# View Reviews

**Paper ID**
298

**Paper Title**
360° Optical Flow using Tangent Images

**Reviewer #1**

## Questions

**1. [ Paper Summary ] What are the key ideas, what is the significance and how are the ideas validated? Please be concise (3-5 sentences).**
The paper proposes to use tangent images for determining 3560° optical flow. The optical flow is performed in submaps, (cube, ikosahedron related) tangential to the unit sphere. The local optical flow maps are fused, taking a global rotation into account. The method is described and experimentally validated.

**2. [ Paper Strengths ] Please summarise the strengths of the paper. (Eg: novelty, insight, theoretical strength, state of the art performance, thorough evaluation). Please provide a clear explanation of why they are valuable.**
The goal to achieve optical flow in all directions is interesting and challenging. Using tangential maps is certainly the choice.

**3. [ Paper Weaknesses ] Please summarize the weaknesses of the paper. (E.g., Lack of novelty, technical errors, insufficient evaluation, etc). You should clearly justify your criticisms with precise and factual comments (E.g., with an explanation of technical errors, citation to prior work if novelty is an issue). Please note: It is not appropriate to ask for comparison with unpublished arXiv papers, and papers published after the BMVC deadline. Please be polite and constructive.**
The paper unfortunately does only work for lanar motions with a camera looking horizontally. The rotation estimation has a technical error: only two parameters are provided, instead of three, and the second parameter (the vertical flow on the projection) does not allow to determine a rotation. The data set is not "hichly realistic" (282) but only contains planar motions, such that pitch and roll angles are not treated.

The concept needs to be corrected and augmented, and then submitted in a later stage.

**4. [ Overall Rating ]**
Strong Reject

**5. [ Justification of Rating ] Please explain how the different strengths and weakness were weighed together to produce the overall rating. Please provide details of questions or ambiguities to be addressed in the rebuttal that might change your rating.**
The paper contains technical errors, the experimental validation is too restricted.

**6. [ Suggestions to Authors ] Any further comments to the authors and suggestions for improving the manuscript (e.g. typos). These are not relevant for your rating.**
comments refe to all aspects:

036: "potentially incorrect flow fields": what does 'potentially' mean here? Either the the flow field (in expectation) is correct or not.

040: So, optical flow method is based on tangent images so far?

049: Hence, this is not new.

051: "global warping method": What is this, why is this necessary, this is not motivated

057 ff: The first two words are a header. They do not belong to the text. The two words need to be repeated, or the fullstop needs to be eliminated, which, however, is not consistent with the following paragraphs.

131: "from image": I suppose: from ERP image I_t to ERP image I_t+1

143: "field of view": How much for the icosahedron map? (72°?)

233-237: A 3D rotation depends on three parameters: Here, only 2 of them are determined.
I understand the horizontal rotation (around the axis of the sphere), i.e. around the vertical axis, i.e. the yaw angle (when referring to a vehicle)
I do not understand the vertical rotation: around which axis is rotated? Is it the roll or the pitch angle which is determined?
This method certainly does not yield correct rotations, since only two parameters are determined, and the vertical rotation cannot be determined as described.
....
The 3D rotation could be determined from the set of tangent images: each tangent image provides a 3D rotation based on the optical flow for that image using ARUN/HUAND/BLOSTEIN's 1987 's method "Least squares fitting for two 3D point sets" (Section III) for determining the rotation from two point sets (start and end point of the optical flow vectors, taking the focal length as third coordinate) and taking the local coordinate system into account. Averaging the rotations would lead to a global 3D rotation with 3 parameters, which can be transfromed into a vector field in any of the chosen maps.

243: "use the cubemap" How is this done?
may be here is something correct hidden ...

278-281: So, only the yaw angle is changing.
What happens if the path is hot horizontal, but a serpentine in a hilly terrain with pitch angles up to +- 10° and roll angles of up to +- 6
("The influence of vehicle body roll angle on the motion stability and maneuverability of the vehicle"
by
K. Parczewski, H. Wnek
Published 2017
Geology
Combustion Engines)
https://pdfs.semanticscholar.org/5629/75fbd749d9cd460a32905ee09f406812bc2c.pdf
The experiment is too limited.
The conceptual error when determining the vertical rotation cannot be detected by this experiment.

282: No, the data set is not "highly realistic"

313: "global rotation": no, only horizontal one!

