

State Orient Power Adaption and Switching Model for Remote Monitoring Systems

¹Dr. Priya Vij, and ²Divya

^{1,2}*Associate Professor, Department of CS & IT, Kalinga University, Naya Raipur, Chhattisgarh, India.*

Abstract: The problem of power adaption in remote monitoring system is well studied. There exists number of approaches to handle the problem. However, they suffer to achieve higher performance in power adaption and switching. To handle this issue, an efficient State orient Power Adaption and Switching Model (SPASM) is presented to support remote monitoring systems. The model monitors the power supply to the remote monitoring system at all the time. Whenever, there is deflection in the input power supply, then the model performs power adaption according to the state of input voltage. The method computes Power Adaption Rate (PAR) for the input voltage and checks the required voltage for the remote monitoring system. Based on the PAR value and the required voltage, the method decide the state of the system and perform power adaption accordingly. As the remote monitoring system needs uninterrupted power supply, the method computes the PAR value at all the time interval and switches the voltage and source towards efficient remote monitoring. The selection of power source is performed by computing Power Switching Support (PSS) for different sources available and optimal source is selected to feed the power supply for the remote monitoring system.

Keywords: Power Adaption, Switching, SPASM, PAR, PSS, remote monitoring.

1. Introduction:

The electric power is the most dominant and precious one in the real world conditions. As the electricity is produced from limited sources which are more scarcity, it must be used in most efficient way. Also, the cost of power generation has been increased due to various reasons. All these encourages the power distribution units to regulate the electric power, with more concern. The electric power produced by the power distribution units are used to support the functioning of various electrical systems. The remote monitoring systems are the one which has been supported by the power distribution systems.

¹ku.priyavij@kalingauniversity.ac.in

²ku.divya@kalingauniversity.ac.in

The remote monitoring systems are used to monitor various activities in any real world environment. For example, it has been used to monitor the activities happening in any industry for security reasons. Similarly, it has been used in medical sector, to support monitoring the health of patients and update the data to some remote server. Similarly, remote monitoring systems are used to monitor variety of activities in any industry or organization.

The remote monitoring systems require uninterrupted power supply which must be continuously working. To perform such operation, the power supply from the normal source is not enough and there should be set of backup supply required to support the system. For example consider a photovoltaic system attached to the RMS, which produces certain volts of power to support the RMS, but in most timing, the power produced by the PV system and the routine power supply would not be efficient to feed the RMS. So, adaption of different power supply is necessary and the system should be switched between various power supplies to perform continuous monitoring.

There exist number of approaches towards switching power supply between different sources. However, they suffer to achieve higher performance in power regulation and switching. By considering all these, an efficient State Orient Power Adaption and Switching Model (SPASM) is presented in this article. The proposed state orient power adaption and switching model monitor the incoming voltage from different sources. With the voltage received, the method computes the value of power adaption rate (PAR) for various sources like regular source and other sources. If the PAR of the regular source is not up to the level then the method computes the Power switching support (PSS) for the other sources. Based on the value of PSS, the method perform switching and adapt the source for the RMS. The detailed working of the model is presented in the next section.

2. Related Works:

There exist number of approaches around the problem of power adaption and switching in power systems. This chapter presents set of methods related to the problem.

A dual digital signal processor (DSP) controller is presented in [1], which is suitable for unified power quality regulators and designs high-power-density switching power supply control system for promoting green environment.

The power plant electrical automation monitoring system utilizing CAN bus technology, as discussed in [2], played a crucial role in enhancing the operational monitoring capabilities and management efficiency of power plant electrical equipment.

The article in [3] introduces a novel adaptive switching control technique that integrates with a nonlinear system to address the intricate operating scenarios of the grid-connected power system.

he publication in [4] introduces a stochastic epidemic model incorporating a Markov process and delay, offering a broader scope than numerous existing models in the field. Furthermore, we present the stochastic threshold indicating the eradication of the illness.

