Response to Reviewer 3 Comments

Thank you very much for your comments. We wish to express our appreciation to the reviewer. The comments have helped us greatly to improve our paper.

**Point 1:** In the Introduction section (line 39), the text references implies that the present work is about a sensor operating in low frequencies, which is confirmed when 5khz as the maximum frequency presented. However, in the section Results and Discussion, the use of high frequency in obtaining the desired results is quoted three times (lines 209, 221 and 229). For the reader it may be difficult to understand the statement "high frequency" when substantially higher frequencies are frequently used for eddy current inspection.

**Response 1:** Exactly as you pointed out, the reader may be confused about the high frequency. We just would like to introduce the low frequency operation as one application of magnetic sensor for non-destructive inspections. To make the purpose clear, we have introduced other advantage of magnetic sensor as bellow:

(Lines 42-44)
In addition, the magnetic sensors are typically small and can detect the magnetic flux density with high resolution. Therefore, the differential of local magnetic flux density can be measured more flexibly using the magnetic sensor array.

The method proposed in this paper made use of the advantage of resolution.

**Point 2:** In the Test Sample and Measurement System, section it is unclear why a frequency range between 200 Hz and 5 kHz (line 84) was used in the flat plate test sample, while a range between 1 kHz and 5 kHz (line 92) was used in the U-shaped ribbed test sample.

**Response 2:** At first, we investigated the basic magnetic responses using the flat plate and the frequency rage was determined by our measurement systems. For the result of the measurement of flat plate, it was found that the range between 1 kHz and 5 kHz was better than 200 Hz and 500 Hz. Therefore, the measurement of U shape rib sample performed between 1 kHz and 5 kHz.

**Point 3:** Are there any application requirements for the choice of lift off between 0.1 and 0.9 mm (line 85) in the lift off study? If there is such a motivation, I believe it would be interesting to contextualize it for the reader.

**Response 3:** We have considered the condition of actual complicated structures and choose the liftoff range. The reason has been added as bellow:

(Lines 91-93)
It is expected that real structures are covered by a thin paint which is uneven and cracked. In addition, for the complicated part of structure, manual probing is required. For this reasons, we assumed the liftoff change to be between 0.1 mm and 0.9 mm under this condition.
Point 4: In the Simulation of Eddy Current and Magnetic Field Distribution, section the reader is not explained why the simulation is performed only by applying the 1 kHz frequency (line 102).

Response 4: The purpose of simulation was to estimate the approximate eddy current distribution and the detectability of the intensity of crack signal inside the induction coil. Therefore, one frequency was enough to achieve the purpose.

Point 5: I wonder if the last paragraph (lines 113-122) and Figure 5 would not be a part of Results and Discussions section.

Response 5: It would be better that the result of simulation was in the part of Result and Discussions section. However, we would like to unify the simulation part and separate it from the actual measurement part, because the main discussion of this paper based on the measured results.

Point 6: In the subsection Crack signal of single sensor, again it is not clear to the reader the reason for choosing the 1 kHz (line 132) as the working frequency.

Response 6: The purpose of the subsection was to show the typical crack signal corresponding to the slit. Therefore, as well as the Point 4, one frequency was enough. The discussion of frequency was described in the 4.4 subsection.

Point 7: The connection sentences (lines 198-200) between the subsections Lissajous curve of the differential vector and Frequency dependence of the crack signal have contributed a lot to the contextualization and fluidity of the text. The same was done (lines 230-233) in the subsection Steel cracks in a complicated structure. It would be an interesting exercise, and can enrich the text, make the same type of textual connection at the end of the Liftoff dependence of the differential parameter subsection.

Response 7: Thank you very much for your suggestion. We have reflected the suggestion and added the sentence at the end of the subsection as bellow:

(Line 194)
In the next subsection, the Lissajous curve of differential parameter is described.

Point 8: The contextualization of the Lissajous curve (line 183) could be earlier in the text.

Response 8: We agreed with you, so we deleted it.

Point 9: Figures 10 and 14 could be larger. They are difficult to see, especially when viewed in grayscale.

Response 9: We made the figures larger.
Point 10: The Conclusions section is clear and assertive. However, the results generated from Simulation of Eddy Current and Magnetic Field Distribution section were not mentioned. In this way, I question again the importance for this work.

Response 10: As you pointed out, the result of simulation was not mentioned. We have revised the conclusion as bellow:

(Lines 270-276)
The extraction method for the detection of cracks in complicated structures was developed. It was shown by simulation and measurement that the crack signal could be obtained with the small sensor probe using the dual-channel TMR sensor and the differential parameter reduced the influence of the liftoff signal. The Lissajous curves of differential parameter clearly differentiated the crack signal and liftoff signal which occurs when probing the complicated structure. Therefore, the extraction technique can be applied to the inspections not only for the welds but also for the other complicated steel structures to detect cracks reliably.