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# Virtual Stability Estimator Model for Three Phase Power System Network

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***Abstract***

*The main objective of this research work is to develop a simple power systems steady state stability estimator in LabView for three phase power system network. LabVIEW based power systems stability estimator has been chosen as the main platform because it is a user friendly and easy to apply in power systems. This research work is intended to simultaneously acclimate the power system engineers with the utilization of LabVIEW with electrical power systems. This proposed work will discuss about the configuration and the improvement of the intelligent instructional VI (virtual instrument) modules in power systems for power systems stability solutions. In the proposed model power systems stability has been carried out and model has been developed such that it can accommodate the latest versions of power systems stability algorithms.*

***Keywords***: *paperPower systems stability, LabVIEW, three phase power system network.*



## 1. Introduction

Earlier implementation of power system programs were severely restricted by the lack of flexibility of main frame computers as well as limitations in graphical support, memory and storage space. Now the evolution of computer technology has removed most of these limitations and made the PC a universal platform for power system simulation. Abundance of cheap memory and new operating systems permit the computers to accommodate large executable code with extensive data storage. In addition the utilization of virtual memory technology has eliminated the traditional limitation of insufficient memory space for executable binary and simulation data. The dynamic memory allocation facility has also enabled optimized usage of the memory space. Application code can be made relocatable and dynamically loaded into the memory and called from the main program only when it is needed. Therefore, memory space is released immediately when it is no longer required. Traditionally, power system programs have been designed using a single programming language. A text-based database file is commonly used, allowing users to construct the database by typing in the power system data using an ordinary text editor.

Recent advancements in software development tools have made it possible for the program binary generated by different compliers on different programming languages to be able to interact with each other. This enables the programmers to exploit the strengths of different languages in the development of single computer software [1]. The software can be separated into a graphical user interface and a simulation engine. The graphical user interface and the simulation engine, have different development tools requirements and hence, different languages are chosen to construct them [5]. The proposed work is to develop and implement LabVIEW based Virtual Instrumentation estimator modules for power system analysis in multi-area power systems [2-3].

Energy management is the process of monitoring, coordinating and controlling the generation, transmission and distribution of electrical energy. An energy control centre utilizes the computer aided tools to monitor, control and optimize the generation, transmission and distribution of electrical energy. The functions of a typical control centre can be categorized into three subsystems as shown in Figure 1 namely the data acquisition and processing subsystem, the energy management/automatic generation control subsystem and the security monitoring and control subsystem. SCADA (supervisory control and data acquisition system) forms the

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front end of EMS (energy management systems). A simple SCADA provides the raw data of the operating condition of the system to the control centre operators. Power systems stability forms the backbone for energy management system. Although reliability remains a central issue, the need for the real time network models becomes more important than before due to new energy market related functions are to be added to the existing EMS. These models are based on the results yielded by power systems stability and are used in network applications such as security monitoring, contingency analysis, optimal power flow, economic dispatch, unit commitment, automatic generation control and economic interchange evaluation.