The end-to-end remote monitoring platform based on the IEEE 11073 standards is presented in [5], which supports personal health devices (PHD).

In [6], a remote management system utilizing LoRa technology is introduced, which incorporates a fuzzy logic judgment system (FLJS) and replaces Boolean logic with fuzzy logic. This system addresses various power quality issues such as power factors, load-side current harmonics, voltage unbalance, as well as grid-side voltage deviation and unbalance.

A asynchronous distributed interval filtering scheme is presented in [7], which work for discrete-time positive Markov jump linear systems (MJLSs) with bounded disturbance under the denial-of-service attack.

In [8], a scheme for controlling a remote group is presented, which was specifically designed and implemented for the thermal environment of rockets. The main power components of the system consist of 108 sets of AC-DC conversion power electronic devices. The communication protocol used is Ethernet Modbus TCP/IP, and the execution terminal utilizes configuration software WinCC and S7-200 Smart PLC.

A remote control system is presented in [9], to support distribution network which dictates where and how to install and implement communication with respect to lowering customer interruption cost and reliability indices.

Extended electromagnetic transients program (EMTP) based transient behavior analysis model is presented in [10], which support the generation of restoration sequences in distribution systems.

In [11], a markov model is introduced that outlines the overall state-transition diagrams of safeguarded components and relays within a protection/component system. This model takes into consideration various factors such as monitoring, self-checking, routine tests, common-cause failures, human error, operation of back-up protection, relay failure to operations, and relay mal-trips.

In [12], a novel approach is introduced for ecological big data adaptive switching compression. This method utilizes a 1D convolutional neural network (1D CNN) to classify data samples into two distinct sets based on their characteristics. By doing so, the method ensures that the samples are appropriately assigned to different compression dictionaries. Afterwards, the switching factor S is determined according to the classification outcomes. This enables the utilization of the discrete cosine transform (DCT) predefined dictionary and the learning dictionary (K-SVD) to dynamically achieve sparse representation and compress the data.

A stochastic algorithm is presented in [13] towards managing power supply in IoT enabled grids. The method uses the social spider algorithm (SSA) for the classification and optimization.

An adaptable, cost-effective, and versatile system is introduced in reference [14] for managing smart home functions and monitoring the environment. The system utilizes an embedded micro web server powered by an Arduino Yún microcontroller, enabling remote device control through Internet connectivity. The Internet-based mobile application for Android devices allows users to control the proposed system remotely.

3. State orient Power Adaption and Switching Model (SPASM):

The model monitors the power supply to the remote monitoring system at all the time. Whenever, there is deflection in the input power supply, and then the model performs power adaption according to the state of input voltage. The method computes Power Adaption Rate (PAR) for the input voltage and checks the required voltage for the remote monitoring system. Based on the PAR value and the required voltage, the method decides the state of the system and performs power adaption accordingly [15]. As the remote monitoring system needs uninterrupted power supply, the method computes the PAR value at all the time interval and switches the voltage and source towards efficient remote monitoring. The selection of power source is performed by computing Power Switching Support (PSS) for different sources available and optimal source is selected to feed the power supply for the remote monitoring system [16].

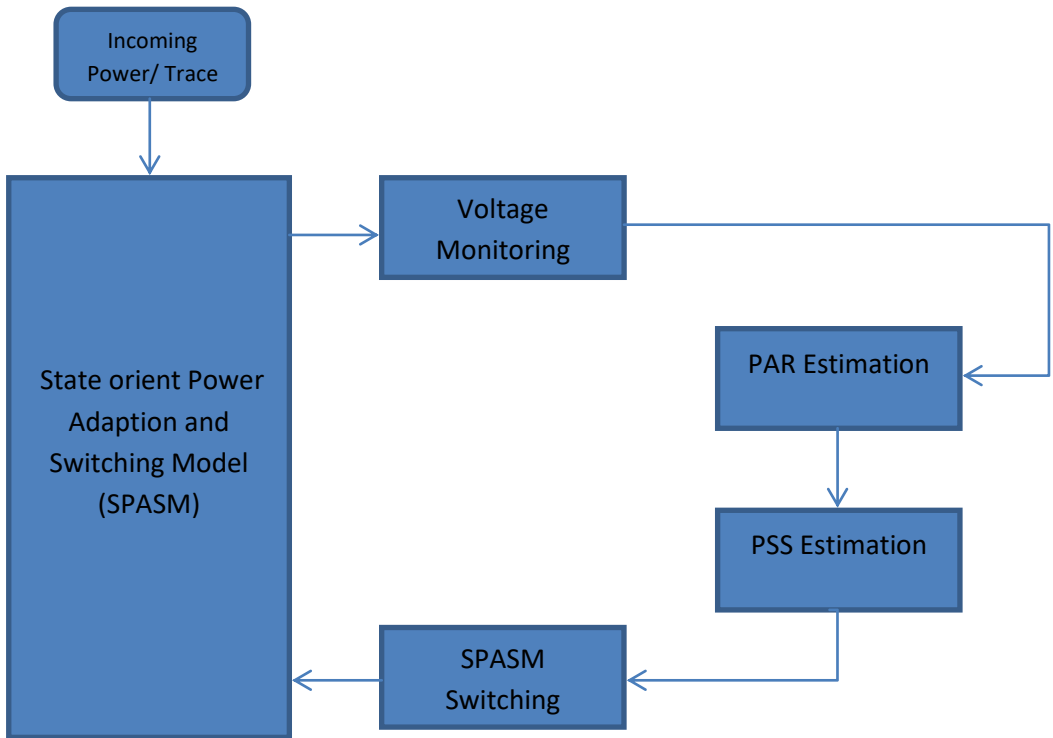


Figure 1: Architecture of proposed SPASM switching model

The architecture of proposed SPASM switching model is presented in Figure 1, where the functions of the model have been detailed in this section.

Voltage Monitoring:

The voltage monitoring scheme always reads the incoming voltage from various sources for the power distribution system. Accordingly, the method computes the power adaption rate (PAR) for the source being used for the remote monitoring system. If the value of PAR is below specific threshold, then it performs PSS estimation for various other sources. Estimated value of PSS has been given to the switching module to perform switching [17].

Algorithm:

Given: Input Voltage I_v

Obtain: Null

Start

 Read input voltage i_v .

 Identify set of sources $S_s = \sum_{i=1}^{size(D_s)} D_s(i).Source$

 While true

 Compute PAR value for primary source.

 PAR = Perform PAR Estimation.

 If $PAR < Th$ then

 For each source s

 Compute Power switching support PSS.

 PSS = perform PSS Estimation.

 End

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Source s = Choose the source with maximum PSS.
Perform SPASM Switching.
Else
    Allow primary source to support.
    Allow other source to charge.
End
End
Stop

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The voltage monitoring reads the incoming voltage from primary source of the remote monitoring system. Based on the input voltage, the method computes the value of PAR and based on that the method computes the PSS value for various sources to perform SPASM switching.

PAR Estimation:

The power adaption rate (PAR) is the measure which represents the suitability of the source towards providing required voltage for the remote monitoring system. It has been measured according to the input voltage received from the source or the residual voltage of a source, and the required voltage of the remote monitoring system. If the remote monitoring system has number of components and electric devices to be run, then the overall voltage has been counted to measure the required voltage. Based on these two factors, the method computes the value of PAR as follows:

$$PAR = \frac{Iv}{VR} \times \mu$$

Where VR- voltage required by the monitoring system and Iv is the residual or input voltage of the source.

