

Influence of the Frequency Ratio of Two Synthetic Jets on the Jet Deflection Characteristics

Kodai Munakata¹, Mayuko Katano¹, Koichi Nishibe², Kotaro Sato³

¹Mechanical Engineering Program in the Graduate School of Engineering/Kogakuin University
2665-1 Nakano-cho, Hachioji-shi, Tokyo 192-0015, Japan

am25089@ns.kogakuin.ac.jp

²Department of Mechanical Engineering/Tokyo City University
1-28-1 Tamatsuzumi, Setagaya-ku, Tokyo 158-8557, Japan

³Department of Mechanical System Engineering/Kogakuin University
2665-1 Nakano-cho, Hachioji-shi, Tokyo 192-0015, Japan

Extended Abstract

Since flow control can be achieved by oscillatory parameters without geometrical changes, there has been a lot of research on synthetic jets [1]. For example, for synthetic jets generated in geometrically asymmetric slots, the jet deflection angle can be controlled by tuning the dimensionless frequency [2]. Furthermore, it has recently been reported that even in a geometrically symmetric field, the direction of jet flow can be adjusted by interfering two synthetic jets, and the effect of phase on flow characteristics under the same frequency condition has been shown, and the limits of jet generation have been discussed [3]. However, the knowledge of the interference problem between two synthetic jets to date is fragmentary, and the onset conditions and deflection mechanism must be clarified in the future. In addition, there are very few reported cases of two synthetic jets with different frequencies.

In this study, two speakers are used as actuators to generate two synthetic jets with different frequencies. Experiments were performed under the following conditions: slot distance $c = 5.0\text{mm}$, slot exit width $b_0 = 5.0\text{mm}$, and representative velocity $U_s = 2.7\text{m/s}$ as defined by Hallman et al [4]. The outlet velocity fluctuation frequency of slot A, $f_A = 40\text{Hz}$, was kept constant, and the velocity fluctuation frequency of slot B, f_B/Hz , was used as a parameter.

In this experiment, the frequency ratio γ was defined as $\gamma = f_B/f_A$, and the effect of γ on the flow characteristics was investigated. The main results confirm that the jet deflects toward slot A when $\gamma < 1$, a condition where f_B/Hz is smaller than f_A , and conversely, when $\gamma > 1$, a condition where f_B/Hz is higher, the jet deflects toward slot A. This indicates that the jet tends to deflect toward the side with the higher frequency in situations where two synthetic jets with different frequencies interfere in this condition range. This suggests that it is possible to control the direction of the flow field by interfering synthetic jets of different frequencies.

References

- [1] D. Kang, K. Nishibe, K. Sato, K. Yokota, "Research on the Flow Characteristics of Synthetic Jet by Vortex Method," Transactions of the JSME, vol.82 no.839 pp.16-163, 2016. Available: <https://doi.org/10.1299/transjsme.16-00163>
- [2] K. Suzuki, T. Hiruma, T. Ito, K. Nishibe, D. Kang, K. Sato, "Flow deflection characteristics of two-dimensional synthetic jets generated from asymmetric stepped slots, " *JFST*, vol.19, no.3, pp.22, 2024. Available: <https://doi.org/10.1299/jfst.2024jfst0022>
- [3] M. Takano, M. Katano, K. Nishibe and K. Sato, "Influence of the Phase of the Oscillation Velocity Distribution at Slot Exit on a Jet Flow," *Thailand: The 13th TSME International Conference on Mechanical Engineering*, Chiang Mai, 2023.
- [4] R. Holman, Y. Utturkar, R. Mittal, B.L. Smith, and L. Cattafesta, "Formation criterion for synthetic jets," *AIAA journal*, Vol.43, No.10, pp.2110-2116, 2005. Available: <https://doi.org/10.2514/1.12033>