Dear Editor and Reviewers:

Thanks a lot for your valuable and professional suggestions on our manuscript!

The replies to the comments are shown as follows.

To the comments of the first reviewer:

1. Q: *Title should be changed, as it does not reflect the content of the work.*

   A: The title of this paper has been revised as "Navigation Algorithm Based on the Boundary Line of New and Old Soil Combined Using Guided Filtering and Improved Anti-noise Morphology" to reflect the main content of the paper.

2. Q: *Nomenclature: "new/old soil", "traditional morphology", "advanced morphology", "structural elements"?*

   A: We have grammatically modified the relevant vocabulary to "new and old soil", "basic morphology", "improved anti-noise morphology" and "Structuring elements".

3. Q: *Organization of a manuscript. Section "Materials and methods" contains only some methods and no materials. Sections 3 and 4 should be part of it. The whole manuscript should be reorganized.*

   A: We have reorganized the manuscript structure.

4. Q: *Description of "intelligent tractor" is not detailed enough. Also, where is the photo of "steering configuration" (Fig. 1 b)?*

   A: The intelligent tractor refers to the traditional tractor updated by using the driving robot designed by the laboratory independently. The tractor driving robot consists of a steering arm, a gears-shifting arm, a break leg, a clutch leg and an accelerator leg which can operate a tractor imitating a tractor driver. The steering arm uses steering motor to driver the steering wheel of the tractor through gears and chain. The pictures of steering configuration and structural schematic diagram were given in the revised paper.

5. Q: *Language - should be improved (e.g. first sentences of Sections 2 and 4).*

   A: We have grammatically modified the relevant vocabulary.

6. Q: *Language - not very scientific in certain places (e.g. "edge dealing"?).*

   A: We have grammatically modified the relevant vocabulary.

7. Q: *Quality of Figs. 2, 5 and 22.*

   A: We have redrawn the above picture in high quality.

8. Q: *Section 4 - Structuring (not structural!) elements are given without honest explanation of their shape and size. In morphological image processing size of structuring element remains in close relation with resolution of processed image (or more precisely - the size / scale of the interesting elements in the picture).*

A: A new set of pictures is used for verifying the effectiveness of our proposed anti-noise morphology algorithm in section 4. The only difference is edge operator during image processing, one is the basic morphology and the other one is anti-noise morphology algorithms. The pictures show that our proposed anti-noise morphology algorithm can decrease the error caused by truncation effect.

9. Q: *Where are references for methods of image processing in Sections 3 and 4? Where is explanation for operators in Eqs. 7 and 8, and where is substantiation for these equations?*

A: (1) The reference of Guided Filtering algorithm in Section 3 is listed behind [He, K.; Sun, J.; Tang, X. Guided Image Filtering. IEEE Transactions on Pattern Analysis and Machine Intelligence 2013, 35, 1397-1409, doi:10.1109/tpami.2012.213.] which has been cited in the introduction part.

(2) The improved anti-noise morphology algorithm was proposed by us in this paper in Section 4. Let f is a grayscale image and B is the matrix of structuring elements. $\oplus$, θ, $\circ$ and $\cdot$ represent expansion operator, corrosion operator, opening operator and closing operator respectively in morphology operation. The edge detection operators are defined as below:

Operator name	Equation	Description
Edge detection gradient operator	$E_1 = f \oplus B - f$	Using expansion operator
Edge detection gradient operator	$E_2 = f - f\theta B$	Using corrosion operator
Edge detection gradient operator	$E_3 = f \oplus B - f\theta B$	Combined using expansion and corrosion operators
Edge detection gradient operator	$E_4 = f - f \circ B$	Using opening operator
Edge detection gradient operator	$E_5 = f \cdot B - f$	Using closing operator
Edge detection gradient operator	$E_6 = f \cdot B - f \circ B$	Using opening and closing operators

By using combination of the operators mentioned above and comparing the experimental results, we got the improved anti-noise morphology operator, as shown in Figure 6, which has advantages such as strong noise resistance, good continuity of extraction line and low edge truncation effect compared with the basic morphology operator.

10. Q: *Fig. 9 - Comparison of different views is pointless. It should be one view with different illumination.*

A: Two pictures of the new and old soil boundary lines in the same place under different light illumination were used to test the effect of Homomorphic Filtering algorithm, which is popular in other applications. The results show that Homomorphic Filtering algorithm is not suitable in new and old boundary line extraction.

11. Q: *Section 5.2 - how was the tractor guided? I presume that the described algorithms were implemented in some kind of microprocessor of CPLD/FPGA? It must be described in detail!*

A: The tractor steering arm is controlled by a motor driver which connected to an industrial computer via 485 bus. The proposed algorithm is run on the industrial computer.

12. Q: *Where is discussion of results with literature?*

A: The discussion of results with literature was given in the last section of the paper.

To the comments of the second reviewer:

Q: *The authors should separate the vision algorithms from the experiments with driving the tractor. The results from the vision side, should be compared to realistic datasets available, and the autonomous plowing should be compared to existing solutions.*

A: We have separated the vision algorithms from the experiments with driving the tractor in the section of experiment. The results have been compared with the existing solution in the last section which shows the advantage of our method.

To the comments of the third reviewer:

1. Q: *Sections 3-4 is a subsection of section 2 (M&M) and should be modified. Moreover some subsections of section 5 reported results and should be positioned in a different part of the paper.*
   A: We have reorganized the manuscript structure.

2. Q: *A discussion section in light of the scientific literature is completely lacking and should be improved.*
   A: The discussion of results with literature was given in the last section of the paper.

3. Q: *In order to further increase the efficiency of the proposes algorithm, do the authors consider methods for color standardization, such as the one proposed by Menesatti et al. 2012 (3D Thin-Plate Spline) published on SENSORS? Please discuss.*
   A: The 3D Thin-Plate Spline method is very good. We will use it in our future work and have cited it the last section of the paper.

4. Q: *Please substitute & with 'and' all over the text.*
   A: We have fixed the issue.

   Thanks again for your valuable suggestions! It is of great significance for improving this article.

   Best regards!

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Wei Lu

8/25/2019
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