

Interactive comment on “Ability of the e-TellTale sensor to detect flow features over wind turbine blades: flow stall/reattachment dynamics” by Antoine Soulier et al.

Anonymous Referee #1

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General comments

In this manuscript, the authors intend to show the ability of robust and practical electronic TellTale sensor to monitor the stall/reattachment of the flow on turbine blades in the field.

The wind tunnel experiment of 2D blade profile with 0.09m in chord length oscillated in 1Hz was conducted at Reynolds number of 2×10^5 with 100Hz TR-PIV measurement. The instants defined by the sudden change of the position of the sensor strip on suction surface detected by PIV image with vision algorithm showed good agreement with exact stall/reattachment instants recognized from the velocity fields regarding the rapid

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motion of the separation point. Other three postprocessing method to quantify the flow state are also discussed.

This work presents an important evaluation of the innovative device for the progress of the sophisticated turbine control including active flow control technologies on the blade. The various experimental techniques and the results to understand the characteristics of dynamic stall are very informative.

I strongly recommend this paper for publication with however revised extensively to clarify the importance of the work in the steps of realization of the technology to the real world and to focus the discussion of the result to the relation of the strip position to the exact stall/reattachment instants. I think it makes this work more impressive and helpful for the readers to understand the capability and challenges of this technology.

I hope the following comments help the authors for their revision.

Specific comments

1. The role of this work for realization of the device is not clear.

The importance of this work lies on the evaluation for e-TellTale but not for a tuft. It should be explained if there are any difficulties specific for e-TellTale to follow the flow dynamics, or to be recognized by image processing conducted in this work.

The most important feature of the sensor is the electrical sensing. But the electrical signals were not evaluated in this work. The correlation of the signals to the strip position should be described more in detail especially if there are some issues left.

If the authors intended to scale-down the full-scale device, the way of design to scale-down should be explained. The experimental condition or the configuration of the sensor for the full-scale wind tunnel test is not clear because the cited reference seems not yet published.

The TR-PIV is conducted in 2D. Does the 3D motion affect the electrical signals?

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To think about this, it is recommended to describe more about the configuration of the e-TellTale in detail including the 'stainless sheet' and the 'small part'.

2. The validity of the position detection is not clear.

The position detection is the most important technique in this work. To ensure the validity of the experiment, clear and correct explanation is necessary. For example, why sx replaced to $sxmax$ instead of $sxmin$ for the state beyond the stall in Fig.15 while sx is decreasing when the flow is detached according to Fig.4.? Is the sx really reaches to 0 at around 0.9s and 5.0s as shown in Fig.15 while the length of the strip is only 0.3c?

3. The objective and the result of the three postprocessing analysis is not clear.

The discussion about these analyses is too long and confusing while this manuscript is worthwhile enough for publishing even without these analyses.

'Because the definition of stall and reattachment instants is a complex problem' at I.321 is not clear to understand the objective because 'the definition' shown in section 4.1 is not complex.

If the objective of the analysis is to investigate the local flow phenomena which governs the motion of the strip, you might mention something more from the small l/c results of the method 1.

If the objective of the analysis is to evaluate the accuracy of each methods to detect the instants, the parameters for each method (such as x/c or l/c for the method 1) should be optimized before the comparison.

In section 5, there are no explanation that the exact instants t^{ref} was defined by the visualization of the velocity field. Moreover, it is concluded that the strip capabilities to follow the stall/reattachment dynamics was validated by comparison to the three methods while the most direct validation seems to come from the comparison to t^{ref} . These are very confusing.

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4. The validity of the zero-crossing criteria is not clear.

For about the 'resolution', describe the way of evaluation of $3.5c/U$ at I.262. Clarify the meaning of the phrase 'at the limit of the measurement precision' in I.265.

It should be described if there are reasons to set the detection threshold as zero. I think it should be optimized for each stall/reattachment instants for each method. Maybe this causes the 'bias' in I.350. Ideally, those instants should be compared to t^{ref} after the optimization.