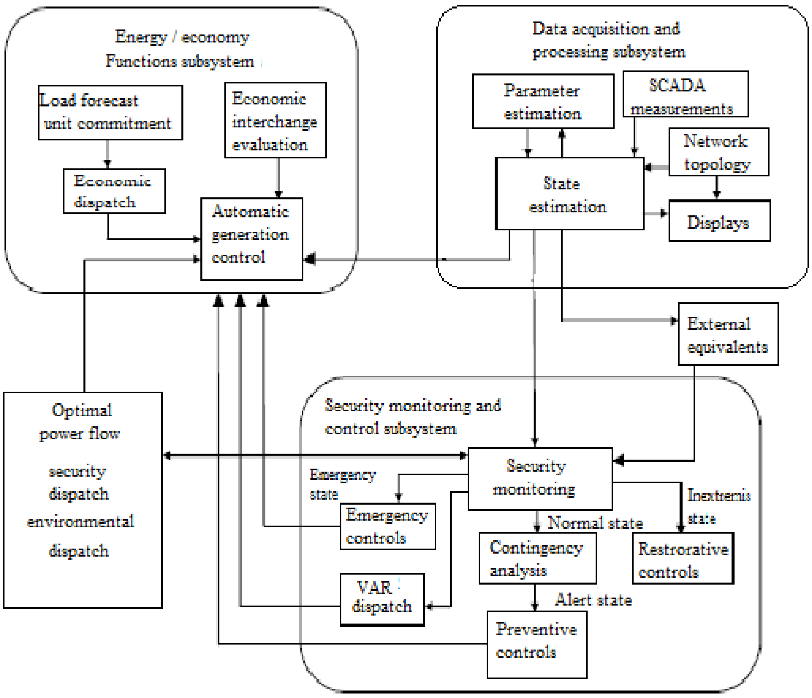


Figure 1. Functional Diagram of Modern Energy Management System

## 2. Virtual Instrumentation based Applications in Electrical Engineering

LabVIEW is an application to interface the computer with a real time experiment. Being extremely powerful, it allows the user to generate and measure analog and digital voltages. It is capable of controlling the timing of the operations performed. The procedures are flexible so that the user will enjoy working with the software due to the simulation that is visible. Writing long lines of program is a complicated task, LabVIEW eliminates the need for this and allows the user to use the blocks easily and implement them as shown in Figure 2.

LabVIEW is to an amazing degree adaptable and a portion of the application zones of LabVIEW are Simulation, Data Acquisition, and Data Processing. The Data Processing library combines signal period, Digital sign preparing (DSP), estimation, channels, windows, cutting edge, likelihood and measurements, direct polynomial math, numerical procedures, instrument control, program change, control systems, and fuzzy logic [4]. These portions of LabVIEW will give an interdisciplinary, composed instructing and learning foundation that joins bunch arranged, hands-on learning experiences all through the outlining advancement and sciences program, connecting with understudies in the plan and examination framework. LabVIEW can orchestrate Data acquisition sheets as appeared in Figure 2 to inspect fundamental information hails (A/D change), produce essential yield signals (D/A change), read and make electronic standards, and control the on-board counters for frequency estimation, pulse generation et cetera. The voltage information sends into the module Data Acquisition board in the PC, which sends information into the PC memory for limit, planning, or other control. [6], [9], [11].

