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Oral Discussions on Session: "Advanced Operations" – Part I

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Abstract

This paper contains the first part of the transcribed oral discussions of Session "Advanced Operations" of the 2013 IREP Symposium-Bulk Power System Dynamics and Control, held on Thursday morning, August 29, 2013. Papers [1]-[4] were presented.

Discussion

Chair: The floor is open to questions.

Marian Anghel (Los Alamos): I have a question for the second paper [2] (presented by Jong Lim). Do you assume in your algorithm that you have PMU measurement in each node in your network? I was curious if you know how the performance of your algorithm degrades as you reduce the number of PMU measurements and also as you play with the amplitude of the noise that you inject in your network. For example you can estimate the percentage of misses in detecting voltage or topology events. How does that depend on the number of PMU measurements and on the noise level? And of course implicitly here is the notion of how do you locate your PMU measurements in order to maximize the performance of your algorithm.

Jong Min Lim (University of Wisconsin): If I understand you correctly you are asking about the number of PMUs in the network. I did a test for the voltage stability assessment and the overall quality is a little bit degraded but it is still reasonable. It's not significantly degraded. But for topology detection, there should be a lot of PMUs installed, in order to define the location where the topology change happens. And also if something happens, you want to detect that something happens in the network, it may not be captured if the number of PMU data is not enough in the system. So this is a very good question. We have thought about that over the last year and we haven't come up with a good algorithm for the PMU placement for the topology detection but for stability assessment itself a reasonable estimation is possible with a restricted number of PMUs.

Claudio Canizares (University of Waterloo): I have exactly the same question.

Chair: I am sorry. We don't allow the same questions.

(Laughter)

C. Canizares: Could you specifically say what is the minimum number of PMUs you require for this? Do you assume that you have PMUs everywhere?

J. Lim: For the simulation we assume that the PMUs are installed everywhere in the system but as I mentioned earlier the stability assessment is possible with a limited number of PMUs.

C. Canizares: How many?

J. Lim: We tested with 10% of the number of buses in the system, which means with the 118-bus system, we tested with 12 PMUs and they still gave us very reasonable assessment for voltage stability.

Bernie Lesieutre (University of Wisconsin): A quick question for Jong Min Lim [2] and one for Misha Cherkov [3]. Jong Min, you showed this platform where you can see all these interesting things in the singular values and changes that happen in the network. Can you comment on the discrimination possibilities? How well can you discriminate between the events that are voltage related and those that are line switches? That didn't seem to come out.

J. Lim: You mean in the slides that I mentioned signal to noise ratio?

B. Lesieutre: When there is a change in the network, how do you know what type of event it is? Is it a line switched out or is it a voltage problem?

J. Lim: It cannot be discriminated from the PMU measurements only, but if we look at…

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Chair: They have a non-discriminatory policy.

(Laughter)

J. Lim: For now it is hard to distinguish if a line is out, or the voltage goes down, but if we look at the left singular vector associated with the largest singular value, it may be possible to distinguish a little bit. But for now it is hard to distinguish between these two.

B. Lesieutre: Thank you. And now I want to ask Misha Chertkov a question. First I want to say I really like this work, this type of work. Then you know I am going to follow up with a nasty question. So a couple of things: one is a modeling question. You propose using this model that is lossless and has constant voltages, but I think this is entirely based on mathematical convenience. So the first question I might want to ask about that is what is the hope that you can extend it in more detailed models? Secondly, before we even get to that, I am confused that all you need is lossless and constant voltage to be able to construct a convex model for this. I am fairly certain I've seen in the literature specific examples that meet that, but still are not convex. So I don't quite know if there is more to your assumptions than that. Is there anything else, such as neglecting reactive power or doing something else beyond that, or is your claim that all you are doing is lossless and constant voltage.

