Dear reviewers,

Thank you very much for your reviewing. The revised descriptions are as follows.

Reviewer 1

English language and style
(x) Extensive editing of English language and style required
( ) Moderate English changes required
( ) English language and style are fine/minor spell check required
( ) I don't feel qualified to judge about the English Language and Style

	Yes	Can be improved	Must be improved	Not applicable
Does the introduction provide sufficient background and include all relevant references?	(x)	( )	( )	( )
Is the research design appropriate?	(x)	( )	( )	( )
Are the methods adequately described?	(x)	( )	( )	( )
Are the results clearly presented?	(x)	( )	( )	( )
Are the conclusions supported by the results?	(x)	( )	( )	( )

Comments and Suggestions for Authors

In the abstract, the wording "an self..." should become "a self..."; "needn't" should be "need not". Abstract lacks clarity and logical connections between the sentences, therefore must be rewritten completely

R: We changed "an self..." into "a self...".

We rewrote the abstract.

"In remote sensing photogrammetric applications, inner orientation parameter (IOP) calibration of remotesensing camera is a prerequisite for determining image position. However, achieving such a calibration without temporal and spatial limitations remains a crucial but an unresolved issue to date. The accuracy of IOP calibration methods of a remotesensing camera determines the performance of image positioning. In this paper, we propose a high-accuracy self-calibration method without temporal and spatial limitations for remotesensing cameras. Our method is based on an auto-collimating dichroic filter combined with a surface micromachining (SM) point-source focal plane. The proposed method can autonomously complete IOP calibration without the need of outside reference targets. The SM procedure is used to manufacture a light transceiver focal plane, which integrates with point sources, a splitter, and a complementary metal oxide semiconductor sensor. A dichroic filter is used to fabricate an auto-collimation light reflection element. The dichroic filter, splitter, and SM point-source focal plane are integrated into a camera to perform an integrated self-calibration. Experimental measurements confirm the effectiveness and convenience of the proposed method. Moreover, the method can achieve micrometer-level precision and can satisfactorily complete real-time calibration without temporal or spatial limitations."

The whole article requires a professional proofreading

R: We proofread this paper.

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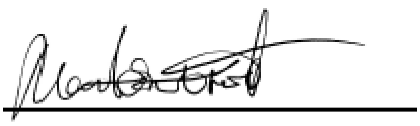
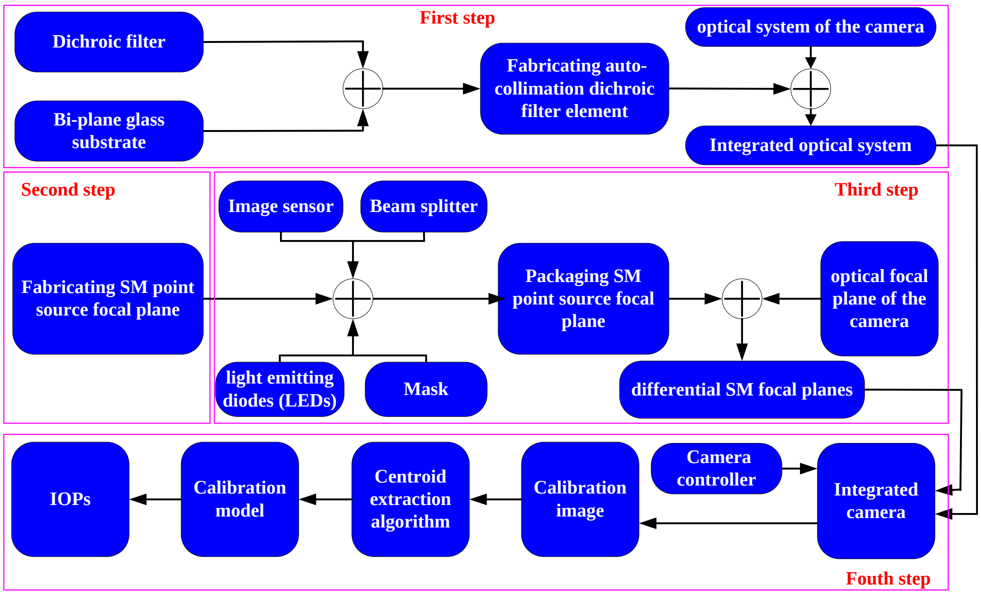


Martin J. Booth

The self calibration method better be described using a logical chart for a better clarity

R: We added the logical chart to describe the self-calibration method in section 2.



