Simulation Analysis of Adaptive Inverse Control for Power Conditioning in Microgrid

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Abstract— In this paper, introduces flat rotation transformation, an improved droop control and droop coefficient selection method, to enhance the operation of an LV micro grid. In addition, this paper proposes a novel power conditioning method based on adaptive inverse control to mitigate frequency deviation caused by the use of fixed droop coefficient. The proposed control method can dynamically and effectively balance power in the micro grid while maintaining frequency at the rated value.

Key words: Micro-grid, Adaptive Controller, Frequency Deviation

I. Introduction

A small scale system and located near the consumer is called the Micro-Grid (MG) system. The interconnection of small generation to low voltage distribution systems can be termed as the Micro Grid. Micro Grids can be operated with and without a connection to the main power network. Small Capacity Hydro Units, Ocean Energy and Biogas Plants, wind, diesel-generation, PV, energy storage etc are the various energy resources in MG for electrification of areas mainly rural areas where there is no possible access to grid electricity due to poor

Access of remote areas to technical skills. The micro grid has to be designed in such a manner so that there is ease in installation, commissioning, operation and maintenances. The micro grid helps in reducing the Expenditure by reducing network congestion &line losses and line costs and there by higher energy efficiency [1] - [3].

II. Microgrid

Basically a micro-grid involves the integration of multiple distributed energy collection sources; the electricity from these sources is gathered, processed and distributed to meet the demand loads. When power electronics interfaces with micro energy forming a single entity, its operation requires a control system. Such a control system is needed, not only to provide flexibility, but also to preserve the specific energy output and the power quality

In recent years, the concept has gotten more interesting where the grouping of an arrangement of loads forming a cluster, together with parallel DG units, constitute what is known as a micro-grid. Small generators can be incorporated into the power system, like in the traditional method where a small generator unit was aimed to reduce the impact of grid operation in each interconnected micro source. For an outage in the grid network due to an error detected in the utility grid, it will systematically affect and shut down the generator units, compared to a micro-grid when the grid network is off, the power shuts down, the micro-grid will systematically disconnect from the grid network and operates independently in providing power to its local load when the utility is back to normal. The schematic diagram of micro-grid power system is shown in Figure 1.

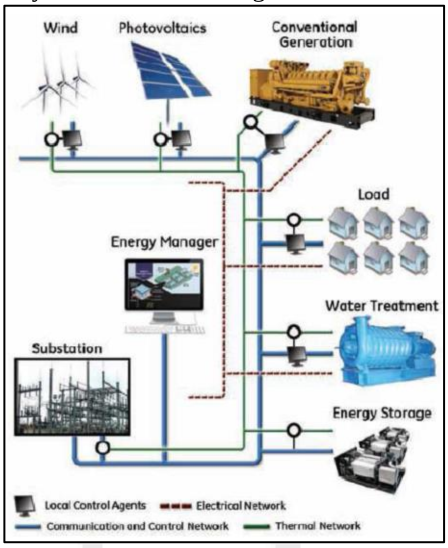


Fig. 1: Micro-grid power system

Protection system is one of the major challenges for micro-grid which must react to both main grid and micro-grid faults.

The structure of micro-grid consists of five major components. These are micro sources (power sources), loads, storage devices, control systems and the point of common coupling. These five components are connected to a low voltage distribution network.

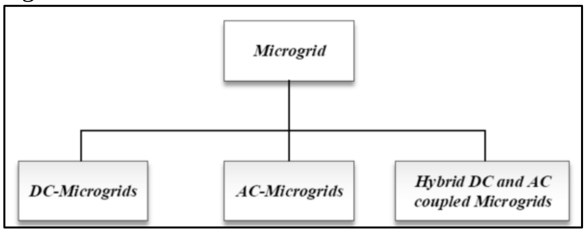


Fig. 2: Types of the micro-grid based power type

Figure 2 represents different types of the micro-grid. Micro-grid loads can be either sensitive or non-sensitive loads, and furthermore, each type of load can be either an electrical or a thermal load. The micro-grid control system makes sure that the ensemble of control tasks is achieved. AC micro-grids may be associated with smart meters, communications and remote controls; these elements will form the basis of future smart grids.

The balance between the power generated and the demand for power can be related to the frequency in the power system. However, this frequency may be subjected to some variation due to the load variation. More frequency deviation occurs from the imbalance of the power, due to several factors such as power plant outages, and line-tripping registration. Therefore, frequency regulation is necessary for the stabilization of the power system.

III. MICROGRID CONTROL METHODS

Micro-grid control includes two terms that are a coordinated (or energy management) and a local control [1]. There has been a great amount of research into different aspects of microgrid control and operation. These aspects include planning and scheduling, DG placement, protection and safety, fault control, cost optimization, renewable energy resources selection and integration, storage systems, combined heat and power (CHP) functionality, resource allocation, economic optimization, voltage profile improvements, etc. A micro-grid is in many aspects different from a conventional grid. A micro-grid covers a smaller geographical area and uses distributed components instead of central components. The power ratings of the sources and loads and the voltage levels are lower in a micro-grid.

Since micro-grids consist of VSI-based distributed generators operating in parallel, the droop control approach has been the most popular choice of control approach so far. The effect of unbalanced and nonlinear load conditions, as well as sudden and random load switching incidents on the terminal voltage of a DER system in islanded mode operation of a micro-grid system is addressed.

If precise knowledge of the plant dynamics is available to the control designer, then adaptive control can be accomplished for the system in Figure 2. The concept of an adaptive-controller design-process then reduces to a computer-aided-control-system-design (CACSD) tool to automatically generate a controller C to meet various design specifications.

