement Unit (PMU) placement problem is referred to as to minimize the amount of PMU installed in a power system and, meanwhile, to maintain the full system's observability. Several algorithms for this problem have been proposed. In my project, four algorithms, including Graph Theoretic Procedure, Depth-First Search, Simulated Annealing Method and Spanning Tree Method, are described, and a simulation utilizing these algorithms and IEEE 14-Bus system will be processed in Matlab.

If everything goes well, a bigger simulation, utilizing IEEE 118-Bus system or bigger, would be processed.

GOALS: Build Matlab code to use the standard state estimator input files and do a complete observability analysis and identify critical measurements, and indicate where pseudo measurements are necessary.

Mahdi Yussuf

Continuation Power Flow (CPF)

The project topic I have chosen is on the theory of Continuation Power Flow (CPF), its algorithm and the uses it serves as solving problems relating to Power Flow. Voltage stability, which is an important area in the field of power systems, will be analyzed using the Continuation Power Flow method, which consists of successive load flows (an iterative process utilizing predictor and corrector steps). The Continuation Power Flow theory is one of several algorithms/theories that aim to solve Power Flow problems, and in the project, comparisons will be made between CPF and several of the other algorithms.

GOALS: Construct a continuation power flow code that will use the .mat files as well as the Xcel Spreadsheet files. Test on voltage collapse cases where load is raised until convergence is no longer attainable on conventional Newton Power Flow.

GROUP SUMMARIES

GROUP 1: Sukumar Santhanam, Vasanthakannan Vijayaraghavan, Niranjan Vijayendra Kumar

Optimal Power Flow (OPF) in Rectangular Form

The objective is to minimize the generating cost of a power flow network. The OPF problem is solved such that both equality and inequality constraints are satisfied. In this project Interior Point Method (IPM) is used to solve the Nonconvex Nonlinear Programming (NLP) problem of OPF, formulated using voltage rectangular coordinates.The objective function that needs to be minimized is the sum of the fuel cost functions of each generator in the power system subject to equality and inequality constraints of load, generation, line and voltage magnitudes.

GOALS: Get the OPF written in rectangular coordinates to solve on many power flow cases and test against existing OPF codes such as the LPOPF of Wollenberg and the PSERC MatPower OPF from Cornell University.

GROUP 2: Dheeraj R Butukuri, Apoorva M Nataraja

OPF using IPM in polar coordinates

OPF is a Non Linear optimization problem used to optimize some objective while satisfying network power flow equations and operational constraints. The objective of the OPF problem in this case is to minimize operating cost of generators and total losses in the system while satisfying power injection and voltage constraints i.e., the equality and inequality constraints. OPF thus solves economic dispatch and power flow whereas PF solves only ED.

The focus of this project is to utilize Interior Point Method (IPM) to solve OPF expressing voltages in polar coordinates. Primal-Dual algorithm of IPM will be used. Power flow convergence for various bus systems will be studied.

GOALS: Get the existing polar coordinates OPF working and test against existing OPF codes such as the LPOPF of Wollenberg and the PSERC MatPower OPF from Cornell University.

GROUP 3: Sai Sri Harsha Chandavarapu , Shreeganesh Bhat

PTDF and LODF calculation

Description: The continual increase in the load has resulted in the operation of power system under stressed conditions where the transmission lines are operating near the security limit levels. Recent blackouts which have been caused due to the cascading faults have been a major concern in modern

power systems thereby bringing out the necessity to evaluate the distribution factors such as the power transfer distribution factors and line outage distribution factors under single and multiple-line outages for power system security studies.
In order to observe the effect of the line outage, the line outage distribution factors (LODF) are being assessed. It helps in understanding the behavior of the system in case of an outage. Power Transfer Distribution Factors (PTDF) are assessed in order to investigate how far the system is from an insecure condition, and how a transaction of active power can affect the loading of the transmission system. It evaluates the maximum allowable flow for a given pair of injection and take-off points.
Aim of the project is to compute PTDF and LODF factors by using sparse matrix methodology to improve the speed and to able to handle large systems.

GOALS: Try to make the PTDF/LODF codes work on large power flow cases.

GROUP 4: Kathryn Maurer and Melissa Newmann

State Estimator using pseudo inverse and using QR algorithm

We will be taking pre-made state estimator code and converting all matrices to sparse matrices. Once that is done we will be getting the orthogonal state estimator code working with the sparse matrices we have created. This project is to fix orthogonal state estimator code to work with sparse matrices and create a program that converts matrices in the state estimator to sparse matrices. The program is also to be able to detect bad data.

GOALS: Make the existing QR algorithm state estimator work (Or write a new one that works). Test on state estimator cases that have many zero injection buses to force the result to have zero P+jQ on those buses.

GROUP 5: Sriram Kannan, Sourav PateL, Soniya Mantri

Contingency Analysis using 1P1Q type Selection Technique

Introduction: The given Matlab program performs worst case contingency selection using DC power flow and analysis using AC power flow (Newton and Fast Decoupled). The conventional way to do it is to perform a DC power flow analysis and list down the worst case contingencies and then perform the AC power flow analysis only on those cases to reduce the computation time. The limitation of DC power flow analysis is that it fails to classify some of the cases (that would fail to converge or cause a voltage collapse) in the worst case contingency list . Running a full AC power flow analysis can be also very slow and unneeded since only the worst case contingencies are needed.
In order to eliminate this problem, the 1P1Q contingency selection technique will be used instead of the DC power flow analysis. In this method, only one iteration of fast decoupled power flow analysis is performed, which gives a fair idea of reactive power flows. It ensures that the voltage collapse cases are not ignored since the reactive power flows are taken into consideration as well. The performance index of this method is very good. To make it faster and efficient, matrix inversion lemma logic to do line outages will also be implemented.
We will be testing this on the IEEE 14 bus system and compare our results with PSS/E. Further scope of the project would include testing this code on a larger IEEE bus system.

GOALS: Write code to test the 1P1Q contingency selection method and test it against other selection methods such as the DC power flow alone. Test against exhaustive case execution of Newton Power Flow solutions to determine if the ranking is close to optimal and if any important cases will be overlooked.