AN OPEN SOURCE FRAMEWORK MODELLING: VISUALIZATION OF VOLTAGE MAGNITUDE AS PSEUDO CONTOUR ON A MAP

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ABSTRACT

Voltage magnitude in power system is essential to maintain a certain limit. Therefore continuous monitoring of voltage level is required and graphical visualization is considerable to be beneficial in helping power system operator. In this paper we combine Geographical Information System (GIS) and optimal power flow based on the interior point method for nonlinear programming by an open source framework. By presenting voltage magnitude in a contour to analyse the situation and immediately response to the system states. Our open source platform is mainly build on the top of Python Programming Language with additional required libraries such as Matplotlib and Basemap on a Linux machine. A masking layer is created to allow only plotting on a certain region of the map. The proposed framework is then applied to the real power system, in this case is southern Sumatera Interconnection System.

Key words: *Voltage Magnitude Monitoring, Pseudo Contour, GIS, Open Source Framework, Python, Electrical Power System*

INTRODUCTION

Voltage magnitude in power system is essential to maintain a certain limits. Therefore continuous monitoring of voltage level is required and graphical visualization is considerable to be beneficial in helping power system operator. The implementation of real continuous monitoring in power system is still using conventional way. The voltage magnitude in each node represents by the number of value in schematic diagram or single diagram. This is work properly and useful to know the voltage magnitude in system but little too hard to wondering about the real condition. The second reason is visualisation continuous monitoring voltage magnitude (Overbye *et al.*, 2000a) with geospatial data provided only by proprietary application.

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Previous research by Milano and Stifter, talking about the integration of a geospatial data or Geographical Information System (GIS) into a power system analysis tool in two-dimensional and three-dimensional in Italian high voltage system. Which is voltage magnitude in every node that mapping into GIS will represented by variety of colour that we call as "Thermometer Colour" or "Heat map".

Two-dimensional contour plots are purposed for the visualization of voltage magnitude level with inclusion of topological information of the power system network. The contour plot complies with the few guideline, that is it natural encoding of information or coordinate of information every node that would be monitoring, task-specific graphics; and no gratuitous graphics. In this paper we purpose the same goal with Milano and Stifer (2009) but with little different technique.

GEOGRAPHICAL INFORMATION SYSTEM

Geographical Information System (GIS) are used generally in engineering field such as mapping survey for civil engineering or geographical engineering. GIS are used to visualise, digitalise and analyse data by linking or mapping geographical location to information. Geospatial data is used for creating maps assigning data and performing spatial analysis. The integration of geographical information system into power system are beneficial of power system monitoring such as voltage magnitude continuous monitoring and also the other monitoring function in power system. In this paper geospatial data consider to node coordinate and boundary of southern Sumatra interconnection system. Including Jambi, Bengkulu, South Sumatera and also Lampung province.

Open Source Framework

Open-Source Framework purpose in this paper research as an environment of work of modelling that we develop. We use Python language version 2.7 as

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scripting language for some reason. Python is a safely, dynamically and strongly typed language. Hence polymorphism, meta-programming and introspection are easy implement and use. Concepts such as safe, dynamic and strong typing as well as meta-programming, polymorphism and relatively advanced programming topics. Our modelling writing in Python language, run on Linux 64 bit machine, with purpose to better performance, and also with additional library such as Matplotlib and Basemap with support handling to read geospatial data.

Two-Dimensional Contour Plot Technique

Much of the data within power system is referenced to the system buses. This includes information such as voltage magnitude level. However buses are only defined as a node discrete point with power system (Milano, 2009) Therefore power system can be visualized as two-dimensional contour plot that has discrete points within throughout the space. The technique develoved in this study is described in the following sections.

Basic Layer (Basemap Layer)

In layer, we just determine the boundary of Southern Sumatera Interconnection system first within Basemap coordinate as basic layer of two-dimensional contour plot (Overbye *et al.,* 2000b)

Table 1 Southern Sumatera Interconnection System coordinates

Variable	Value
Low longitude	101.01
Low latitude	-8.5
High longitude	108.0
Low latitude	1.5

After we determine basic layer of two-dimensional contour plot, we need to create dummy nodes that covering square our basemap coordinate at table 1. The dummy nodes purposed to manipulate weight between nodes inside and outside the basemap in order to avoid white space that will appear if there is no any weight. From basemap library we need some feature for handling shape file into our

basemap, this purposed to distinguish each area that will be appear in our basemap, but also this is very importance in masking process, in masking process we need another tool to convert shapefile into text, and then we could extraction the information of each boundary node.