Reviewer 2

English language and style

(x) Extensive editing of English language and style required

( ) Moderate English changes required

( ) English language and style are fine/minor spell check required

( ) I don't feel qualified to judge about the English Language and Style

	Yes	Can be improved	Must be improved	Not applicable
Does the introduction provide sufficient background and include all relevant references?	(x)	( )	( )	( )
Is the research design appropriate?	(x)	( )	( )	( )
Are the methods adequately described?	(x)	( )	( )	( )
Are the results clearly presented?	(x)	( )	( )	( )
Are the conclusions supported by the results?	(x)	( )	( )	( )

Comments and Suggestions for Authors

The self-calibration method described in the paper is very interesting and the method is well described. The proposed solution offers high accuracy and solves temporal and spatial limitations. However, It would be interesting to explain if it would be possible to integrate the proposed method in optical systems.

R: we added the explanations of integrating the proposed method in optical systems in Section 2.

"The SMFP is installed on the interleaving area between two CCD sensors of the focal plane assemblies. A dichroic filter element is also integrated into the optical system of the camera. The calibration optical path can be designed based on the optical system of the camera. The dichroic filter element can be installed on the supporting truss of secondary mirror of the optical system. Based on the size of the truss of the secondary mirror, the size of a dichroic filter element can be determined without extra light obstruction. The reflection angle of the dichroic filter element is designed based on the field of view of the camera."

By other hand, there are many writing and grammar errors in the paper. The number of pages is also counted incorrectly

R: We polished this paper.

We corrected the number of pages.

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Martin J. Booth

Reviewer 3

Self-Calibration Method Based on Surface Micromaching of Light Transceiver Focal

Plane for Optical Camera

Jin Li 1,2,3,4* , Si Liu 6 , and ZhengJun Wang1,2,3

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6 School of Engineering and Information Technology University of New South Wales, Canberra, Australia

R: One author is missing. We add the author whose number is 5.

"Jin Li,[1,2,3,4*], Yuan Zhang,[5] Si Liu,[6] and ZhengJun Wang[1,2,3]"

SOME PRINCIPAL REMARKS

There are, of course, in-orbit methods for determining the quality of the wave fronts in front of the detector array by means of a special optical hardware. Please give some hints in your paper.

R: We added the descriptions about this point in introduction section.

"To complete the high-accuracy positioning of remote sensing camera, high imaging quality and high calibration accuracy of IOPs are needed. Numerous technologies have been proposed to improve the imaging quality of remotesensing cameras [14–15]. Specifically, a special optical hardware, such as wave front sensor [16], can determine the quality of wave fronts in front of detector array to correct dynamic optical aberrations that blur images. Advanced technologies can ensure high imaging quality for remotesensing cameras."

For a resolution on the ground of less than 0.5 m GSD the earth is no longer infinitely far. If the satellite is rotated by 35 ° or 40 ° (in roll direction), the image sharpness changes. How are they taken into account in your calculation?

R: Our method does not depend the ground targets to calibrate internal parameters. The camera itself can calibrate the internal parameters. The lights of point-sources on optical focal plane pass through the optical system to become the parallel lights. The parallel lights are reflected and again pass through the optical system and converge to the focal plane. If satellite is rotated by 35 ° or 40 ° (in roll direction), the calibration image sharpness may change. We use the centroid extraction algorithm based on mathematical morphology to obtain the position information. These extraction algorithms can accurately extract the centroid of image point from the background noises.

The evaluator of the satellite data uses a different model for the inner orientation (e.g., the Brown model). How, in particular, is the intersection of the optical axis with the focal plane determined in your model?