Misha Chertkov (Los Alamos): Thank you, Bernie for the very good questions. So, first one is on hopes for further generalizations. Of course, there are multiple directions where we want to go. Voltage is not the only one. I think we discussed this before: Voltage is pretty much a local phenomenon and probably we are OK setting voltages appropriately and maybe iterating again. More important is our assumption about this criterion, which we use for synchronization. We basically are saying that we monitor synchronization by a certain auxiliary variable and we in fact limit ourselves in this assumption to existence of solution. So you may have a perturbation and even though you have solution, you start sliding. This is not accounted in this type of approach. We want to account for region of attraction and that's probably the most interesting extension. That's for the first question. On the second question, first of all I would like to see this paper. As a general remark to the fact that there is a statement in this paper that the problem is not convex, this doesn't mean that there is no convex reformulation. We know multiple situations, where a smart change of variables works. So, in-between those two questions there is something extra. If you ask me if I account for reactive power constraints, I don't account for them, either. And yes you are right. So there are multiple things which are not accounted for and we take just one step at a time I guess.

Janusz Bialek (Durham University): A question to Misha Chertkov [3]. Maybe I misunderstood about two of the assumptions behind your methodology. The first you said you have some Gaussian distribution. But if it is wind, wind does not follow Gauss distribution, it follows Weibull distribution. And the second question about another assumption. You said that you assume independence between different sites. And well, if sites are 100 kilometer apart, they are indeed independent. But what happens in fact is that you have wind farms in wind areas that are quite close to each other, and then you cannot assume independence.

M. Chertkov: Yes, thank you, Janusz, very good questions. So now on Gaussian: there are two ways to answer this question. I can argue as physicist and I can go to fluid mechanics type of discussion, why statistics of turbulence is closed to Gaussian etc., etc. I will not be doing that. It will not be perfectly Gaussian, certainly they will be tails and probably Weibull will be in some cases better. However answering to this question is a kind of data crossing. Think about Denvin Stock answering this question. So, what then would be to say? He would say that's what out-of-sample test is about. So we stick to Gaussian because we know how to handle this analytically. However, you give me whatever distribution you want, and then I'll adjust parameters of Gaussian to fit it. And then I test, I just illustrate to you that with certain choice of parameters basically in practice we'll achieve the same. So, that's an assumption. Now it was the independence question, right? So about independence, you are absolutely right. If wind farms are too close and if we are not talking about 15 minutes but an hour, I am in trouble with this assumption, and we need to do something else. Well, independence is much tougher to deal with within our approach, than relaxation from Gauss to Weibull, etc. But what I basically am saying is that if wind speed is 15 meters per second and we are talking about 15 minutes, there is no way to bring correlation from one site to another, if they are hundred kilometers apart. It is this assumption that I was making.

J. Bialek: So what is the time scale you are talking about?

M. Chertkov: I am talking 15 minutes. OPF repeated every 15 minutes. Well in 15 minutes, with 15 meters per second, you will be 10-15 km, but not hundred.

Thierry Van Cutsem (University of Liege): Two small questions to the second presenter [2] (Jong Lim) based upon previously raised questions. So after the topological change there is a delay to get new information if I understand well? And that comes from two things. One is the window, the data window that you need to rebuild because you have to clear your memory from the past evolution, and the second one is the CPU effort to compute singular value decomposition. Is this correct? If so, it looks like the problem is the larger the system the more time it takes to get new information. While with all this distributed measurements we could expect to have more local processing, let's say, which would avoid this problem of size. So my first question is to ask for a comment from you about this issue and very quickly the second one: after an event there is a load response, because downstream there are tap changers, capacitors that can be switched etc. That change seems to be, let's say, faster than the daily load change, but slower than the noise in the load, so can you accommodate this in your method because you explained at the beginning that you have to separate the slow trend from the fast one.

J. Lim: Can you repeat the second question?

T. Van Cutsem: The second question is: did you consider the effect of the load response, the load dynamics itself, which is something that looks like faster than the daily load change, but slower than the random noise, random variation, random fluctuation of the load.

J. Lim: Thank you for your comment and questions. We have thought about the computation time and we are currently considering network decomposition to enhance the computation time for a very large network. We are currently working on that. Also, as you can see in the slide if we use Lanzcos Arnoldi algorithm, we can compute the first several singular values more quickly than computing the full SVD. And also we have, if we use the characteristic of the PMU data matrix we can also enhance the computation time, as well. So we are still working on that direction. Thank you very much for your question. And for the second one… Professor and I have briefly discussed about load dynamics of the system. You can't capture that characteristic with the algorithm for now. Actually, we had the chance to talk about it with industry and they mentioned that if they consider the dynamic characteristic in the system, it still has a very similar power flow response to that I showed in the graph, the ellipsoid shape in Voltage magnitude and angle domain. I guess that it still is possible that you can still capture that characteristic in the system.

