Voltage control of 20kv power distribution network feeder system using MPC for energy efficiency

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Abstract

In this paper, applying of model-based predictive control (MPC) method to 20kv power distribution network feeder system will be considered and compared, as comparing with suggested method has better and desired control performance. Today's energy conservation is the important for modern countries. Therefore this subject should state in first priority for develop. The several methods suggested for achieving to better performance but we should select the way near to our sources. Advanced countries always have serious programs because attend to this cause to become powerful. Some researchers attend to write new papers about energy conservation for this reason. Energy such as oil, wind…and related equipment has the main role. Our country needs to vast plan and we should understand that energy sources are so important.

Large and nonlinear, Dynamic systems such as power systems account important challenging for analysis and modeling and identification. Various methods have appeared and developed to solve created problems such as magnitude and complex model of real power system, also consumed loads are parts of power systems, as large scale modeling is necessary appeared. MPC solution is using one estimated model of system for prediction of process future output and minimizing of quadratic goal function for construction control signal and achieving optimal control signal at each time and totally MPC say to control methods that with help model of considerable process and minimizing criteria function achieve desired control signals. At this algorithm desired trajectory equal predicted horizon determined at past, now should control signals adjust predicted output possible to desired trajectory to near.

Keywords

Energy efficiency, Power systems, Model-based Predictive Control, feeder system, Power distribution networks, Prediction horizon

Introduction

Voltage control is the main issue in distribution networks, because load increasing and distributed generation will be effective for perform this subject. In this study MPC as best solution and approach is introduced. MPC strategy is the certain and optimize algorithm for proposed case study, the 20kv power distribution network feeder system [1] is suitable and applicable therefore importance of this work will be appeared. The fact growing of electric power systems in world and finding the good approach have spread motivation for researchers and scientists to focus investigations toward this area of studies. The goal of this paper is proposed novel trend in energy conservation with selecting 20kv power system accompanying modern control strategy by bright and fabulous results. Voltage variations, power quality and protection issues are some challenging and important on distributed generation networks [2]. Novel and innovative control approach such as MPC for ensuring a proper and reliable operation of 20kv power system is necessary. This paper is organized as follows, 20kv power distribution network feeder system; the voltage control problem in distribution networks is discussed. MPC the general theory and algorithm are presented. Simulations and comparisons also illustrated. A conclusion and the future research are presented at the end of this paper.

20kv power distribution network feeder system

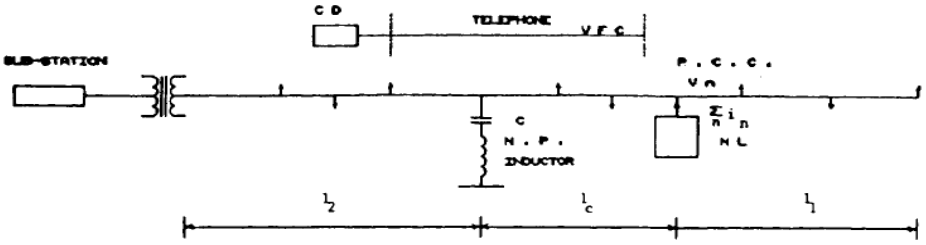
Some work at past [3] performed as solution to voltage profile, short circuit currents, protection scheme, unbalanced voltages and stability issues. Increasingly high penetrations of renewable energy resources are renewing interest in modeling power system dynamic behavior in both transmission and distribution networks. An equivalent dynamic model of a 20kv power distribution network feeder system is extremely important. A dynamic equivalent works by simplifying the complexity of the distribution network and reducing the computation time required to run a full dynamic simulation. It offers a simple and low order representation of the system without comprising distribution network dynamic characteristics and behavior as seen by the external grid [4].

Based on a typical 20 kV medium voltage distribution network configuration, a suitable network model will be proposed for the required investigations. The mathematical model of the network will be implemented using MATLAB program. A primary (110/20 kV) substation feeds a rural overhead network consisting of several feeders of many tens of kilometers length and suburban underground network containing several short feeders. Based on the simulation results, practical observations will be presented and should be considered during network planning and operation to achieve the required transient performance of the network [5].

