Response to Reviewer #2 (Manuscript ID: applsci-1883462)

Sep 3, 2022, Takuto Ogawa, Kengo Asada, Makoto Sato, Tomoaki Tatsukawa, and Kozo Fujii

This manuscript is the revision of the original manuscript (ID: applsci-1883462). We wish to express our appreciation to the reviewer for the fruitful comments toward revision. We revised the original manuscript according to the comments from the reviewers. Also, in response to the assistant editor's remarks regarding the similarity, we have made some improvements to reduce the similarity. Most of the similarities were due to the commonalities in the equation explanations with other papers, and the descriptions have been modified to show the difference. In addition, although not specifically pointed out by reviewers, we are currently working with "MDPI English Editing Service" to make minor typographical corrections in order to further refine the manuscript.We hope this revision will facilitate the publication of our manuscript in the special issue of *MDPI Applied Science Journal*.

First, here are an overview of 2 extensive revisions in the manuscript.

1. Adding a new section
   We have added a new section (Sec. 4.5) to clarify the novelty of the present study.
   With this addition, the novelty descriptions in the Abstract, Introduction, and Conclusions have also been modified.
2. Adding a new table
   We have added a new table (Table. 2) to explain the validation of the present simulations more carefully.
   With this addition, some sentences are appended for an explanation of the table.

Second, here are your main comment and my response.

Large-eddy simulations of the flows over a NACA0015 airfoil were conducted to investigate a flow control authority of a dielectric barrier discharge plasma actuator at pre-stall angles of attack. The paper topic is interesting to the reader. The LES simulation is quite challenging. The simulation results are explained. However, the novelty is not apparent. The discussion and analysis need to be more profound. Therefore, the recommendation for the publication is a revision, and provide the following comments for correction.

A. To make the discussion more profound, we have added a new section (Sec. 4.5) for comparing cases of pre-stall angles and post-stall angles. The novelty clarified by the addition of Sec. 4.5 is shown in the section of Abstract, Introduction, and Conclusions. More details are described in following responses to your concerns.

Third, here are your 4 concerns and my responses.

C1. I recommend that the author add some literature and rewrite their introduction by identifying the previous research gap in the computational study of plasma actuator flow control. What is the strong point of using the LES simulations? What is the novelty of this paper?

A1.1. Regarding the novelty of the present study
There are two main novelties of the present study. The first novelty is confirming the good flow control authority of the plasma actuator for the aerodynamic characteristics of the airfoil at pre-stall angles of attack. The second novelty is clarifying the difference in control mechanism of the burst actuation with higher burst frequency (F^+=6) at the near-stall angles (α = 10 and 12) and the lower angles (α = 4, 6, and 8). The discussion for the first novelty was

described in the section of aerodynamic characteristics (Sec. 4.2). However, the discussion for the second novelty was not written sufficiently. Therefore, we have added the new section (Sec. 4.5) for the discussion for the second novelty. And these main points have been appended to the section of Introduction (Secs. 1, Lines: 93-104), Abstract (Lines: 8-14), and Conclusions (Sec. 5, Lines: 533-546). In addition, some paragraphs have been modified in Sec. 1 (Lines: 46-63) with citing several literature [8–13]. to identify the previous research gap in the computational study of plasma actuator flow control.
In Sec. 4.5, the second novelty is shown by comparing cases of near-stall angles and the lower angles. At both near-stall and the lower angles, an improvement in aerodynamic characteristics is observed, but the phenomena leading to the improvement is different. At near-stall angles, the turbulent transition is rapidly promoted by the plasma actuator, and the flow is reattached. Whereas, at the lower angles, the transport of two-dimensional vortex structures, which maintain their structures up to downstream and suppress the turbulent transition, makes the flow reattachment.

A1.2. Regarding the advantage of LES
The advantage of LES is that the influence of flow controls using the plasma actuator on the flow can be analyzed in detail. Previous studies [2, 4] show that small fluid fluctuations such as turbulence play an important role in fluid controls using the plasma actuator. In the Reynolds-averaged Navier-Stokes equation (RANS) method, the small fluctuations induced by the plasma actuator are immediately damped. Therefore a high-fidelity LES is required to simulate the small fluid fluctuations properly. These explanations have been appended to Introduction (Sec. 1, Lines: 87-91).