Ian Hiskens (University of Michigan): A comment regarding the fourth paper [4]. It's interesting to look at the reference list and note that every single reference is authored by the authors of the paper.

Chair: They got into the infinite loop of quoting themselves.

I. Hiskens: A comment for the second paper (Jong Lim) [2]. There seems to be an interesting connection between the technique used in this paper and Christine Chen's work yesterday. They are doing slightly different things but one would imagine that as the singular value gets closer to zero, the system becomes more sensitive and that would also show up in her work where the sensitivities are being calculated in a kind of similar manner from PMU data. I am sure you cannot immediately comment on the connection between the two papers, but I would encourage both groups to think about what are the connections between those two different techniques.

Chair: OK. We have a minimum time arrival policy for the mikes.

David Hill (University of Sydney). Just following up Ian's comments. A couple of days ago, I expressed some mild cynicism, I think, of the idea of going for the big data approach at the expense of, you know, models and usual techniques. This is just a comment, but it comes up here. We use singular values because the voltages and the normal measurements were not good indicators of the proximity of voltage collapse. So we went to singular values. You still have to calibrate these things. You still have to know how the numerical value of a singular value has meaning in terms of the distance to collapse. And I can't see how you can really do that without having some kind of associated studies, which is on the model of the network. And the way I would suggest we see that, is we have off-line studies which help us get a kind of calibration and then the online measurements supplement that or tune it up and help you make final decisions. And so we shouldn't forget that we still have models there and we can study these and bring them into the picture as well. Just as a general comment.

Marian Anghel (Los Alamos): I think I have a follow up to Bernie Lesieutre's and David Hill's comments. I suspect it is actually possible to discriminate between topological and voltage events, because the response of power flows in the network I suspect are different for each kind of event. And since you have access to data and you can generate simulated data and label them according to the type of events you induce into your network, you can probably use statistical classification algorithms to try to learn the type of events you have. And, also, a similar algorithm, for example, it's implicit in your technique, to start at a threshold when you decide that you detect an event in your network or not, and you can apply cross-validation techniques to select this threshold appropriately. So there are clearly ways to follow up in your work and bring statistical learning techniques to make the choices that are necessary to be quantified in a rigorous framework.

Costas Vournas (NTUA): My question is for Misha Chertkov [3]. I like the idea of using probabilities of failure, but we should take into account that if you have one line overloaded, then you have a cascade of events, so normally what we do is maintain N-1 security. So I was wondering if you can put contingencies into your approach and then have probability of N-1 event. Of course, it will be more complex, but can this be done?

M. Chertkov: Thank you, Costas. I think I'll answer the same way Steven Low answered this question. The same question was asked to Steven. If you can put N-1 contingencies in his approach and you just have more conditions, but it is not exponentially many constraints. And it is the same thing here. Especially this cutting plane approach, which allows you to add those constraints as you need. Adding constraints N-1 will not complicate things. As far as cascading is concerned, it is of course a much more difficult story, but supposedly what we are suggesting is more or less for a normal operation, however, under a lot of fluctuations form renewables.

C. Vournas: I was just hoping to see this approach to have N-1 followed with the probability of having a failure. Thank you.

M. Chertkov. Thank you for the suggestion. We will certainly do it. I don't think it is a problem.

Chair: How do you get those probabilities?

M. Chertkov: Probabilities are exogenous, probabilities of your events, of wind fluctuations, but you can see instead of just one configuration, which is the normal configuration, all those N-1 configurations additionally.

Chair: The problem here is one of dependent or independent events. And that's a sequence of highly depended events which occur at the speed of light.

M. Chertkov: Well, I am not discussing this situation. I am discussing…

Chair: Yet the question was asked about cascaded outages.

M. Chertkov: Yes and no. So Costas started from cascading but then he said that usually we do N-1 and I was responding to N-1 and I said that cascading is a much more difficult thing. Exactly because of what you just said.

Steven Low (CalTech): I have a question for Misha [3].

Chair: You guys are ignoring the other presenters here. And given that Le Xie was up all night and we have a presenter from Japan for whom you didn't ask questions, after this, I am going to entertain questions only to these other two guys. Ok?