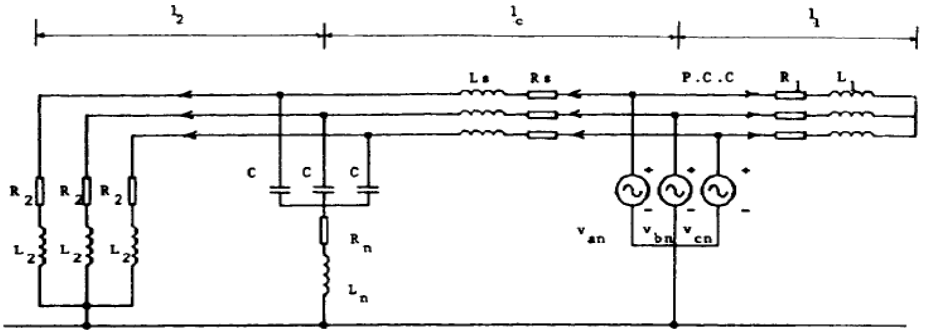
Modern power systems have an extensive electrical distribution to provide reliable power to all of the power plant. Electrical power cannot be economically stored the plants must be online to produce power when the electrical demand is present [6].

All analysis in the engineering sciences starts with the formulation of appropriate models. A model, and in power system analysis we almost invariably then mean a mathematical model, is a set of equations or relations, which appropriately describes the interactions between different quantities in the time frame studied and with the desired accuracy of a physical or engineered component or system. Hence, depending on the purpose of the analysis different models of the same physical system or components might be valid. It is recalled that the general model of a

transmission line was given by the telegraph equation, which is a partial differential equation, and by assuming stationary sinusoidal conditions the long line equations, ordinary differential equations, were obtained. By solving these equations and restricting the interest to the conditions at the ends of the lines [7].



1. Distribution feeder scheme (given R and L/mile for feeder configuration).



2. Equivalent circuit with customer loads ignored (only feeders R, L are included).

Figure1: 20kv power distribution network feeder system [1]

The model of 20kv power distribution network feeder system [1] is with below transfer function and discretize at 0.6 sampling time.

$$G(S)=\frac{84.52S^2+1.276*10^4S+5.218*10^8}{S^3+0.4199S^2+0.06028S+0.09802} \quad (1)$$

$$T_S=0.6$$

$$G(z)=\frac{1.764*10^7*z^2+6.626*10^7z+1.555*10^7}{z^3-2.748z^2+2.544z-0.7773} \quad (2)$$

Model-based Predictive Control (MPC)

Aim of control is controller designing with various strategies as system output under control behaves same reference output system. Almost control problems in industries are nonlinear and some control variables. MPC or receding horizon control is form of control that current control command in each sampling time with solving limited horizon open loop optimal control problem obtained and using process current state such as primary state, optimization result of optimal control sequence and primary control in this sequence apply to process. Main differences with ordinary control is using of pre estimation of control law. MPC controller output for next or future calculated as plant predicted output possibly near to desire path that usually practically is filtered input reference path. MPC usually as constrained MPC introduced and is model based on control method that rarely with popularity in industry state in very attention as by on line optimization of future path performed. Especially in each sampling time start of state same time with open loop optimal control problem on limited horizon solved. MPC submit good structure of theoretical base for guaranteeing stability and feasibility also is only progressive control methodology that exist

essential application in industrial control problems and nearly main success due to unique ability for simple and effective applying hard constrained on state and control variables. Also, MPC is based on ordinary optimal control that by minimization or minimization/maximization of some performance criteria for fixed limited horizon or unlimited horizon obtained [8].
MPC is effective control algorithms that broadly use in chemical process industries, as in each sampling time MPC from process model estimation for solving open loop optimization problem. Also in performance optimal control calculated but only first calculated input apply to plant, because obtained model is only estimation of real process model. Several important applications in distillation tower, paper producing factory, servo mechanism, robot arms is observable [9].