C2. The paper uses a NACA0015 airfoil for computational simulation. It is a symmetrical airfoil, and a few real wings use this kind of airfoil. Therefore, the reason for determining the geometrical model and setup needs to be explained in detail. Moreover, the limitation of the simulation results should be stated in the paper due to only a specific model, and a numerical setup was selected.

A2.1. Regarding the reason for determining the geometrical model and setup need
The reason for determining geometrical model to the NACA0015 is because of the NACA0015 airfoil flows have been investigated in many previous studies [1–5], and a wealth of experimental and numerical data is available for comparison. The thickness of this airfoil is not practical for actual flights. However, such a thick airfoil is less restrictive in structural design and has the advantage that a large amount of fuel can be loaded inside a wing. Therefore, the range of aircraft design possibilities will expand if the flow controls can improve the aerodynamic characteristics.
So, we considered the NACA0015 as an appropriate model to use for the present study. These explanations have been appended to the Introduction (Sec. 1, Lines: 78-85).

A2.2. Regarding the limitation of the simulation
Although quantitative conclusions cannot be shown because the magnitude of an improvement in aerodynamic characteristics depends on models, the conclusions reached in the present study are considered valid if the model has a pressure gradient near the trailing edge, as in NACA0015. However, if the model has a pressure gradient near the trailing edge, as in NACA0015, the conclusions obtained in this study are considered valid. Note that the phenomena identified in this study may not be confirmed for thin models or models with flat top surfaces [6], because the characteristics of turbulent transitions are very different. These explanations have been appended to the Results and Discussion (Sec. 4, Lines: 518-522) and Conclusions (Sec. 5, Lines: 550-552).

C3. The CFD simulation uses experiment data for validation (Figure 5). Therefore, I strongly recommend that the experiment data limitation and condition for validation need to be explained. Moreover, the mean absolute percentage error (MAPE) between the experiment and simulation should be presented.

A3.1. Regarding the explanation of the experiment data limitation

The details of the experiment data limitation and the condition of the validation data have been appended to the section of Validation (Sec. 4.1, Lines: 255-269) with citing the previous study by Sekimoto et al. [4]. Noted that the experimental data is for private communication from Dr. Satoshi Sekimoto of Tokyo University of Agriculture and Technology, and a study that focus primarily on the analysis of the experimental data will be published in the future.

A3.2. Regarding the presentation of the error between the experiment and simulation

A discussion for the errors between the experiment and simulations has been appended to the section of Validation (Sec. 4.1, Lines: 272-273, 276) with Table. 1. When MAPE is calculated based on C_p, the denominator becomes very small in the process of calculating MAPE near the trailing edge, resulting in a very high MAPE value. Therefore, we used Mean Absolute Error (MAE), which is MAPE with its denominator removed, for evaluating more substantial errors.

Table 1 Mean absolute error (MAE) between the result of the C_p distribution obtained by the experiments and simulations.

	α [deg]		
	6	8	10
PA-OFF	0.100392	0.121827	0.111632
Continuous	0.133853	0.151402	0.167080
Burst	0.132916	0.074882	0.143713

C4. The main topic is a computational study of Plasma actuator Flow Control. Therefore, results and discussion should be expanded by describing the research's major findings numerically and comparing them to previous studies. In addition, the current research area's gaps must be highlighted, and future study directions must be presented.

A4. To clarify the novelty and major findings, we have added Sec. 4.5 as the section to compare the post-stall angles cases in the previous studies with the pre-stall angles cases in the present study. Future works will include broader analysis of the effectiveness of burst mode control at pre-stall angles, such as applications of the flow control to flows over relatively thin airfoils with small pressure gradient. These explanations have been added to Conclusions (Sec. 5, Lines: 550-552).

References

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We would like to thank the reviewer for his/her comments and hope that the current manuscript is acceptable for publication in *MDPI Applied Science Journal*.

Sincerely,

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