R: We adopt two conjugated SMFPs to build a differential structure to perform calibration calculation. Two conjugate SMFPs are symmetrical with respect to the

intersection of the optical axis with the focal plane. The center of line between two conjugate SMFPs is the intersection of the optical axis with the focal plane.

How do you handle distortion? (If you use a 3 Mirror telescope, you will have distortion.)
R: In order to reach 5m positioning precision, the distortion correction requires 5μm precision. We use multiple point sources to calculate the optical system distortion by using the least square method.

PROPOSED SELF-CALIBRATION METHOD

A good overview about accuracy:
For example, in order for an camera to reach a positioning accuracy of 5m, the distribution of primary errors of the camera should be as follows:
(1) the attitude determination accuracy is within 10”(angular seconds);
(2) the precision orbit determination is within 0.2m;
(3) the angle calibration accuracy between the star tracker and the optical camera is within 5";
(4) camera lens distortion calibration accuracy is within 5μm;
(5) the principal distance calibration accuracy is within 50μm;
(6) the principal point calibration accuracy is within a third of a pixel.
An important consideration, how these error requirements comes from, how calculated and how do the error requirements change when using a system as described later (pp. 11, l312)?
R: The error distribution of a remote sensing camera is obtained by the positioning algorithm. Without GCPs, the error distribution equation can be built based on position of homologous pixel point of forward-looking and back-looking images, IOP, and a series of coordinate transforms from camera to ground. Generally, the error distribution can be divided into two aspects: (1) camera imaging, the accuracy includes pixels points’ measurement error and IOP measurement accuracy. (2) position and attitude accuracy at forward-looking and back-looking imaging time. Combined with the device performance of satellite, the error distribution equations can calculate the optimal error distribution.

The description of the basic principle is difficult to understand. Fig. 1 shows the telescope and the optical beam path. The direction of the red and blue rays should be draw in. What means Target, and the big latter A, B & C. What means the spot image down, left. How the sketch in the middle left related to the the upper drawing.
Summery: Fig. 1 needs a much more better description, the colors should be change to improve the contrast.
R: (1) We modified the description of the basic principle. We added the figure explanations.

“These lights are then sensed by the charge-coupled device (CCD) sensor to complete on-orbit imaging. In Fig. 1, A denotes the auto-collimation dichroic filter, which is plated on a bi-plane substrate located near the secondary mirror to fabricate an auto-collimation light reflection element. In Fig.1, B denotes the focal plane of the remote sensing camera. In the focal plane B, multiple CCD sensors use a stagger arrangement strategy (Fig. 1 (b)).Two conjugated SM-PSFPs are installed on the interlace area on focal plane assembly B. Moreover, C denotes one of the SM-PSFPs. In the interlace area, the point-source photomask, beam splitter prism, and image sensor are integrated into SM-PSFP C (Fig. 1 (d)). When the LED of the SM-PSFP is lighted, the lights pass through the photomask to produce multiple point sources. The splitter prism turns the lights of the point sources by 90°. In other words, the point sources outgo lights from the sensor surface of the SM-PSFP on the focal plane. The gray and color scales of an equivalent points ource are shown in Fig.1(d). These scales show a Gaussian distribution. Fig.1(c) shows the equivalent path. The auto-collimating light path includes two point sources, a camera lens, an auto-collimation dichroic filter, and an image detector. According to the optical path of camera, the SM point sources are auto-collimating lights when they pass through the focusing, folding, tertiary, primary, and secondary mirrors of camera lenses. Moreover, the auto-collimating lights are reflected by the auto-collimation dichroic filter and return to the camera lens. Outgoing lights of the camera are incidents on the focal plane detector."

(2) We add the direction of the red and blue rays in Fig.1.

(2) We changed the colors in Fig.1.

The function of a dichroic filter is known. Why is this used here? In Fig. 2, on the left, we now have red, green, and blue rays. In what context is the image of Fig. 1?

