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Oral Discussions on Session: "Managing Uncertainty in Power Systems" – Part II

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Chair: Göran Andersson (ETH)

Abstract

This paper contains the second part of the transcribed oral discussions of Session "Managing Uncertainty in Power Systems" of the 2013 IREP Symposium-Bulk Power System Dynamics and Control, held on Thursday afternoon, August 29, 2013. Papers [1]-[3] were presented. After the Symposium, the written discussion [4] was submitted, to which authors responded by the closures [5], [6].

Discussion

Chair: The floor is open for discussion.

Costas Vournas (NTUA): A question for Dimitra Apostolopoulou [3]. I think that as an Illinois student you should look at the literature, where there is quasi-steady state approximation for secondary frequency control, or AGC, where you assume a common frequency for the whole system. So again you have full detail for the generating units as far as their generated power is concerned, so you can include your model for the wind, but you get rid of the electromechanical oscillations between machines. So I guess for using probabilistic approach, you could get maybe easier and perhaps more interesting results.

Dimitra Apostolopoulou (University of Illinois): Thank you very much. We are going to look into that.

Anthony Papavasiliou (Catholic University of Louvain): Also a question for Dimitra. I am not sure I got the comparison between Dynkin's formula and Monte Carlo. Dynkin will give you closed form expressions for mean variances and most things you would like to compute. And then for Monte Carlo, you maintain the assumption of the Wiener process for the wind speed?

D. Apostolopoulou: We run Monte Carlo simulations, where the wind is driven by a Wiener process. We do so by using the fact that the Wiener process is the integral of a Gaussian white noise process.

A. Papavasiliou: So you maintain the assumption. My experience with wind data, at least daily wind data, from hour-to-hour, is that that's quite a bad model. So do you have access to actual data, wind speed data in the time resolution that you want and would you be able to test your models through Monte Carlo simulations, but against field data of wind speed?

D. Apostolopoulou: That's a good idea. I don't think we have available data, but that would be good, to find actual data and run the simulations and do it in the reverse order, construct our dynamical model from data…

A. Papavasiliou: I can see how this process better approximates the wind speed for short time scales, like you are doing, but for daily or hourly resolution it's not so. That was all.

D. Apostolopoulou: Thank you.

Bernie Lesieutre (University of Wisconsin): A couple of questions, one for the second paper [2] and one for the third paper [3]. I will do the third paper first since it is already being discussed. It's interesting to see you map things through AGC and all the responses to AGC. It's also used not just for generation control, but also for monitoring the reliability of the grid and in fact enforcing penalties. So have you considered taking this analysis and applying it to that regard? What is the probability that you will be penalized for exceeding the CPS2 requirement that uses AGC as input?

D. Apostolopoulou: That is what we are working on right now. Translating this framework to CPS1, CPS2 or like the BAAL that they are trying to implement now. Because if you think about it, these CPS1 and 2 are just averages of the area control error and system's frequency, which may be represented using the proposed framework.

B. Lesieutre: Thank you. My question for the second paper [2] is this. It's interesting and nice to see using the cumulant for doing your calculations that allow you to do some complex studies using arbitrary distributions, or something other than Gaussian. But your example looks

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it's nice and Gaussian. Have you looked at other distributions at all?

Duong Le (Politecnico di Milano): Thank you for your question. In this paper, because we didn't have distribution for the input random variables, so we just assumed that the distributions are Gaussian. But we can make the computation using the model with distributions different from Gaussian. And in fact we are working on that and we have obtained some results using different distributions. Thank you.

Alex Papalexopoulos (ECCO International): It is a question for paper [2]. You use generation distribution slack formulation. In many commercial applications we use a load distributed slack formulation. It seems that the participation factors that come from the latter are more stable because using a generation slack distributed formulation, because of the tripping generators coming in and out of the system, interface with SCADA and so on, there may be a change in the participation factors that may impact your algorithms. Have you considered using load distribution slack formulation and why you chose the generation distribution slack formulation?

D. Le: Thank you for your question. Actually, in our paper we showed the participation factors for generators and not for the load. Because firstly we developed the model for the single slack bus and we met the distribution of power injections at the slack bus with very large variation. So we tried to manage that problem and we made use the distributed slack bus model so that we can distribute the variation to all generators in the system. Your recommendation to consider load distribution slack formulation is very good, thank you. I will consider about that in the future.

Juan Carlos Muñoz (University of Waterloo): My question is going to the first paper [1]. You are using DC power flow in your robust optimization problem. My question is if there is any limitation to use the AC approach in such a way so as to take into account security limits for example. How are you going to take into account for example available transfer capability, if these values are going to be given as an input, as an interval, or are you going to incorporate these in your model?