PSS Estimation:

The power switching support is the measure which represents the suitability of the source in providing required voltage for the running of all components of the RMS. It has been measured based on the overall voltage required by all the units of the RMS and the available voltage in the source. It has been measured as follows:

$$PSS = \sum_{i=1}^{size(Ms)} Ms(i).Vr - \left(\frac{Rv(s)}{VR} \times \mu\right)$$

Where MS is the monitoring system and Rv is the residual voltage of any source s.

SPASM Switching:

The state orient power adaption and switching algorithm reads the set of sources and their power switching support measured in the previous stage. Accordingly, the method identifies the most valued source which can support the RMS in efficient way. Identified source has been switched to discharge mode and the rest are switched to charging mode.

Algorithm:

Given: Source Set ss, Rms set Rmss

Obtain: Null

Start

Read ss, Rmss.

$size(ss)$

Source s = $Max(ss(i).Rms)$

$i = 1$

Trigger s to discharge mode.

Trigger other sources to charging mode.

Stop

The SPASM model schedules the sources into charging and discharge mode according to the state of the resource and RMS.

4. Results and Discussion:

The proposed state orient power adaption and switching model (SPASM) has been implemented with Simulink. The performance of the model has been evaluated under various parameters and presented in this section.

Parameter	Value
Tool Used	Simulink
No of sources	100
Time	10 minutes

Table 1: Experimental Details

The experimental details used towards performance analysis are presented in table 1.

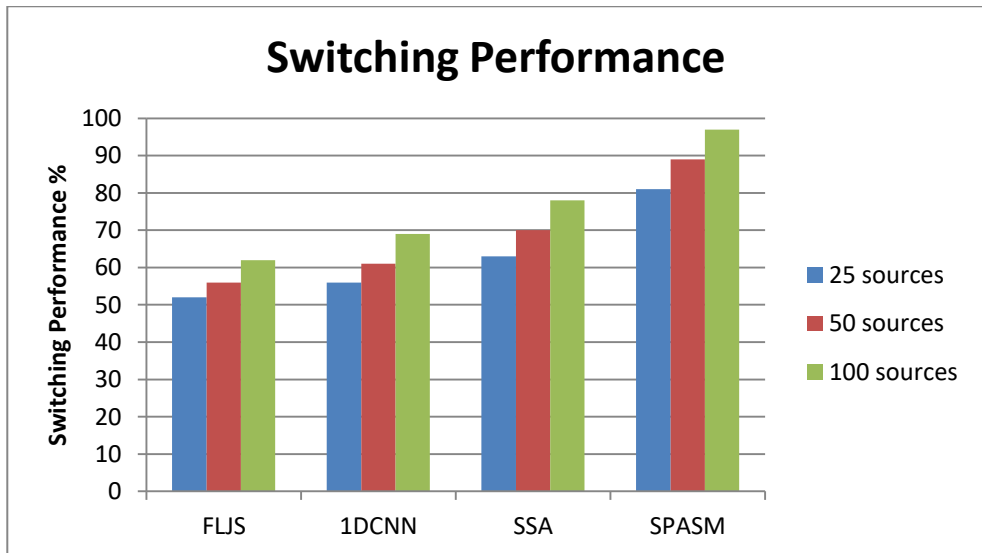


Figure 2: Switching Performance

The performance of method in source switching is measured and presented in Figure 2. The SPASM model introduces higher performance than others.

