

English Title (Arial 18-Point)

On the Experimental and Application Study of High-Curvature Wing for Load-Task UAV ^{1*}

First Author ¹, Second Author ¹, and Third Author ² (Arial 11-point)

¹Affiliation-1 (Times New Roman 10-point)

²Affiliation-2 (Times New Roman 10-point)

Chieh-Nin Sun ¹ and Yung-Lan Yeh ^{2**}

¹Department of Aviation Services and Management of China University of Science and Technology
No.200, Zhonghua St., Hengshan Shiang, Hsinchu County 31241, Taiwan R.O.C.

²Department of Engineering & Management of Advanced Technology of Chang Jung Christian University
No.1, Changda Rd., Gueiren District, Tainan City 71101, R.O.C.

ABSTRACT: Each paper should have abstract (not exceeding 200 words). The abstract should appear at the beginning of the manuscript. They should not only indicate the subject and scope of coverage but also, in the case of research papers, give major results and conclusions. Times New Roman 11-Point

ABSTRACT

Abstract Context: Times New Roman 10-Point)

Present work studies the aerodynamic properties of high curvature wing for UAV using wind tunnel test and CFD simulation. The high curvature S1210 wing is adopted for experiment and simulation. The lift condition with different AoA, the ground effect and wind speed effect are key topics to be examined and discussed in detail. The real flight test also be carried out in this work to verify the experiment and simulation results. Experimental results indicate that the high curvature wing not only has high AoA flight performance but also possesses ground effect when flies near ground. The ground effect is dependent on wing span and happens at distance lower than 1/4 span from the ground. Moreover, the flow over the wing surface does not separate till 18° AoA. It illustrates that the high curvature S1210 wing is a good choice for task UAV. Especially the UAV needs to takeoff in short distance and fly at bad weather or strong head wind.

Keywords: Several keywords (no more than 5 words) for the paper should be given below the abstract. Times New Roman 10-Point.

Keywords: High curvature, Task UAV, S1210, Ground effect

¹

^{2**} To whom correspondence should be addressed, E-mail: ylyeh1229@gmail.com

Text Format: The title of each section should be numbered by I, II, III and placed in the middle of a line (all capitals in Times New Roman 11-Point.) Titles of sub-sections are placed to the left with or without a preceding number. Times New Roman 10-Point.

I. INTRODUCTION

In past decade, there were more and more contraries committed to develop and research on unmanned aerial system (UAS) and unmanned aerial vehicle (UAV). Most obvious features of UAV are low-cost, high-flexibility, high-automation and high-resolution for detection. Based on previous causes, UAV gradually replaced manned aircraft to execute common mission including disaster relief, airborne support. As for special missions are landscape photography and military reconnaissance. Special UAV likes USA RQ-4 Global Hawk. Its endurance and flight range are over 24 hours and larger than 25,000 km. It can perform long-term military reconnaissance mission in the battle. In order to simulate flight trajectory of cruise missile and improve training efficiency, the Flamingo II UAV in Taiwan was developed to be a military drone aircraft. Until today, more and more different types UAV were used for different military or civilian purposes.

II. SETUP AND METHODOLOGY

S1210 is a typical high-performance wing because of its high curvature. Based on the theorem of aerodynamic [3], wing with high curvature has ground effect when near ground and flow on wing surface is not easy to separate at high angle of attack. Especially at relative low-speed flight,

All equations and mathematical formulas should be typewritten. Equations should be numbered serially on the right hand side by Arabic numerals in parentheses. Leave proper space above and below all of the mathematical expressions.

$$f_i(\vec{r} + \vec{c}_i \Delta t, t + \Delta t) - f_i(\vec{r}, t) = \frac{-1}{\tau} (f_i - f_i^{eq}) \quad (1)$$

$$\rho(\vec{x}, t) = \sum f_i(\vec{x}, t) \quad (2)$$

$$\vec{u}(\vec{x}, t) = \sum \vec{c}_i f_i(\vec{x}, t) / \rho(\vec{x}, t) \quad (3)$$

The authors are requested to submit professional quality illustrations with sharp lines and good contrast. Once the paper is accepted, the authors should promptly supply original copies (or electronic files) of all illustrations. All illustrations should be numbered, titled and have descriptive captions. Illustrations may be reduced to a 8-cm column width. It is therefore important that lettering be legible after reduction by as much as 4:1.