Naoto Yorino (Hiroshima University): I am sorry I couldn't catch the question, can you please repeat?

J. C. Muñoz: Basically, if you can incorporate AC power flow models and how are you going to take into account different security limitations, for example, available transfer capability, are these going to be modeled as an interval, as an input?

N. Yorino: OK, in this presentation we used a linear model. But if we replace that part by AC power flow, it becomes an OPF. So basically it is theoretically possible, and also any formulation for that part can be useful, but the problem is the computation, and also it is possible, but some time erroneous. For example, in today's previous session, there is an OPF second order, quadratic approximation. In such an approach, it can be useful, but basically it is quite difficult, I think, in reality.

Chair: I have a question for the third presentation [3]. You said, that you can also use this method for detecting cyber-attacks on the AGC. Could you please say a few words about that and how fast it could be? Because timing is here an issue, perhaps the attacker can cause something serious before you have detected it. Could you comment on that, please?

D. Apostolopoulou: Thank you. The whole concept of detecting cyber-attack is that you calculate the system frequency statistics and you can compare them with the statistics you know there exist in the wind, or the noise in the communication channel. So, if you see that there is a difference, you simply have to look into that. You are right it could be good to catch that very fast, because if it is too late there is no point at all, but I think it could be used, computationally it's not very hard. So I think it could be used in fast time scales and could be useful in that case. But for those extensions we haven't worked very thoroughly, so I cannot be more specific yet.

Steven Low (Cal Tech): I have a question about the third paper [3]. It is very nice. So my question is: the framework you presented can estimate means and second moments. Have you got any information about the probability, not a mean and second moment but for example the probability a bad event happens that lessens some threshold?

D. Apostolopoulou: So, we want to calculate the probability distribution function of the whole variable. That is, if you have the mean value and several moments, you can construct a good approximation of that. Is your question if this is a probability assigned to the value of the second moment or…

S. Low: So for example, can one develop following the same approach you are taking, a propagated probability rather than a propagated first and second moment?

D. Apostolopoulou: Sorry, I am not sure I follow…

S. Low: Maybe we can take it off line...

D. Apostolopoulou: We'll talk about it later. I am sorry.

Robin Preece (University of Manchester): Just following from the last point. Have you looked how accurate the method is for estimating high-order moments beyond the second? Because, if your output is not following a Gaussian, then you are going to need much more moments to actually produce the PDF of the output. And just how well the method performs for that?

D. Apostolopoulou: Thank you. We have done up to third moment in this simple example where everything works, so it converges to zero. We are planning to run simulations in bigger systems where maybe the system is not appropriate and we will see your point, if expanding to more and more moments we can see what the PDF is like.

Claudio Canizares (University of Waterloo): This is a question for Professor Yorino [1]. Regarding the computation of the robust stability region you define, the security region you define. Is that done on-line or off-line as you compute those limits? Thanks.

N. Yorino: Basically the computation itself is for the future problem. Many of them are. But this time in the presentation it is on-line. Does this answer your question?

C. Canizares: So can you say on-line or off-line?

Naoto Yorino: OK, security, it is basically off-line.

Chair: OK. If there are no further questions, I would like to thank all the presenters.

References

[1] N. Yorino, Y. Sasaki, E. Popov Hristov, Y. Zoka and Y. Okumoto, "Dynamic Load Dispatch for Power System Robust Security Against Uncertainties," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece.

[2] D. Le, A. Berizzi, C. Bovo, E. Ciapessoni, D. Cirio, A. Pitto and G. Gross, "A Probabilistic Approach to Power System Security Assessment under Uncertainty," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece.

[3] D. Apostolopoulou, Y. Chen, J. Zhang, A. Dominguez-Garcia and P. Sauer, "Effects of Various Uncertainty Sources on Automatic Generation Control Systems," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece.

[4] O. A. Mousavi and R. Cherkaoui, Discussion on "Uncertainty Management in Power Systems," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece.

[5] D. Apostolopoulou, Y. C. Chen, J. Zhang, A. D. Domínguez-García, and P. W. Sauer, Closure of "Effects of Various Uncertainty Sources on Automatic Generation Control Systems," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece

[6] N. Yorino, Y. Sasaki, E. P. Hristov, Y. Zoka and Yoshiharu Okumoto, Closure of "Dynamic Load Dispatch for Power System Robust Security Against Uncertainties," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece