From: Domański Paweł <pawel.domanski@pw.edu.pl>
Sent: Tuesday, June 25, 2024 12:50 PM
To: Sigurd Skogestad <sigurd.skogestad@ntnu.no>
Subject: after reading your paper in Annual Reviews in Control
Importance: High

Dear Sir,

My name is Pawel Domanski, and I am with Warsaw University of Technology. I had a chance to listen to your invited lecture during the IFAC-PID 2024 and after that I have read your paper that you mentioned entitled "Advanced control using decomposition and simple elements" published in Annual Reviews in Control in 2023.

I find your paper very interesting and to speak frankly it is a pity that such an article appeared only after so many years, because the discussion and reflection on the state of process control engineering is completely missing.

Apart from my research at the University I have got an opportunity to work for industry (power generation and chemical engineering) for more than 25 years. I started with Advanced Process Control combustion optimization projects continuing with various MPCs with nonlinear models and DMC as well (all supervisory over PID regulatory layer). As the young engineer I was very excited about this technology and the reflection came later that the success of the project was strongly dependent on fine tuning of the PID controllers in the regulatory layer. Right now, I am focusing on Control Performance Assessment projects and feasibility studies.
[].Control.performance.assessment.is.obviously.a.very.important.area¿which.I.personally.has.not.worked.so.much.on¡

And at that point I had a chance to listen to you and read your paper. After that I got some comments:

1. Generally, all the elements E1 ... E18 are very important and partially exist in industry. However, their existence vanishes, slowly but continuously. The discussion "why?" would be long, however as it was noticed in my paper during IFAC
[].This.is.the.paper.on.Sic*PI?.Could.you.send.me.a.copy?please?
   its is because of "no time, no money, no people" and I would add – "no passion".
[].I.think.the.main.reason.it.disappears.is.that.the.lack.people.don"t.know.it.exists.as.a.general.approach.for.plantwide.control¡.people.are.told.again.and.again.the.MPC.is.the.solution.of.the.future¡

2. In the beginning I had a problem with your term: ARC – "Advanced Regulatory Control". I see no advanced elements there.
You are right. In the paper I make the comment that "advanced control" anything beyond PI(D) control .
They are well known for years, but somehow forgotten and considered obsolete.
[].Exactly?This.is.the.main.problem.as.I.see.it¡.
And the fact that they are old and simple does not discredit them. I used to utilize the name "Pseudo-Advanced Control". However, the name doesn't matter, cause the subject is

important. Therefore, I will be using your concept of the ARC. Maybe the word Advanced in its name will make it more interesting?

[].I.think.it.can.help.a.little?yes¡

    3.   I find some missing elements:

        a.   Filtering of the noises using a combination of the deadband and the first order inertia, which can be implemented in the feedback line or for the control error. They are used to limit unrequired controller reaction to noises and protect the actuator from unnecessary moves limiting the valve travel index.

[].I.do.mention.deadband.under.E7❷¿.» Simple nonlinear static elements (like multiplication, division, absolute value, square root, dead zone, dead band, limiter (saturation element), on/off)".

But of course a lot more could be said about this. For example, for switched systems there are many practical tricks (including use of deadband, delay in switching back, etc.) that may be used to avoid that one gets into "limit cycles or even chaotic behavior".

        b.   Linearization of the nonlinear actuator characteristics using its inverter curve unless this issue is hidden behind your element E13.

[].Actually.it"s.hidden.in.the.nonlinear.feedforward.in.» E70¿ Calculation blocks (including nonlinear feedforward and decoupling)"

        c.   Nonlinear P element in the PI/PID controller depending on the control error implemented as the f(x) curve.

[].Yes?a.lot.more.can.be.said.about.this¡.It.is.partly.included.in.» E76¿gain.scheduling‹ ¡

        d.   Use of the rate limiter apart from the min/max limiters.

[].Yes

        e.   Use of the tracking mechanisms supporting switching, control mode changes (MAN, AUTO, RCAS or supervisory) in the control loops.

[].Yes?important.in.practice

        f.   Utilization of the SAMA drawings. You mention the P&IDs, but they allow only the strategic perspective over the control structure. Academia loop drawings are almost not used in industry. SAMA drawings are an industrial standard allowing to design and discuss the functional scheme of the proposed control structure, while its tactical final representation is programmed in the DCS/PLC oriented proprietary language. SAMA drawings are universal and common in industry and it's a pity that nobody teaches them. I know only one book on power engineering controls that uses it.

[].Yes¡.I.assume.that.once.the.P™ID.exists?one.can.automatize.this.step.of.going.to.a.more. detailed.description.that.can.be.programmed.in.DCS–PLC¡.There.are.also.a.lot.of.issues. related.to.startup.and.shutdown.here¡

        g.   Distinguishing the three-element control as such, due to its importance (drum level control forms the classical example). I am aware that it's hidden behind the elements you discussed, but in industry it is considered rather separately. And in academia people do not talk about it.