R: (1) we added the explanations of the using of the function of a dichroic filter.

"Following the requirements of calibration accuracy for the remotesensing camera, Eq.1 can determine the angle of the two planes of the dichroic filter element. For example, the extraction accuracy of our centroid extraction algorithm is less than 0.1 pixels and the pixel size of the image sensor is 6 μm. When α≥0.35°, the designed calibration accuracy is less than 0.05 mm. Therefore, the angle between the two planes of the dichroic filter element mustbe larger than 0.35°."

(2) In Fig.1, the rays are also red and blue. We added the label in the Fig.1 like Fig.2.

Please shorten the section from (pp.5, l.160) to (pp.6, l.185) drastically.

R: We shortened the descriptions from (pp.5, l.160) to (pp.6, l.185) drastically.

"In the second step, we fabricate an SM-PSFP and then integrate it into the optical focal plane of camera. The SM point sources are installed on the focal plane. This arrangement indicates that the monitoring optical path is auto-collimating. Thus, principal distance and principal point can be monitored as needed. To ensure a sufficiently small size and low power consumption, we use SM procedures to fabricate a point-source focal plane. The point-source focal plane is mainly composed of the fabricated mask by the SM process, a housing, and an electrical system. The assembly of the point-source focal plane is shown in Fig. 4. The fabrication process of the mask can be summarized into two steps: (1) chromium, gold, and tantalum materials are plated on a specified glass substrate; and (2) photoetching is performed on the metal layers to obtain several small apertures."

CALIBRATION CALCULATION BASED ON THE DIFFERENTIAL SM FOCAL PLANES

The calculations and the representations are somewhat in-transparent. Please improve.

R: We polish the calculation and the representations.

EXPERIMENT AND ANALYSIS

Table 2 – what is Δ/?, Please reformat deviation in (μm)

In both tables please only use the necessary numbers behind the comma.

R: (1) We add the explanations of Δ*l*.

"In Table 2, Δl is the variation of relative positions of the two SMFPs (Eq.16)"

(2) We reformat deviation in (μm).

(3) We changed the numbers behind the comma in both tables.

General Remarks

As a reader it seems that the paper consists of three different text parts. It is well seen in the optical sketches:

Fig.1, middle, left

Fig. 4, upper right

Fig. 5

Fig. 6 & 7

The test and the figures should be unified.

R: We unified the test and the figures.

The reader does not understand why the semiconductor-physical part and the microprocessing are explained in detail. It should be summarized in this paper strongly and in a separate paper published.

R: We shortened the descriptions from (pp.5, l.160) to (pp.6, l.185) drastically.

In Fig. 6 & 7 the colors should be changed because of the bad contrast.

R: We changed the colors in Fig.6 &7.

The text contains many language errors or typos and is partially badly formatted (especially the tables). Sometimes blanks are missing or there are too many.

R: We polished this paper. We also corrected the format.

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Signature of the editor representative:

Martin J. Booth

Here is a conflict:
Author Contributions:
J.L. and F.X. designed initial experimental scheme, and suggested the directions of the experiments. **J.L. and Y.Z.** deduced the accuracy measurement method algorithm, performed the experiments, analyzed the experiments data, and wrote the manuscript. **Z.L. and Z.W.** processed and analyzed the experiments data. **S.L.** analyzed the experiments data and revised the manuscript. All authors reviewed the manuscript.
Authors are
JL - Jin Li
SL - Si Liu
ZW - ZhengJun Wang
Who is F.X., Y.Z. & Z.L.?
R: We corrected the mistakes. Authors are:
JL - Jin Li
SL - Si Liu
YZ- Yuan Zhang
ZW - ZhengJun Wang
“J.L. designed initial experimental scheme, and suggested the directions of the experiments. J.L. and Y.Z. deduced the accuracy measurement method algorithm, performed the experiments, analyzed the experiments data, and wrote the manuscript. Z.W. processed and analyzed the experiments data. S.L. analyzed the experiments data and revised the manuscript. All authors reviewed the manuscript.**”**