**Reviewer #2**

## Questions

**1. [ Paper Summary ] What are the key ideas, what is the significance and how are the ideas validated? Please be concise (3-5 sentences).**
A 360 optical flow estimation method is proposed, to account for equirectangular distortion and large camera-rotation. Main idea is to use tangent images with existing flow estimation and stitch them together. Results seem promising with comparison to general methods.

**2. [ Paper Strengths ] Please summarise the strengths of the paper. (Eg: novelty, insight, theoretical strength, state of the art performance, thorough evaluation). Please provide a clear explanation of why they are valuable.**
1. it's interesting to see flow estimation using 360 images;
2. simple extension based on existing flow estimation, but works well;
3. the multi-step global warping method is nice.

**3. [ Paper Weaknesses ] Please summarize the weaknesses of the paper. (E.g., Lack of novelty, technical errors, insufficient evaluation, etc). You should clearly justify your criticisms with precise and factual comments (E.g., with an explanation of technical errors, citation to prior work if novelty is an issue). Please note: It is not appropriate to ask for comparison with unpublished arXiv papers, and papers published after the BMVC deadline. Please be polite and constructive.**
1. it is not clear how multiple tangent flows are stitched together;
2. it is a shame that only perspective SOTAs are considered in evaluations, though some recent work consider 360 in flow estimation;
3. some insight analysis is missing to support the idea that blending is helping boundary area. Some qualitative results with highlights at overlapping locations will be nice to show this.

**4. [ Overall Rating ]**
Borderline Accept

**5. [ Justification of Rating ] Please explain how the different strengths and weakness were weighed together to produce the overall rating. Please provide details of questions or ambiguities to be addressed in the rebuttal that might change your rating.**
The proposed optical flow method is a valuable addition to the family of omnidirectional image applications. The idea of making use of tangent images for flow estimation is sensible and proved to be effective. However, the effect of weight blending and rotational warping is not prominent. Most importantly, evaluation comparisons are limited to methods using perspective methods.

**Reviewer #3**

## Questions

**1. [ Paper Summary ] What are the key ideas, what is the significance and how are the ideas validated? Please be concise (3-5 sentences).**
The proposed method suggests leveraging gnomonic projection to convert the ERP images in a sequence of steps and calculate the motion field in each step. These motion fields are then combined to form the final estimation. The results show that the proposed method can achieve state-of-the-art performance in comparison with other state-of-the-art motion estimation techniques

**2. [ Paper Strengths ] Please summarise the strengths of the paper. (Eg: novelty, insight, theoretical strength, state of the art performance, thorough evaluation). Please provide a clear explanation of why they**

**are valuable.**
The paper is well written and well structured, the figures are also informative and of good quality.

The idea seems to be novel and the performance shows significant improvement in comparison to other motion estimation methods.

**3. [ Paper Weaknesses ] Please summarize the weaknesses of the paper. (E.g., Lack of novelty, technical errors, insufficient evaluation, etc). You should clearly justify your criticisms with precise and factual comments (E.g., with an explanation of technical errors, citation to prior work if novelty is an issue). Please note: It is not appropriate to ask for comparison with unpublished arXiv papers, and papers published after the BMVC deadline. Please be polite and constructive.**
There are some major concerns about this idea.

How all the networks whose performance is reported in table 1, are trained? How about the fine-tuning process?

The suspicion is that if all the networks are trained to estimate motion between two normal frames, then there is no way they can generalize to this application. In that case, the authors are comparing two different things in table 1 which is not correct. Here, the objects in between the two input frames undergo significant distortion and that is why the proposed converting scheme works well in comparison with the estimation of a network that is trained on normal data.

These methods (e.g. PWC-Net, RAFT) are very powerful techniques and if the combination of the resolution of the input data (NOT mentioned in the paper) and the motion distribution in the data (NOT mentioned in the paper) fit in their range of operation, there is considerable doubt about the large gap in the reported results.

**4. [ Overall Rating ]**
Borderline Reject

**5. [ Justification of Rating ] Please explain how the different strengths and weakness were weighed together to produce the overall rating. Please provide details of questions or ambiguities to be addressed in the rebuttal that might change your rating.**
Please refer to the weaknesses section.

**6. [ Suggestions to Authors ] Any further comments to the authors and suggestions for improving the manuscript (e.g. typos). These are not relevant for your rating.**
Please refer to the weakneses section.