Moreover, if zero is calculated using the mean value in one cycle, the strategy on how to apply this to the field should be explained because the motion is not cyclic in the field.

The delay of the reattachment instances is described to be owing to the smoothing procedure in many sections. But I think the reason lies not only in the smoothing procedure but also in this threshold setting.

To think more about the interesting results that the dispersion of the delay is larger for reattachment than for stall, showing the average and the dispersion of the (td-tc) and the (th-tg) not only (tc+td) and (tg+th) is recommended to understand the rapidity of each phenomena.

Technical corrections

There are too many errors. Spelling should be checked. Symbols should be correctly defined. Adding the list of symbols is recommended. Labels should be added on each axis of the graphs. Too long paragraph should be divided. I'd like to ask authors for their comment if there are my misunderstanding

Section 1.

- I.31: The footnotes should be avoided in this journal. Web pages can be listed as references. Check the same trough the manuscript.

- I.39: The change of the paragraph is recommended before 'The present - '.

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- I.47: The change of the paragraph is recommended before 'The experiment - '.
- I.48: paragraph -> section?
- Fig.1: solve -> solved?

Section 2.1

- I.54: Is ' ' permitted in this journal? If not, check through the manuscript.
- I.57: 65-421 -> 65(4)-421?
- I.68: Is it impossible to specify AOA not only $\Delta\alpha_0$?
- I.71: reduce frequency -> reduced frequency?
- I.72: a -> an?
- I.72: It seems not just at mid-span by Fig.3.
- I.76: Describe more about what and how for the checking.
- I.79: 'attached' means fully attached or TE separated?
- I.80: stall state -> stall/reattachment instance?

Section 2.2

- Fig.3: Experimentat -> Experimental
- Fig.3: Show the axis in the figure.

Section 3.1

- I.100: Add '(OpenCV)' for the later use.
- Fig.4: Does 'attached' mean fully attached or TE separated?
- I.117: spanwise -> vertical?

Section 3.2

- eq.1: Addition of an arrow over 'PM' is recommended to clarify the vector.
- I.127: M points -> points M?
- I.127: center P -> center point P?
- I.127: '∈S' is duplicated with 'points M of the square area'.
- I.128-129: How to place 3, 7, or 9 grid point in the square area around P?
- I.133: as (Mulleneres and Raffel,2013) -> as the work by Mulleners (Mulleneres and

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Raffel,2013) Is this manner permitted in this journal? If not, check the same through the manuscript.

- Fig.6: Example -> Example

Section 3.3

- I.139: Is the index n of a and Ψ better to be written as (n) to avoid confusing.
- I.142: n is confusing because it is used for index of both eigen vectors and time.
- I.139: Equations should be numbered. Check the same through the manuscripts.
- I.143: Add on u

Section 4.1

- I.163: Is $\Delta\alpha$ same as $\Delta\alpha_0$ at I.68?
- I.175: How to know the pressure gradient?
- I.177: It is clearer to describe that (g) to (h) is related to reattachment phenomena as the same as I.172.
- I.183: Isn't it used for the second comparison not only for the first comparison?
- Fig.7: Add labels on the vertical axis or explain which is the direction of AOA increase.
- Fig.7: below?
- Fig.8: The label on the color-bar is not consistent with the figure caption.
- I.198: $(2\lambda^n)$ -> $\sqrt{(2\lambda^n)}$?
- Fig.10: Add a label on the vertical axis.
- Fig.11: The label on the color bar is not consistent with the figure caption.
- Fig.11: Add labels on each axis.
- Fig.11: How to mask the blade profile before the images with different AOA analyzed in POD?
- Fig.13: Add a label on the color bar.

Section 4.2

- I.207: What the 'robust' means?