Middle Layer (Contouring Algorithm)

In this layer we focusing on Contouring algorithm in this paper describe as listing below

Data = (data – xmin)/(xmax – xmin)

Data = (data - ymin)/(ymax – ymin)

pcolormesh(xi,yi,zi,vmin=0.95,vmax=1.05)

From the clip of Python syntax above, it counting the gradation between nodes. Each node are compare with another node and compare again with another node, if the distance between two node are close and node value not too different produce the ″heat map″ gradation contour not to different in colour gradation. If the node value too different and distance are far produce the varying heat map far from node. The contour algorithm in our python scripting using *pcolormesh* function that make a pseudocolor plot using a quadrilateral mesh. In this layer we combine with mathematic modelling of power system, we combine with interior point method for nonlinear programming. Because we just need the result of mathematic modelling to parse into each node value. We could try not only interior point method for nonlinear programming but also another mathematic modelling.

The node in this layer not only contains value as Voltage magnitude but also contain another info such as geospatial data (coordinate each node). Within power system, it′s certain limit to maintain voltage magnitude. Thus when viewing system data it may be helpful to highlight any violation in these certain limit. This can be achieved by varying the colour-mapping to include a discrete jumping colour when the limit is crossed. Contour and temperature maps have proved to be an effective solution for visualization results of a variety of power system analyses

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Top Layer (Masking Two-Dimensional Contour Southern Sumatera Temperature Maps)

Masking is top layer in two-dimensional contour plot technique. In this layer we just focusing on how to show contouring only inside the basemaps. In this layer to propose above, we use another open source tools like shp2txt and Open Jump. In open jump we extracting specific shapefile global shapefile, as an example in this project paper we extracting Southern Sumatra interconnection area with shapefile format from Indonesia shapefile format. After we have shape are we use shp2txt to extracting coordinate as boundary area.

In python script boundary area from extracting coordinate use as maps area and conditional parameter, if contour area inside the coordinate area the contour would be show, but if contour area outside the coordinate it would not show. From the rule above we found the way how to show two-dimensional contouring Southern Sumatra Interconnection area maps.
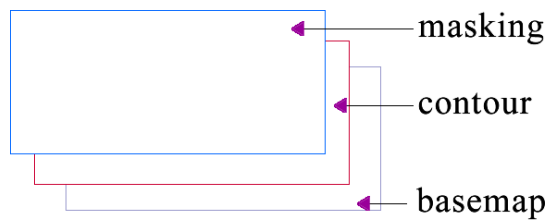

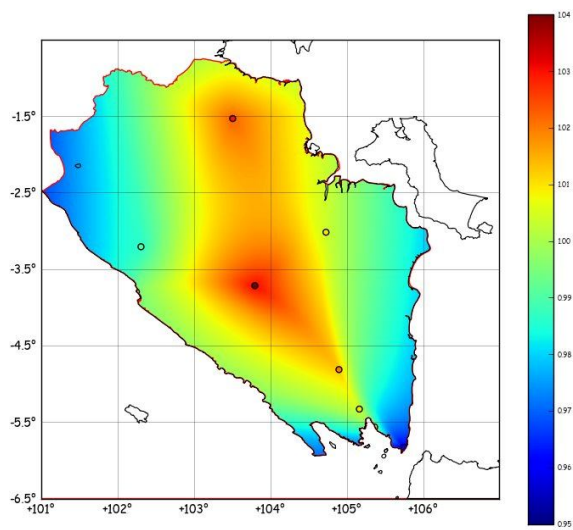**Figure 1.** Illustration how two-dimensional contour technique development

Figure 2. Southern Sumatera two-Dimensional Contour

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CONCLUSION

From the above, with open source philosophy is possible to create a tool for visualization of Voltage magnitude in power system incorporate with geospatial data. We believe that the results are promising.

ACKNOWLEDGMENTS

Acknowledge support of BBS Unilanet, and the Support of Electrical Engineering University of Lampung, and the Support of the University of Lampung.

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