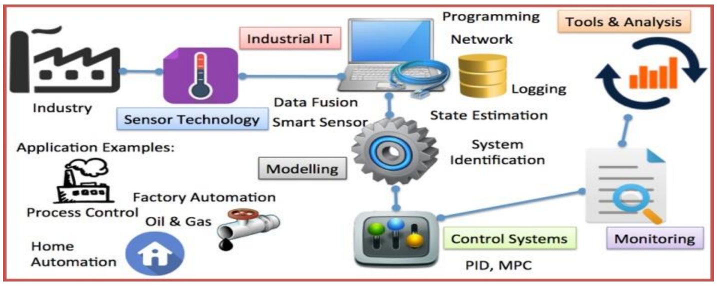


Figure 2. LabView Based Data Communications Network

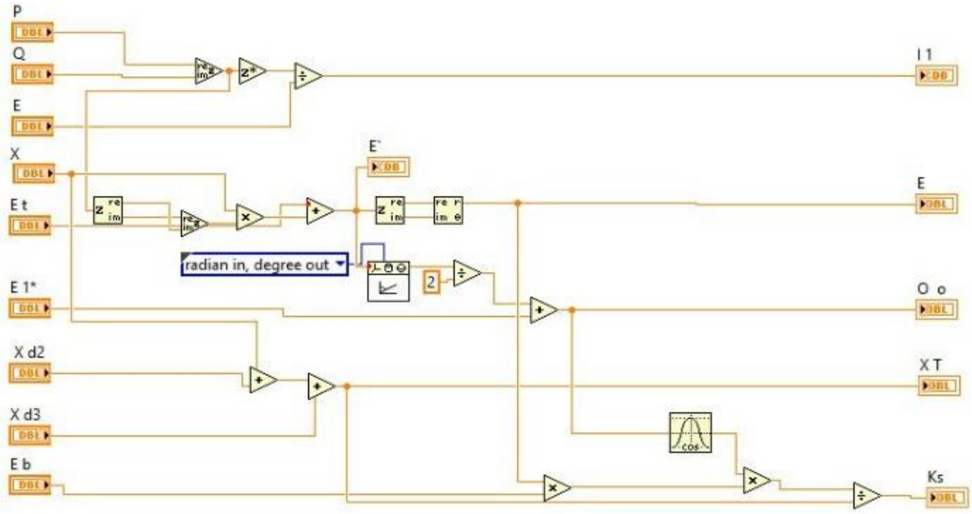


Figure 3. Power Systems Stability Calculator LabView Model

**3. Power Systems Stability**

The stability of an interconnected power system is its ability to return to normal or stable operation after having been subjected to some form of disturbance. Conversely, instability considerations have been recognized as an essential part of power system planning for a long time. With interconnected systems continually growing in size and extending over vast geographical regions, it is becoming increasingly more difficult to maintain synchronism between various parts of a power system. The voltage stability problem is now a serious concern to the electric utility industry. Electric power utilities today are facing many challenges due to ever-increasing complexity in their operation and structure. In the recent years, one of the problems that receive wide attention is the voltage instability. With an open access market, poorly scheduled generation for the competitive bidding is one of many reasons for voltage instability problem in the deregulated electricity environment. Thus, in order to relieve or at least minimize the system from the voltage instability problem many electric utilities and researchers have devoted a great deal of efforts in system studies related to static voltage stability. In the static voltage stability study, Continuation Power Flow (CPF) and optimization methods are the main analysis techniques and they are used to find voltage stability margin or loading margin (LM) of the system. Utilities and researchers are developing software based on these techniques, for the study. The CPF technique involves in solving a series of load flow calculation with predictor and corrector steps. The optimization technique involves in solving equations of necessary conditions based on an objective function and constraints. Many large interconnected power systems are experiencing abnormally high or low voltages and voltage collapse. These voltage problems are associated with the increased load of transmission lines, insufficient local reactive supply, and the shipping of power across long distances. The heart of the voltage stability problem is the voltage drop that occurs when the power system experiences a heavy load, and one serious type of voltage instability is voltage collapse. Voltage collapse is characterized by an initial slow progressive decline in the voltage magnitude of the power system buses and a final rapid decline in the voltage magnitude. Today's complex, large scale power systems require highly sophisticated techniques for monitoring and control to maintain the system in a secure and reliable state. There is a constant need to update information about the system to be used for security and stability assessment, load frequency control and a host of other purposes. The steady state stability is basically concerned with the determination of the upper limit of machine loadings before losing synchronism, provided the loading is increased gradually.

The Dynamic instability is more probable than steady state instability, small disturbances are continually occurring in s power system which are small enough not to cause the system to lose synchronism but do excite the system into the state of natural oscillations. The transient stability limit is almost always lower than the steady state limit, location and, magnitude of disturbance. This indicates the need for automating the power systems stability calculations and developing a power systems stability estimation in a good platform is essential. LabView is a powerful tool to create a calculator model for power systems stability analysis [8].

## 4. LabVIEW Based Power Systems Stability Calculator Model

In this proposed LabVIEW based power systems stability estimation model, initially the real time power system data obtained as input. After collecting the data, the block diagram panel will be used to design the power systems stability estimation model [7] as shown in Figure 3. Based on the power angle equations certain simpled assumptions are made such as Mechanical power input to the machine remains constant during the period of electromechanical transient of interest. In other words, it means that the effect of the turbine governing loop is ignored, being much slower than the speed of the transient. Rotor speed changes are insignificant. Effect of voltage regulating loop during the transient is ignored, as a consequence the generated machine emf remains constant. The main objective of the estimator is to determine the power angle to determine the steady state stability of the synchronous machine in a power system network. Before finding out the power angle of the proposed power plants in a power system network damping coefficient, synchronizing coefficient, eigen values, damped frequency of oscillations, damping ratio, undamped natural frequency. After finding the above factors the estimator need to find the time response of a synchronous machine with suitable eigen vectors and participation matrix for a specific power plants. The proposed estimation model is implemented such that any new algorithms can be implemented in a LabVIEW environment without much difficulty. Since the problem of power systems stability is to keep the load angle of the inter connected power system network within the safe operating limits for the various types of disturbances. Since the electrical load and disturbance is highly dynamic and variable, the input data for the proposed model has been designed with a high variable range as shown in Figure 4.

