Subject:

Re: Email ballot for approval of OP1.004 as an American National Standard

From:

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Date:

4/30/2014 11:21

To:

Dave Aikens <daikens@savvyoptics.com>

CC:

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Dave,

I can't remember whether "affirmative with comments" requires a reballot (tried calling you to get clarification but I guess I will have to wait). I noticed a couple of things with the slope that warrant some minor commentary, but I think I'd rather get the standard out there rather than see it get held for relative minutiae.

For the first point in regard to slope, I refer to my comment regarding 4.7; upon further review, I believe I misinterpreted the project leader's comment. Long story short (details at bottom of note), I believe most of the interferometers out there will not calculate the proposed default slope calculation. I personally have no problem with the calculation, because it is easy enough for me to use other software to do the analysis. I am concerned, however, that our representatives from "shop floor" component companies do not fully appreciate what the default will do.

What I believe will happen is...

1) Designers won't bother specifying a slope algorithm; they'll assume the metrology software their vendors are using will conform with the default standard.

2) Fabricators will use their MetroPro(TM) slope function on the shop floor, using the machine they performed the measurement with, and will assume their software conforms with the default standard (which, as of today, it likely won't).

3) The likely scenario is thus a slope evaluation that doesn't meet the standard.

To rectify this, the fabricator will have to...

A) Talk with the component designer (customer) and get them to change the slope algorithm on the print to the 3 point algorithm that MetroPro uses, or

B) Upgrade their instrument to a new software, likely requiring a new computer and considerable expense, or

C) Performing the analysis offline (using modern software) instead of at the machine that it was measured on, or

D) Write their own code to do the slope analysis.

"B" and "D" cost money, likely significant amounts. "C" may not be something that fits within the production flow that component manufacturers want (it is likely they want an on-machine evaluation). "A" is fine if a supplier has already won a bid (dialog with the customer is a good thing), but a potential nuisance when the component is out for competitive bidding.

In this particular instance, I don't expect the algorithm choice to have a huge impact on the result, especially since there is typically going to be additional filtering associated with the evaluation length. But I am curious as to our position on creating default standards that don't match "default" measurement and analysis capabilities. Of course, this is unavoidable for "new" calculations (e.g. freeform surface description). But "old" calculations like slope, Zernike computation, filtering, and so on will have implementations in existing measurement and analysis equipment. I think making "default slope" something that the old equipment doesn't actually compute is a source of confusion.

On a related note, the 7-point wide margin is more than what is needed to meet Note 2. The reference cited in note 2 says "Note also that after determining the gradient at each pixel, the code ignores a strip of 5 pixels around the edge of the array before calculating a histogram and rms. This reflects the doubt that the gradients near the edges (both from the gradient technique and from the low-pass filtering) are accurate."

I assume the person who worked on our standard just added 2 pixels to the number quoted here to avoid using the custom edge algorithm. But the number quoted here is accounting for both the slope sampling and filtering. The slope algorithm only needs a 2 point exclusion to avoid switching algorithms (5 point kernel, so center pixel plus 2 on either side - to keep the kernel on the valid domain thus requires it to be 2 pixels in); this would end up being 4 pixels off the diameter (2 around the edge). The rest of the trim is for the filtering effects, which is a fuzzier notion. I personally would recommend peeling off half of the integration length - but that is in length units rather than pixel units (and would be 2% of the aperture by default). In the NIF document, I believe the length to pixel conversion is largely fixed since similar equipment was used to perform the measurements. Yet if an instrument of much higher lateral resolution were used, the recommended 5 pixel margin in the NIF doc (or 7 in our doc) would need to be increased.

This is a relatively finicky detail, but the distinction of the 7 points (2 from sampling, 2 to avoid changing slope algorithms at the edge, and 3 to suppress filtering artifacts) will become more important down the road when 4k or 16k cameras become the norm. Perhaps a white paper or journal article should be published giving some guidelines and examples of how to pick parameters for evaluation against standards.

At any rate, my preference would be to get the standard published, since it is a significant improvement over what is out there. I just want to be sure that the representatives who make components (e.g. Optimax) are OK with the implications of this slope default, and to point out tat we have a pixel exclusion that really ought be a combination pixel/length exclusion.

-Paul.

Details of my previous comment & project leader response

Comment

While I have no objection to the equations listed, as a practical matter it makes me a little uneasy to see a default for a standard be something that commonly used metrology software doesn't calculate.

I believe that most slope calculations implemented in commercially software are via the 2 point method (though I am not positive).

As I understand it, the most common method of evaluating slope specs today is to low-pass filter the data according to an integration length (often with a Fourier filter, but sometimes with a simple convolution filter such as a moving average), then apply the (2 point) slope calculation.

Proposed change

Not sure. I think people will resist a default standard that is not easily computable with the software they have. Having a little more mention of what I would consider the current default (low-pass filter followed by slope) might help.

The project leader's response

No change made. There is commercially available software that makes the calculation exactly as described. The current language describes a default and specifically allows for other algorithms (2 point, etc) to be specified.

I first interpreted the project leader's response as "MetroPro software can be configured to do the calculation this way", and thought "fine - I must have just never run across the feature". I believe Zygo(R) is the market leader in wavefront measurement devices in this domain, so that is what I use as a benchmark.

Upon closer review today, I no longer believe this to be the case. I think the project leader is referring to Mx, Zygo's current software, which does indeed support the proposed default calculation. Based on the MetroPro user manual and doing a couple sample calculations, I am reasonably certain that MetroPro does NOT support the proposed default calculation. And I believe the vast majority of instruments in the field are running MetroPro.

While I am all for software upgrades (the newer, more powerful Mx is certainly an upgrade over the older MetroPro software), the problem is that it is not readily achievable on many instruments. Mx requires Windows 7 64 bit; most legacy instruments don't have this OS or a computer that will support it.