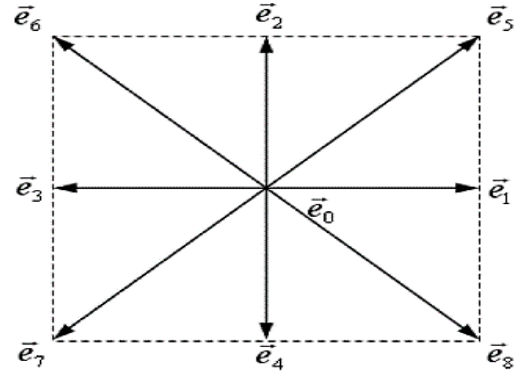


Figure X D2Q9 model (Arial 10-Point)

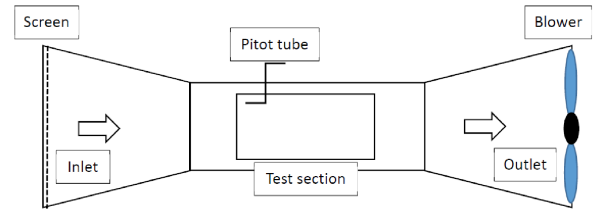


Figure X Low-speed suction type wind tunnel in Hsin-Chu campus of CUST

Table X Time-Averages of Estimation Errors (Arial 10-Point)

State Filter	Position (km)	Velocity (km/s)
EKF 1	7.98	0.11
EKFIF 1	0.02	0.03
RF	0.02	0.03
RLSEIF	0.02	0.03

III. RESULTS AND DISCUSSION

This section will well discuss the experimental results. Firstly, the fundamental concept of the ground effect will be examined from some important references to identify the key control factor. Then the wind tunnel experiment and CFD simulation are executed to investigate the ground effect, high AoA performance and wind speed effect in the second step. In the final stage, the real flight test will be implemented to further confirm the ground effect. An airborne digital GPS is used to know the altitude variation during takeoff process.

IV. CONCLUSION

Present work studies the aerodynamic properties of high curvature wing for UAV using wind tunnel test and CFD simulation in detail. The high curvature S1210 wing

was adopted for experiment and simulation. The lift condition with different AoA, the ground effect and wind speed effect are key topics to be examined and discussed in detail. The real flight test also be carried out in this work.

ACKNOWLEDGMENTS

Acknowledgments should be kept in minimum words and be given as a paragraph at the end of the text.

Ministry of Science and Technology of R.O.C. supports this work with contract number of MOST 105-2221-E-157-005-MY2. The authors would also like to special thank to Prof. Tang-Cheng Chen for his technical support to construct test UAV using carbon fiber composites material.

REFERENCES

References should be numbered in the order in which they are cited at the end of the manuscript in the following form:

For a Journal:

- [1] Pekins CD, "Development of Airplane Stability and Control Technology," *Journal of Aeronautics, Astronautics and Aviation*, Vol. 7, No. 4, 1970, pp. 290-301.

For a conference preceedings:

- [2] Bakker JT, "Effect of Control System Delays on Fighter Flying Qualities," AGARD Conference Proceedings, No. 333, 1982, pp. 18-1 to 18-16.

For a technical report:

- [3] Medioni GR, "Segmentation of Images into Regions Using Edge Information," Tech. Rep. 101, Intelligent Systems Group, University of Southern California, Los Angeles, Mar. 1983.

For an authored book:

- [4] Huenecke K, *Modern Combat Aircraft Design*. Annapolis, Maryland, Naval Institute Press, 1987, Chap. 13, pp. 237-249.

For an article in an edited book:

- [5] Wittman JH, "Analysis of a Hybrid Frequency-Time Hopping Random Access Satellite Communication System," *Spread Spectrum Techniques*, R. C. Dixon, Ed., New York, NY, IEEE Press, 1976, pp. 193-200.

- [1] Reid EG, "A full scale investigation of ground effect," NACA Technical Report 265, 1927.
- [2] Zerihan J, Zhang X, "Aerodynamics of gurney flaps on a wing in ground effect," *AIAA Journal*, Vol. 39, No. 5, 2001, pp. 772-780.
- [3] Ahmed MR, Sharma SD, "An investigation on the aerodynamics of a symmetrical airfoil in ground effect," *Experimental Thermal and Fluid Science*, Vol. 29, 2005, pp. 633-647.
- [4] Luo SC, Chen YS, "Ground effect on flow past a wing with a NACA0015 cross-section," *Experimental Thermal and Fluid Science*, Vol. 40, 2012, pp. 18-28.

- [5] Shan X, Chen H, "Simulation of nonideal gases and liquid-gas phase transitions by the lattice Boltzmann equation," *Physical Review E*, Vol. 49, No. 4, 1994, pp. 2941-2948.
- [6] Thürey N, Rüde U, Körner C, "Interactive Free Surface Fluids with the Lattice Boltzmann Method," in "Technical Report 05-4," University of Erlangen-Nuremberg, Germany 2005.
- [7] Sukop MC, Thorne JTD, *Lattice Boltzmann Modeling*. Germany: Springer-Verlag, 2005.
- [8] Zhang RL, Di QF, Wang XL, Gu CY, "Numerical study of wall wettabilities and topography on drag reduction effect in micro-channel flow by Lattice Boltzmann Method," *Journal of Hydrodynamics, Ser. B*, Vol. 22, No. 3, 2010, pp. 366-372.