Interactive comment on "Image GeoRectification And Feature Tracking toolbox: ImGRAFT" *by* A. Messerli and A. Grinsted

Anonymous Referee #1

Received and published: 24 September 2014

General comments

This paper presents an overview of a Matlab-based software package which provides a method for georeferencing and georectifying oblique imagery, and then carrying out feature-tracking from a series of such images, separated in time but collected from the same view-point. This is a tremendously exciting prospect, since as the authors state, time-lapse imagery is becoming more popular, but extracting quantifiable information regarding surface displacement is far from straightforward. Providing a package that puts this procedure more easily in reach is therefore of huge potential interest and of benefit to many (including myself!). Having said all that, I must therefore say that I was ultimately a little underwhelmed by what the paper contains. The paper starts well

and promises much, but in actual fact, much of the technical details of how the software works is omitted, and a fairly broad-brush approach is applied in which only generic details are provided. I accept that a blow-by-blow account of the precise process behind the technique is beyond the scope of the paper (particularly as the code is available for potential users to interrogate and use via the authors associated website), however I would have liked to have seen a little more detail here. I was also disappointed to see that there was very little discussion of quantified results, or much attempt to assess just how good the software is. General statements about flow patterns one might expect of a typical alpine glacier are not sufficient. Much more is needed. Overall then, I like this paper's promise, and what the software can do, but I feel that there is some work to be done to bring the paper up to a standard worthy of publication. Below, I outline the things that I believe need to be acted upon.

Specific comments

1. P497, L4 – you say this 'needs to be corrected for' but it is unclear if you are stating this as a requirement before application of your methodology, or if this is done as part of the ImGRAFT package. This needs to be clearer. I would hope that it is done here, and I believe it is, but it needs to be stated as such, especially as the package is flagged up as 'complete'.

2. P498, L1 – I would like to know more about the background to the approach you take to your DEM – i.e. filling in crevasses. In other words, what is the justification for following this approach? There is ultimately an awful lot of smoothing of and manipulation of the DEM – what are the implications of doing all this for your results? Have you explored this?

3. P498, L5 – you talk about your weighting constant (a) and that it is equal to 1 in this case. There is no explanation as to why this is, and what situations might arise where a is not 1. I think you need to explain this more fully, otherwise surely a could be omitted.

4. P498, L16 – you say that there is 10 m of surface lowering in a melt season, but

it's not clear if you mean that you observed this in the field, or if you mean that your ImGRAFT approach reveals this.

5. P498, L25 – you indicate that there is a manual on your website – I cannot find this manual.

6. P499, L2 – it is not clear to me what a 'model camera' is, and particularly how this relates to a 'master camera' (referred to later). Are these different, or are they the same thing? It is really important that the terminology used is clear.

7. P499, L3 – similar to my first point above, it is not clear whether this determination of 'camera view parameters' is done here in the software, of if it needs to be done beforehand.

8. P499-500 – the georectification section (4.2) is quite basic. You need to give more details as to what is done in ImGRAFT. Also, why doesn't this stage appear on Figure 2 at all? Figure 2 needs to be a complete guide to the processing stages.

9. P500, L11 – 'the initial version' – this implies there is another, more recent version. Is there? If so, how do they differ? Why mention an earlier version? What does the more recent version do?

10. P500, L16 – presumably ice flow is just inferred from differences between two images.

11. P500, L24 – when you talk about 'camera B', do you just mean an image captured in the second of two time periods, as opposed to a camera in a different location, as is suggested here?

12. P501, L15-19 – in light of this limitation, why don't you show velocities along flow then?

13. P502, L5 – you mention 'offset to camera' here, but it does not appear in Figure 2, despite pointing your reader to this. It is quite frustrating to have Figure 2 missing

some key elements, and not tying up with the text.

14. P502, L6 – what is the threshold for 'high' velocity? When does it become acceptably low? Similarly, on L8, you say that the velocity field is removed if the 'problem persists'. This seems very subjective. You need to be more rigorous in your criteria.