Section 4.2.1

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- I.218-221: Specify whether the x-y axis is moving with the oscillating blade or not.
- I.218: 'streamwise' means the direction of U_∞ ?
- I.221: This integral doesn't represent an average.
- I.225: averaged -> average
- I.225: Unorm(t) -> Unorm (t, xstrip)
- I.226: Is 'gradient' refers to the spatial derivative? Otherwise, it is better to specify that it means time derivative. Check the same trough the manuscript.
- I.228 $t_{stall}^{ref}(ic)$ -> $t_{stall}^{ref}(ic) - (ic) \cdot T$. Check this trough the manuscript or, for example, define at I.181 as $t_{stall}^{ref}(ic) = (tc + td)/2 - (ic) \cdot T$ for the later simplicity.
- I.229: Is Unorm/U really nearly equal 1?
- I.234: sudden gradient -> peak of time derivative?
- I.234: Are these time derivatives for each l/s shown in Fig.14?
- I.234: 14a -> 14b?
- I.239: what is (see1)?
- Fig.14: Add the label for vertical axis.
- Fig.14a: t^{visu} -> t^{ref} ?
- Fig.14b: Add overline if this t^{ref} is an average. Check the same trough the manuscript
- I.245: xtrip -> xstrip
- I.246: smooting -> smoothing
- I.249: for sake of -> for the sake of
- I.251: fiter -> filter
- I.254: What is 'mean'? An average in one cycle?
- Fig.15: Add the label for vertical axis.
- Fig.15: What is " on U?
- Fig.15: What is 'brut'?
- Fig.15: Are ● and ○ opposite? Check the same through the manuscript
- Fig.15: sliding averaged -> moving average?
- Fig.16: Add the label for vertical axis.
- Fig.16a: What is " on U?

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- Fig.16b: Does the ic starts from 0? Check the same through the manuscript
- I.260: $-8.6c/U$ -> -8.6 ?
- I.261: $-15c/U$ -> -15 ?
- I.261: What is 'chord time'?
- I.261: smothing -> smoothing
- I.263: $3.5U/c$ -> $3.5c/U$?

Section 4.2.2

- I.280: As for -> As in or As the same for?
- I.280: separated -> reattachment
- I.282 $-2.5c/U$ -> -2.5
- I.283: What is 'decre'?
- I.284: important?
- I.283-287: These sentences are inconsistent. Which is difficult to detect stall or reattachment?
- I.285: Is the share layer of Fig 9 (h) so close to detect vortex?
- I.285: this?
- I.288: $-18c/U$ -> -18
- Fig.17caption: averaged -> average
- Fig.17a: Add the label for vertical axis.
- Fig.17b: Why are there no data for attached for $ic=5$?

Section 4.2.3

- I.293,296: by(Merius)?
- I.297: averaged -> average
- I.297: Is the 2000 snapshot with 1600Hz during 1.25 sec used for calculation?
- I.298 and Fig.19caption: What is i of Ψi ?
- Fig.19: Is the label of color-bar correct?
- Fig.19c: Why the $a(t)$ is plotted in 100Hz not 1600Hz?
- Fig.19caption: averaged -> average

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- I.317: t_{stall}^{m3} -> t_{attach}^{m3}
- I.317: Do not divide by U_{∞} .

Section 4.2.4

- I.328: The reason of exploration of instantaneous method is differ from I.244.
- I.347: removed -> subtracted
- I.351: (5)?
- I.353: et?
- Fig.21: Add a label on the vertical axis.
- Fig.22: A label of the vertical axis is not correct.
- Fig.22caption: three methods?
- Fig.22: Is it OK to start by attachment?
- Fig.23: Add a label of the vertical axis
- Fig.23: What is brut?
- Fig.23: Are 'e's different from 'c's?
- Fig.23: Why are there any $sxc/sxcmax=1$?
- Fig.23: Why the value goes to negative while Fig.21 is all positive?

Section 5

- I.359: 65 -> 65(4)
- I.360: sensors were not at the trailing edge
- I.362: Why the method of section 4.1 is not included in the method?
- I.368: dicriminate -> discriminate
- I.375: mouvement -> movement
- I.378: strip (electrical) signal?

Reference

- Braud2018: The journal name is mistaken
- Chamorro: N27 -> 27,13, pp1-13
- De Gregorio: The third author's name is mistaken
- Sirovich1987: The journal name is mistaken

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