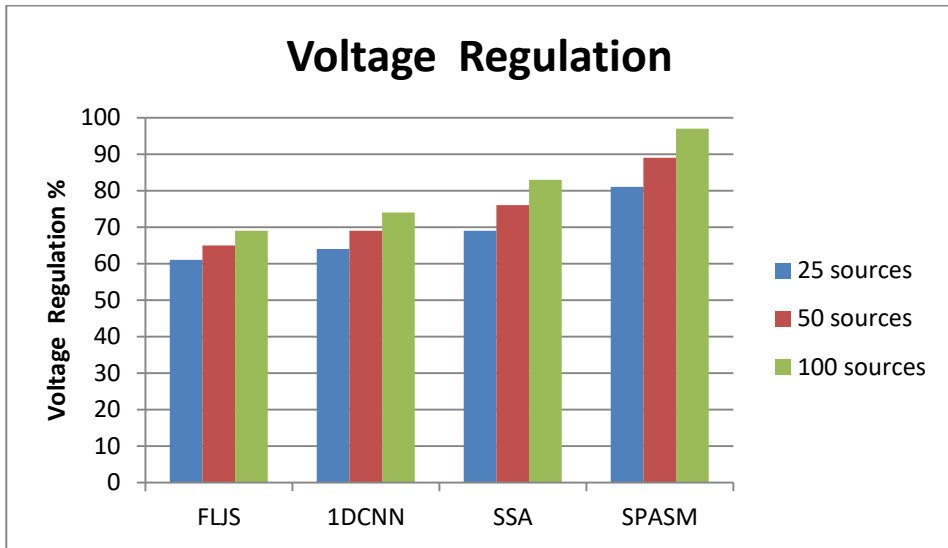


Figure 2: Voltage Regulation Performance

The performance of methods in voltage regulation is measured and presented in Figure 3. The proposed SPASM method produces higher voltage regulation performance than others.

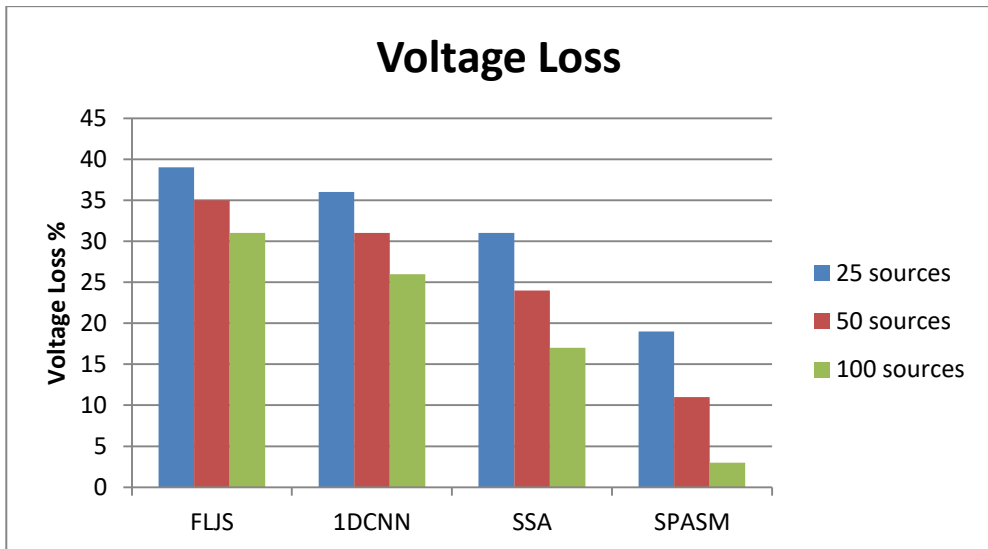


Figure 4: Voltage Loss

The voltage loss introduced by various models is measured and compared in Figure 4. The SPASM model introduces less voltage loss than other models.

5. Conclusion:

This paper presented a novel state orient power adaption and switching model (SPASM). The model monitors the power supply to the remote monitoring system at all the time. Whenever, there is deflection in the input power supply, and then the model performs power adaption according to the state of input voltage. The method computes Power

Adaption Rate (PAR) for the input voltage and checks the required voltage for the remote monitoring system. Based on the PAR value and the required voltage, the method decides the state of the system and performs power adaption accordingly. As the remote monitoring system needs uninterrupted power supply, the method computes the PAR value at all the time interval and switches the voltage and source towards efficient remote monitoring. The selection of power source is performed by computing Power Switching Support (PSS) for different sources available and optimal source is selected to feed the power supply for the remote monitoring system. The method improves the performance of switching and voltage regulation with less voltage loss.

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