15. P502, L19 – 'effectively the same time period'. What does this mean? Is it or isn't it the same time period? I also don't really understand how you carry out this error estimate. How do you calculate velocity for the same time period using independent image pairs? Do you have multiple cameras, or are you using consecutive image pairs…in which case they are not for the same time period, in which case things could differ.

16. P503, L3 – this is very vague. What are the expected flow patterns for an alpine glacier, and what do you mean when you say your measurements 'match'? You need to tell us much more precisely what you mean, and also to tell us something about the velocities measured. Give us some numbers too.

17. P503, L21 – again, this is vague – what are the 'distinct time periods' for which no detectable motion is likely (or expected)?

18. P503-504 – I think the explanation of the effects of illumination is a bit long-winded and repetitive. I think you can say (much more simply and quickly) that illumination is important and that the area you chose to focus on is not really affected by changes in illumination.

19. P504, L10 – I disagree with your statement regarding what Figure 4c shows. This figure does not say anything about the effects of shadows – what it shows us is that in the specific area, there is minimal variation in velocities. You may choose to infer from this that shadow has minimal effects, but the figure does not 'clearly' show this in its own right, as you suggest.

20. P504, L12 – do you mean Table 1 rather than Figure 1?

21. P504 – I'm a bit disappointed not to see a more detailed analysis of velocity patterns across the study area – surely the value of the approach is to produce a detailed, distributed data-set. In which case, it's a shame not to discuss it more. I'd also like to know more about how good the method is in reproducing real velocities.

22. P505, L9-11 – it would be preferable to explain the section about the ability to use lower-quality cameras earlier on, rather than here in the conclusions.

23. P505, L17-19 – I don't know why you start discussing filters and signal-to-noise ratios here. This material should appear much earlier on. Conclusions are where you summarise what has gone before, not introduce new material.

24. P505, L25 – I am disappointed that your approach does not account for inaccuracies in DEMs. I understand that in your case, this is not relevant as you were fortunate to be able to get a DEM at exactly the right time. However, for most applications, this will not be feasible. Given you claim that ImGRAFT is flexible and user-friendly, I think you need to consider the implications of DEM accuracy more fully, so that other users can apply this tool.

25. Figure 2 – I think a lot of work is needed to improve this. I have mentioned in various places above that there is a mismatch between what is mentioned in the text and what is mentioned in the figure. There are even more examples of this. You mention 'rock template match' in the table, but this does not appear in the text. Instead, 'template match rock' appears on L3 of P502 – is this the same thing? Presumably it is, but you need to be consistent with your terminology. Similarly, there is no mention in the text of the 'optimise secondary camera' phase. What does this mean? I thought you were using imagery from a single camera. Further, you mention 'master camera' in the figure but not 'model camera'. Are these the same? It is fundamentally important that the text of your manuscript should track the boxes in this image, so that the figure is actually useful.

Technical corrections

1. P493, L16 – remove 'be' after 'otherwise only'. 2. P493, L22 – 'a own'? Not sure what you mean here. Do you mean 'our own'? 3. P493, L23 – comma after 'rectified'. 4. P497, L12 – I would say that section 3.2: 'DEM preparation' is part of the methodology. 5. P498, L13-15 – you say that on a surface where melting occurs, 'it is important to consider the effect on the accuracy of the result'. However, you've said virtually the same thing in the previous sentence. There's therefore a bit of repetition here which could be removed and tidied up. 6. P499, L10 – insert 'is' between 'previously' and 'caused'. 7. P500, L17 – 'and to and reduce' doesn't make sense. I think you just need to remove the second 'and'. 8. P501, L22 – remove 'are' from after 'regions'. 9. P504, L17 – 'then' instead of 'then' after 'Table 1...' 10. P504, L20 – I don't understand how an error of 5 cm d-1 when the velocity is 60cm d-1 equates to an error estimate of 7%. Surely it's 12%? 11. P504, L21 – what is the point of the '(or < 10)'?