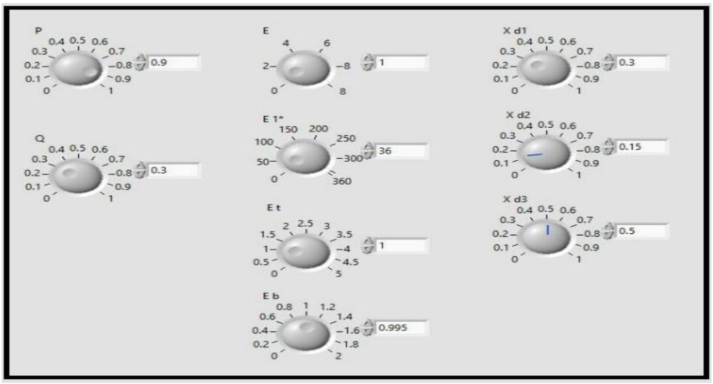


Figure 4. Power Systems Stability Solution Calculator Input

### 4.1. Step by Step Developmental Procedure for Power Systems Stability Calculator [10]

Implementation of power systems stability of the LabView platform is needed to the following steps to follow while implementing the model in a stand alone system [12].

1. The measurement input data are given as a input to the power systems stability estimation design to calculate the measurement vector.
2. A boolean push button tool used here to calculate power angle ∂. Then the calculated value is taken for further calculations.
3. For the calculated ∂ value, and the given measurement data for without error case, the new state measurement vector fuction was found.
4. Based on the measurement data, new ∂ values were found for without error case. For error considering case, similarly the measurement data are converted to P.U values and the measurement vector function was formed.
5. Similarly the different measurement vector functions are found for different values in the next and then the power flow values were also found and it has been shown in Figure 5.

## 5. Results

A simple power systems stability estimation model has been implemented by using LabView. The result was shown in Figure 5. The Figure 3 gives the power systems stability solution for the power system network in the LabVIEW window. The inputs are fed in the front panel of LabVIEW and the power systems stability runs automatically. Finally the power systems stability solution displays the output [9] on the front panel as shown in Figure 5. Using these approach different methods of power systems stability analysis can be done for different numbers of bus system for three phase power system. This innovative model is very useful and handy for power engineers for calculating power systems stability calculation. Proposed work has been developed such that different versions of power systems stability algorithms can be implemented for power systems stability calculations.

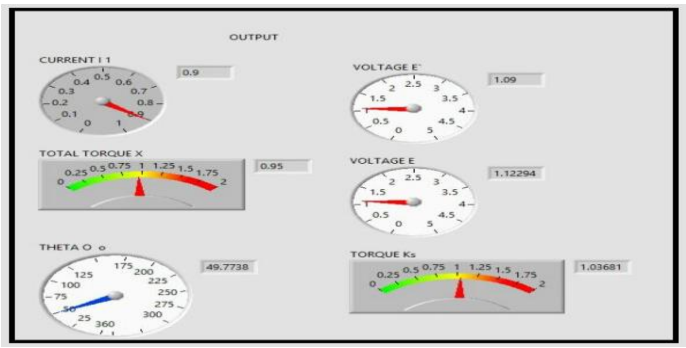


Figure 5. Power Systems Stability Solution Calculator Output

## 6. Conclusion

An effective LabVIEW based power systems stability estimation model has been developed for a power system network. In this model, the power systems stability solutions were obtained to determine the load angle of the multi-machine power systems in a state state condition. This model has been developed such that any recent algorithms of power systems stability can be implemented without any reservations. The virtual power systems stability model has been implemented model in LabView will be useful to the electrical engineers. Accordingly the proposed model can be implemented in multi-area power system network [9]. A viable execution of this methodology proposed in this paper was implemented for 9, 13 and 15 bus test systems. In like manner the proposed model can be executed for extensive power system network spread over geologically separated. As future scope the entire power system analysis, such as contingency analysis, transient stability, fault analysis etc., can be implemented in a LabVIEW based environment.

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