S. Low: Thanks for the last question. So one follow-up on Janusz' question about independence. Is it possible to look at extreme events, where in a case that you just studied you assume that everything is independent, in the other extreme you assume that the variables are exactly the same everywhere. So that the demand is the same everywhere and every node in your circuit follows the same variable. The same variable in one extreme. And then is it possible to show that in a general case where things are correlated, but not the same variable, you always fall in between the two cases?

M. Chertkov: Thank you Steven, yes, I absolutely agree with you and that's actually another approach. So we reduced ourselves to Gaussian and correlations because it was simple but originally we thought about using deviation exactly along the lines of what you said. So in this case we are not actually limited to correlations but you need to have the exogenous forecast, right? Probabilistic forecast. But anyway thank you. Very good suggestion. It should be done and can be done.

Glauco Taranto (FURJ): I see I have to be in the waiting list for number two paper after your remark. Put me on the waiting list because I don't have a question for the other papers.

Chair: Go ahead. Ask your question. I have to be very nice to you because you sponsored such a beautiful event in Buzios last time.

Glauco Taranto: Thank you. My question is for Mr. Lim [2]. I want you to comment, you showed a plot, if I recall, that shows four events, when you compared the model-based and your approach and it looked like your approach did better in the one of the switching capacitor. I want you to comment on this.

J. Lim: In the model-based one, it shows a bit slightly, maybe you cannot notice that in this big screen, it shows a little bit of changes of proper Jacobian inverse, but since our algorithm is subject to the respective state so it may give us more sensitive result than the largest singular value of proper Jacobian inverse. Is this answering your question? Do you want any more comments on that?

G. Taranto: It did, but I still don't understand well, but It's OK.

T. Van Cutsem: For the last presenter [4]. Just a quick comment and I would like to have your feeling. Basically the topic is how a distribution system can help solving transmission issues, as seen from very far. I guess that it could be easier to solve a voltage problem than the one of restructuring that you have shown in your presentation. My feeling is that for solving voltage problem, the emergency signals sent from the transmission could be really taken care of in an active distribution network management. Could you comment on this possible extension or have you heard about this? Are the authors thinking of this?

Le Xie (Texas A&M). I am not co-author, I am just presenting the paper. First of all I will pass along the information, the questions. My understanding of the paper, what the authors are trying to convey, is that it is not a top-down approach but rather is a bottom-up approach. I think that perhaps is the key difference. You try to coordinate an active group of users, which could be dynamically changing over time, to manage congestion-related problems, or the voltage problem that you mentioned. That I think also depends on the possibility of opening up a sub-transmission level innovated market signals, or tiered structures to accommodate that. So I think that's what the authors are trying to promote. But I certainly will pass along the question to the authors.

Chair: They are looking for jobs in Portugal. They would like to develop some sub-transmission market operations and I think it's a job creation program...

Le Xie: Just to go back to your question yesterday. One should think about how to incentivize small customers. One possible way is to directly pass along the LMPs to the end user. But this is only one possibility. Is there any other possibility and what is the way to differentiate customers with given technology? What is the way to differentiate customers of different preferences? I think that's what the authors try to promote.

Chair: I don't see any hands up. I think everybody is ready for coffee. I would like to thank all the presenters this morning and we will adjourn for 15 minutes. When the bell tolls please everybody come in because we lock the doors.

References

[1] J. Sakaguchi, H. Miyauchi and T. Misawa, "Risk Assessment of Power Plant Investment by Three Level Ordered Probit Model Considering Project Suspension," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece.

[2] J. Lim and C. DeMarco, "Model-free Voltage Stability Assessments via Singular Value Analysis of PMU data," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece.

[3] R. Bent, D. Bienstock and M. Chertkov, "Synchronization-Aware and Algorithm-Efficient Chance Constrained Optimal Power Flow," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece.

[4] M. Ilic, J.-Y. Joo, P. Carvalho, L. Ferreira and B. Almeida, "Dynamic Monitoring and Decision Systems (DYMONDS) Framework for Reliable and Efficient Congestion Management in Smart Distribution Grids," Bulk Power Systems Dynamics and Control – IX (IREP), August 25-30, 2013, Rethymnon, Crete, Greece.