Simulations and comparisons

The simulation results with MATLAB software have below case study matrices.

$$A=\begin{bmatrix} 0.6997 & 2.0511 & 0.4529 \\ 0 & 1.0244 & 1 \\ 0 & -0.0616 & 1.0244 \end{bmatrix}$$

$$B=10^3*\begin{bmatrix} 0 \\ 0 \\ 8.8214 \end{bmatrix}$$

$$C=10^3*\begin{bmatrix} 4.2001 & 9.0565 & 1.9996 \end{bmatrix}$$

$$D=\begin{bmatrix} 0 \end{bmatrix}$$

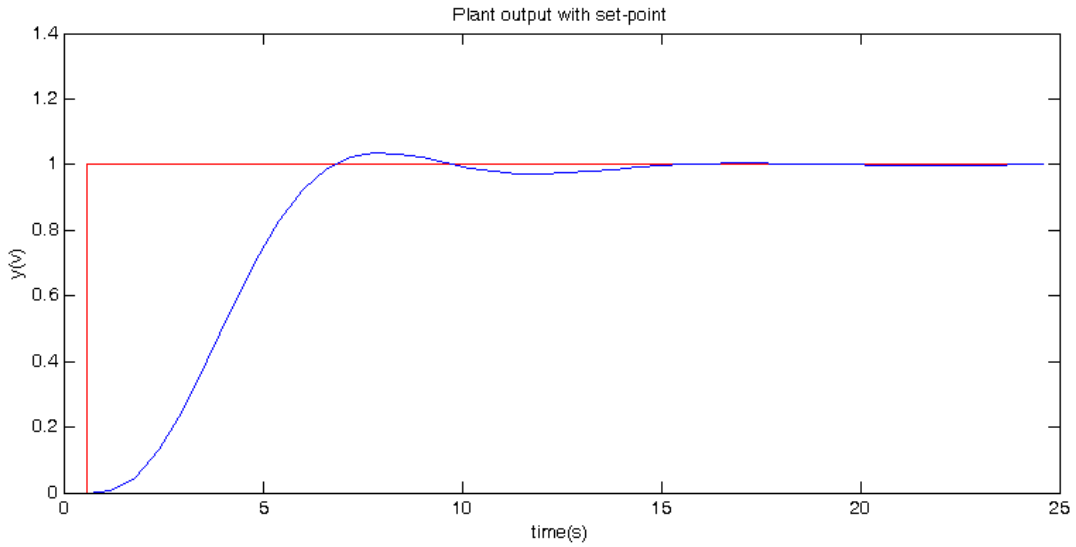


Figure2: 20kv power distribution network feeder system output with set-point

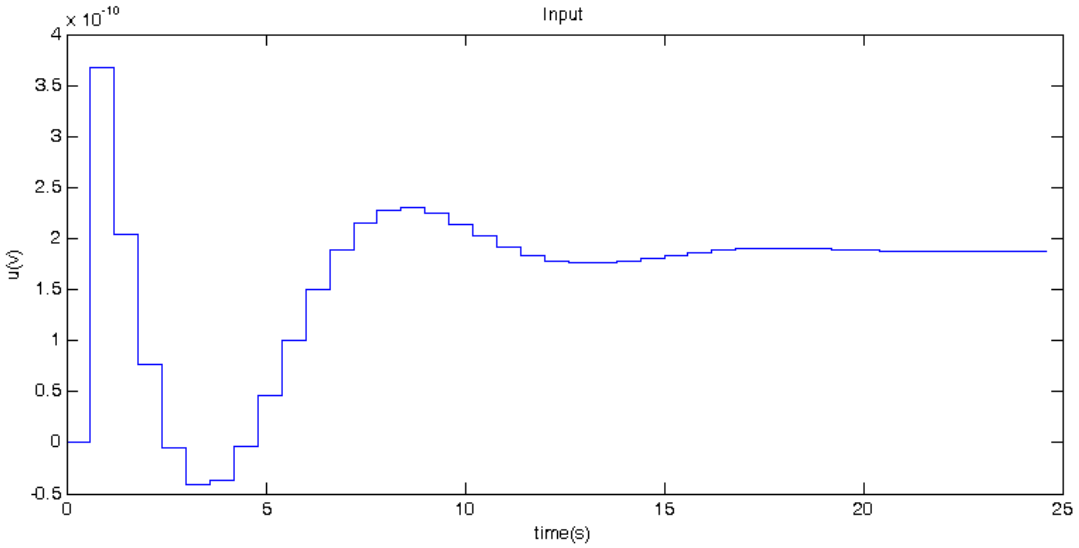


Figure3: 20kv power distribution network feeder system input

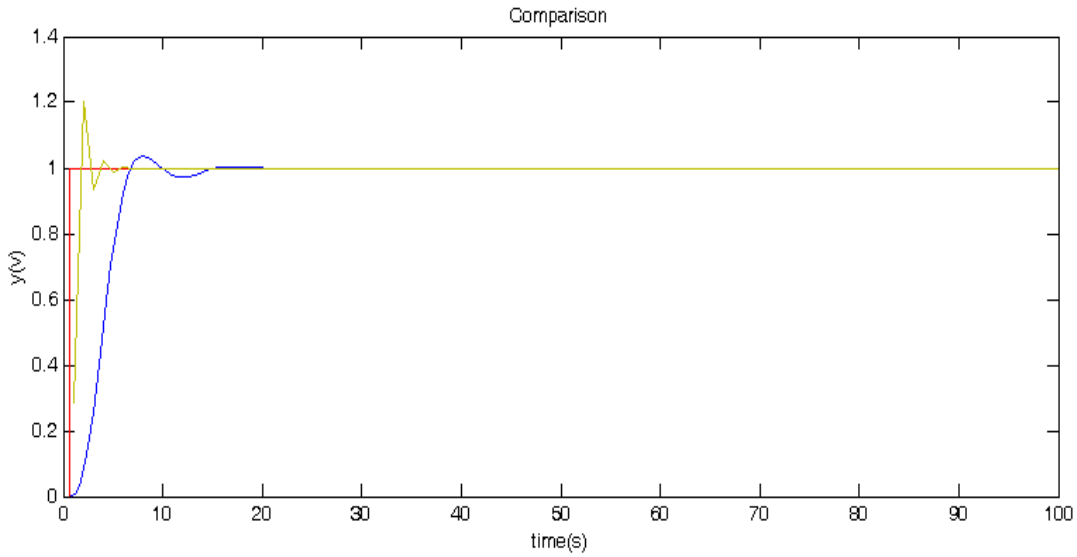


Figure4: 20kv power distribution network feeder system comparison

Conclusions and recommendations

In this paper strongly voltage control of 20kv power distribution network feeder system using MPC for energy efficiency considered. This study shows finally the importance to manage the distribution network with ensuring energy efficiency by MPC. Two approach of MPC implemented to 20kv power distribution network feeder system. Voltage control is the main issue in distribution networks, because load increasing and distributed generation will be effective for perform this subject. Novel and innovative control approach such as MPC for ensuring a proper and reliable operation of 20kv power system is necessary. Modern power systems have an extensive electrical distribution to provide reliable power to all of the power plant. All analysis in the engineering sciences starts with the formulation of appropriate models. A model, and in power system analysis we almost invariably then mean a mathematical model, is a set of equations or relations, which appropriately describes the interactions between different quantities in the time frame studied and with the desired accuracy of a physical or engineered component or system. The model of 20kv power distribution network feeder system with related transfer function considered.

Aim of control is controller designing with various strategies as system output under control behaves same reference output system. Almost control problems in industries are nonlinear and some control variables. MPC is effective control algorithms that broadly use in chemical process industries, as in each sampling time MPC from process model estimation for solving open loop optimization problem. Also in performance optimal control calculated but only first calculated input apply to plant, because obtained model is only estimation of real process model. I offer to other researcher to study robust MPC or other approaches for power systems due to main importance of such systems and controls.

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