[].You.are.talking.about.overrides.at.High.and.low.levels.using.selectors?

        h.   Sensor validation i.e., checking whether the signal is valid. Generally, it's an aspect of the signal's quality.

[].Obviously.important?but.I.view.error.checking.etc¡.to.be.outside.what.I.am.concerned. with?which.is.deciding.on.the.control.architecture.and.logic¡

        i.   The whole subject of the Control Performance Assessment – an engineer should know how to assess if a single loop or the multi-loop system works properly.

[].Also.outside?as.I.see.it¡

4. Some elements require different perspective. It especially applies to the decoupling elements. The standard academia approach using the -G_{u}^{-1}/G_{d} is not used in industry, because standard DCS/PLCs do not support it using standard blocks. Practically, it is done in different way using first order inertias combinations. You paper in general uses standard control system blockware and it would be worth to apply it to decoupling as well. I know that the industrial approach is a simplification, but useful and working.

[].I.think.industry.implements.decoupling.using.feedforward.thinking?which.is.what.I. allude.to?for.example?in.Figures.8❷and.96¡.I.don"t.discuss.the.addition.of.dynamic. elements.which.typically.are.delays.or.first_order.elements¡

5. I agree that the Smiths predictor is not mentioned. There are two schools, one that supports it and the second vice versa. In my opinion it brings more risks than benefits.

[].Exactly?I.agree

6. You mention that the MPC is justified if we know the future and may utilize this knowledge. However, at least to my knowledge existing application hardly use it. I know one project that aimed at doing short-term predictions to be used as the DVs predictions over the control horizon.

[].I.have.seen.some.practical.applications.in.the.oil.and.gas.industry¡

7. I like the naming "robust, yet fragile". It well defines the main issue of the APC/MPC. It is the main problem with their implementations. They are "not sustainable" – in my industrial environment this aspect was called this way.

[].Yes?I.agree

The subject of the control system sustainability remains unaddressed in the literature, though it is responsible for process sustainability and nowadays everybody talks about sustainability. At that point it could be worth to bring the notion of the notion "resilience". Control system should be resilient.

8. Finally, there is one thing that I fully disagree with you: your comments about ChatGPT. I know that it is very trendy right now, but I consider it extremely harmful. It may bring some short-term benefits, but in a long term I see no positives. It will diminish engineering knowledge and the knowledge as such, destroy education, break confidence and limit engineering boldness.

[].I.think.maybe.you.will.be.proven.to.be.wrong.here¡.ChatGPT.can.be.a.way.of.maintaining. the.knowledge.of.the.APC.elements.which.may.otherwise.be.disappearing.- .partly. because.it.is.a.lot.of.knowledge.and.experience.needed.to.be.put.one.engineer"s.head¡. I"m.here.talking.about.using.ChatGPT.to.suggest.control.architectures.(which.the.engineer. may.look.at.and.comment.at?for.example.saying?»this.loop.is.not.good‹).and.not.to.tune. the.controllers¡

[].

It happened that my mail is somehow long. I would like to finish it with some questions to you:

1. What is more important in the notion "process control": the process or the control?

[].I.thinks.it"s.the.combination.on.the.structural.level¡.»Control.architecture‹ .is.the.popular. term.today¡.

2. Which person has the chance to become better process control engineer: the one with the education in technology engineering (chemical, power, heat, etc.) and trained to control or the one with the education in control trained to the technology?

[].I.think.the.person.with.the.process.background.can.do.the.best¡.The.control.part.is.easier. to.»automize‹ _

3. What is more important in the education of process control engineering: proficiency in solving mathematical problems or a feel for physics/chemistry.

[].Of.course.the.latter.(the.structural.part)¡.But.I.try.to.teach.both¡

I hope my lengthy email did not bore you
[].Not.at.all?It"s.very.interesting¡
. However, the subject matters for me a lot, and you were the first who addressed it.
[].Thank.you¡

Looking forward to your response.

Dear Sir,

Thanks for your reply. Yes, you can share my comment on your homepage.

Please find below my responses to some your in-text comments:

- Control Performance Assessment is within my interest. I will be happy to share with you my observations if you would wish.
- Please find attached my paper on sic!PI. I hope that soon we will have further results, also the theoretical ones.
- People – I agree that it is the crucial element. Control engineers should be well educated, have decision freedom and be brave. As the education is not efficient, and they have no mentor in industry (these people just retire) they are afraid to be brave and their freedom becomes more and more limited.
- Startup and shutdown logics are really an important issue, not addressed. Moreover, there should be a talk on the control system startup, which is complex process requiring specific skills and knowledge. Simple copy-paste or following the procedures concludes in very passive and restricted solution being quite far away from good ones (not talking about optimal).
- Three element control is a cascaded control (two elements are PV for upper and lower controllers) + the feedforward (the third element). Drum level control constitutes its classical examples where cascaded control takes care for the level control – the upper controller controls the drum level, while the lower one the feedwater flow using the valve. The feedforward element decouples the steam consumption flow. What is interesting in the drum level process it is that it's nonminimumphase.

Regards,

Pawel