**Reviewer #4**

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## Questions

**1. [ Paper Summary ] What are the key ideas, what is the significance and how are the ideas validated? Please be concise (3-5 sentences).**
This paper proposes a 360 optical flow method based on tangent images. For 360 optical flow, the author define an optical flow suitable for equirectangular. The method leverages gnomonic projection to locally convert ERP images to perspective images and samples the ERP images to a cubemap and icosahedron faces. The proposed method is evaluated on synthetic and real datasets.

**2. [ Paper Strengths ] Please summarise the strengths of the paper. (Eg: novelty, insight, theoretical strength, state of the art performance, thorough evaluation). Please provide a clear explanation of why they are valuable.**

- The author created an optical flow dataset directly through the replica dataset. Then, after dividing the camera path by circle/line, they performed experiments. In addition, it was tested with a real dataset.
- It accurately pointed out that the performance of the optical flow network for the existing perspective image is not good in the ERP image, and the problem is solved using tangent images.
- The author proposed a warping-based global rotation optical flow. Although warping-based optical flow has been proposed in previous studies, a new suggested method on 360 is valuable.
-The advantages of ERP, cubemap, and icosahedron representations were mentioned, and they proposed a new network fusion framework.

**3. [ Paper Weaknesses ] Please summarize the weaknesses of the paper. (E.g., Lack of novelty, technical errors, insufficient evaluation, etc). You should clearly justify your criticisms with precise and factual comments (E.g., with an explanation of technical errors, citation to prior work if novelty is an issue). Please note: It is not appropriate to ask for comparison with unpublished arXiv papers, and papers published after the BMVC deadline. Please be polite and constructive.**

- projection & stitching

[Projection & stitching - tangent optical flow blending] part needs to be written in more detail. Two terms for calculating the blending weight should be explained in terms of formulas. It cannot be determined whether weights that can help optical flow blending are created based on the currently written content. Even in ablation, w/o weight results outperform the full method. It is necessary to look further to see if there are any problems with the methodology. In addition, since optical flow is obtained after separation into several perspective images, performance degradation in optical flow blending can be a fatal disadvantage of the methodology presented in this paper.

- Global rotation warping

This paper divided a horizontal flow component and a vertical flow component to obtain horizontal rotation and vertical rotation, respectively, but in reality, an optimization method is needed to find a rotation matrix that minimizes the error with the estimated optical flow. I would like to see a more mathematical derivation process.

-Weakness of Proposed framework

The currently proposed framework is a structure that cannot operate robustly for large translations. If the translation is large, the rotation matrix, which corrects it to enter the FOV area before the icosahedron, cannot play any role. If that happens, there will be more pixels that the optical flow will go out of the tangent image. Your framework has a critical issue.

-Comparison with previous 360 optical flow network

As mentioned in the related works of this paper, there are recent papers on 360 optical flow [2,5]. However, the author does not mention any advantages of the proposed methodology compared to these recent papers. The author needs to explain in detail what strengths it has when compared to the existing methodologies.

**4. [ Overall Rating ]**

Borderline Reject

**5. [ Justification of Rating ] Please explain how the different strengths and weakness were weighed together to produce the overall rating. Please provide details of questions or ambiguities to be addressed in the rebuttal that might change your rating.**

The strength of this paper is that it has experimentally proven that the existing methods used in the perspective image do not work well in the ERP image, and that a new methodology that works well in the ERP image is presented. However, the proposed framework has weaknesses in the lack of a formal derivation process and explanation for the methodology. Also, the author does not mention any advantages of the proposed methodology compared to these recent papers. Therefore, I give borderline reject.

**6. [ Suggestions to Authors ] Any further comments to the authors and suggestions for improving the manuscript (e.g. typos). These are not relevant for your rating.**

In summary, the biggest concerns are as follows:

1) Additional mathematical explanations are needed for optical flow blending and global rotation warping, which are some of the methods presented in this paper. It is impossible to judge how good the proposed methodology is based on the current writing alone.

2) Compared with the methodologies presented in previous papers on 360 optical flow, the author needs to clearly explain the strengths of the methodologies presented in this paper. The models compared to the proposed in paper are not 360 optical flows.

Comment and Plan from Mingze Yuan:

Deadline of revision 3 September 2021 (23:59 GM).Paper improvement plan:1. Add camera moving verticall