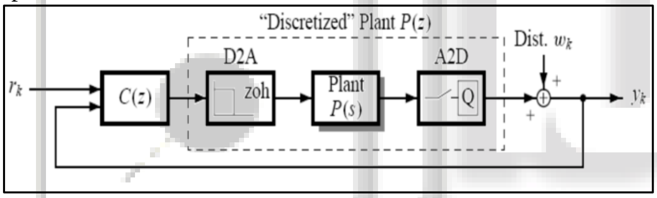
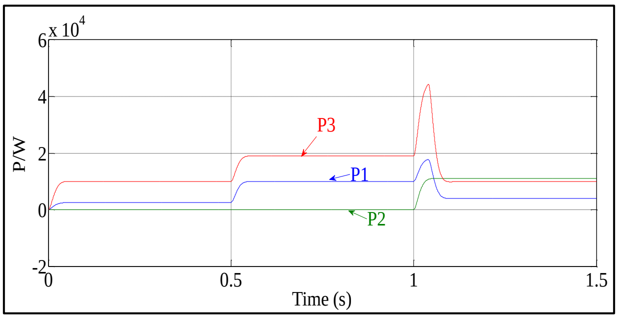


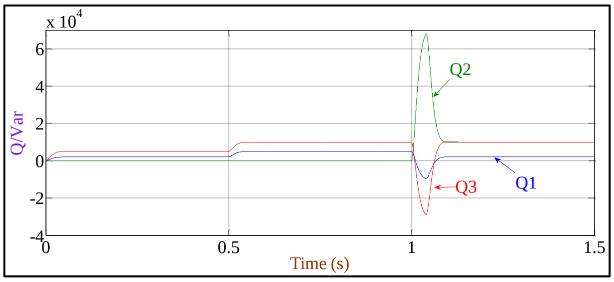
Fig. 2: Digital control system modified

IV. SIMULATION RESULT ANALYSIS

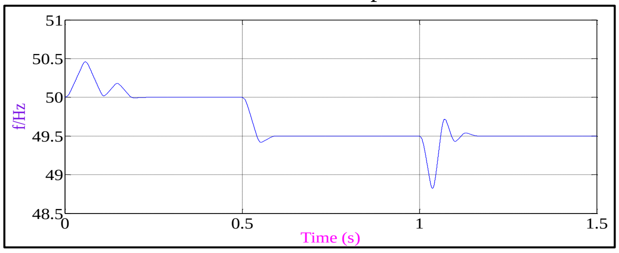
As is seen in Figure 3(a), when using conventional droop control method, the output power distribution is unreasonable. Then putting micro source 2 on at 1.0 s, the output active power and of micro sources has a large transient dynamic response, in other words, the dynamic response characteristic is bad. Figure 3(b) shows that output reactive power and are negative and micro sources begin to absorb the reactive power, so the reactive circulating-current occurs when micro source 2 is connected to the micro grid. As is seen in Figure 3(c), the system frequency fluctuates badly because of the sudden load increases at s and the access of micro source 2 at 1.0 s.



Active power output

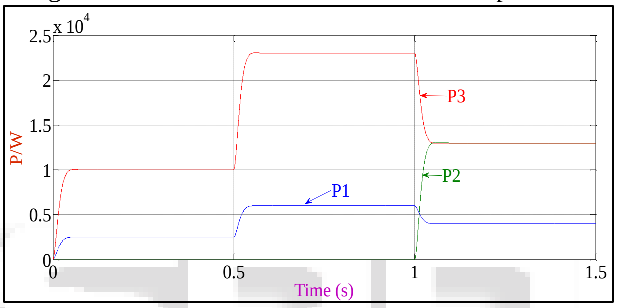


Curves of conventional droop control method

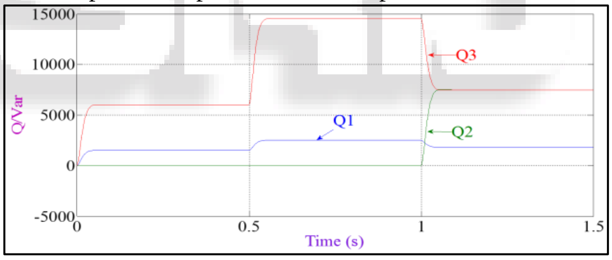


Frequency variation curve of the conventional droop control method

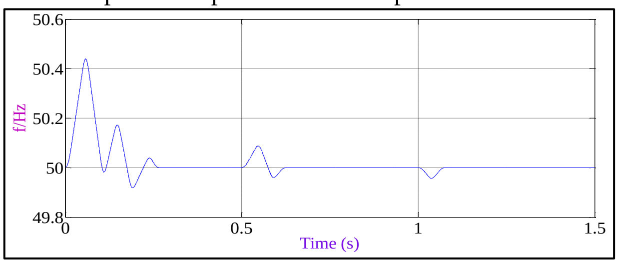
Fig. 3: Simulation curves of traditional droop control



Active power output curves of adaptive inverse control



Reactive power output curves of adaptive inverse control



Frequency variation curve of adaptive inverse control

Fig. 4: Frequency variation of adaptive inverse control

As can be seen in Figure 4(a), when using active power conditioning based on adaptive inverse control, micro source can make a reasonable distribution of load according to the dynamic variation of active power frequency droop coefficients

V. CONCLUSION

In this paper, Conventional droop control has fixed droop coefficients; it will cause frequency deviation and so that it cannot guarantee the output frequency. In this thesis proposes adaptive inverse control based power conditioning method. Simulation results show that this method can dynamically adjust the weight coefficients of digital filters online and in real time, validate zero-error frequency regulation. Moreover, it provides a strong assurance to the constant operation of the micro-grid.

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