Computational Analysis-Based Noise Model for Urban Air Mobility Considering Social Acceptance

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Content

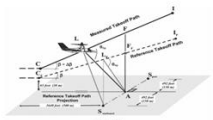
1. Introduction
2. Research Objectives
3. Background Standards and Regulations
4. Noise Analysis
5. Conclusion

Introduction

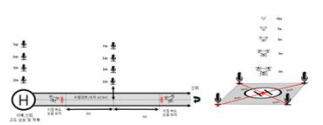
Final goal of research

Noise Acquisition Method

Noise Acquisition Process & Scenario



Flight Noise Acquisition Method

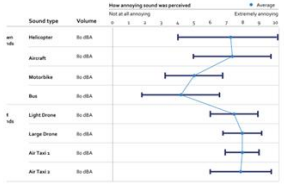


Social Acceptance considered Noise Evaluation Metrics

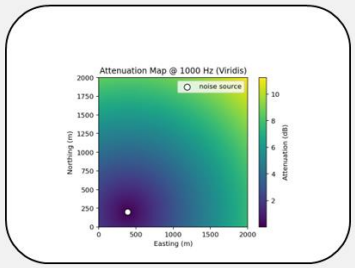
Auditory Test

Noise Evaluation Metric

Noise Evaluation Criteria

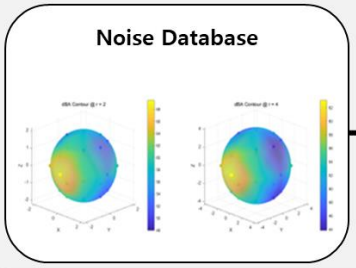


Noise Absorption

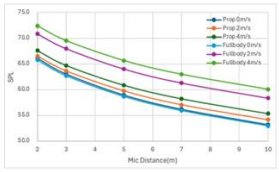


Noise Database & Acceleration

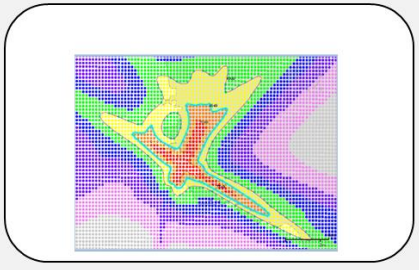
Noise Database



Noise Prediction Acceleration



Noise Contour Map



Research Objective

Research Background

- Prediction of UAM noise for Corridor design and Evaluation
- UAM Noise Consider Social Acceptance, existing Regulations & Standards

Goal of this Study

- To define UAM Noise Hemisphere acquisition process
- To compare Field test process and computational analysis process
- Guide for Field test microphone array procedure & noise acquisition

Standard and Regulations

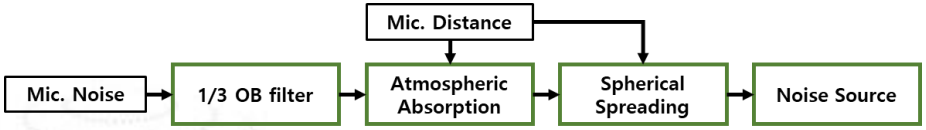
Cat.	Org.	Titles
Stds.	ISO	**ISO 1996** - Acoustics — Description, measurement and assessment of environmental noise
		ISO 9613 - Acoustics — Attenuation of sound during propagation outdoors
	SAE	**SAE-AIR-1845A** - Procedure for the Calculation of Airplane Noise in the Vicinity of Airports
		SAE-ARP-866A - Standard value of atmospheric absorption as a function of temperature and humidity
		SAE-ARP-5534 - Application of Pure-Tone Atmospheric Absorption Losses to One-Third Octave-Band Data
Cert.	MOLIT	**KAS Part 36** Aircraft Noise Standards
	FAA	**FAA 14 CFR Part 36** Noise Standards: Aircraft Type and Airworthiness Certification

Noise Analysis

Modeling of Noise Hemisphere

- Noise Hemisphere construction
  1. Back-propagation to source
  2. Re-propagation to unit distance(1m)

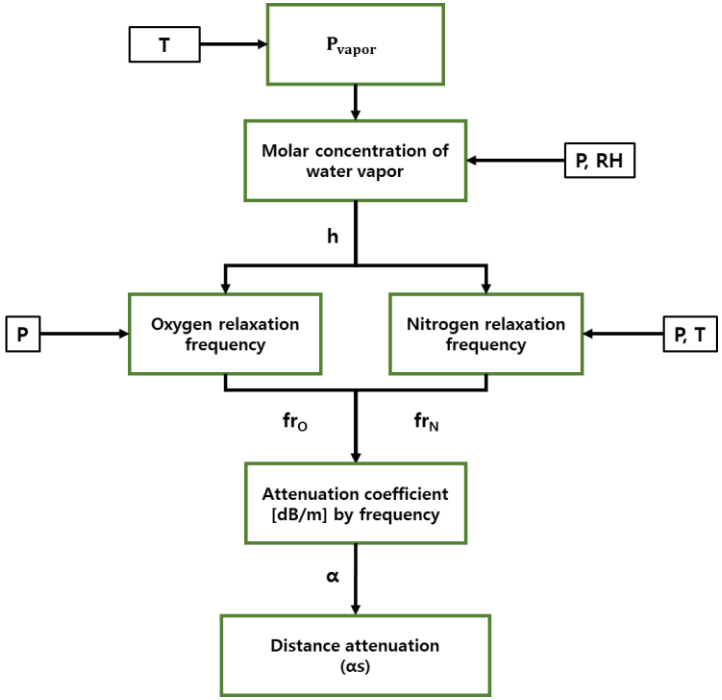
$$L_{sphere} = L_{mic} - A_{spr} - A_{atm}$$



- Spherical Spreading

$$A_{spr} = 20\log_{10}(r)\,\mathrm{dB}, \text{which } r_0 = 1(\mathrm{m})$$

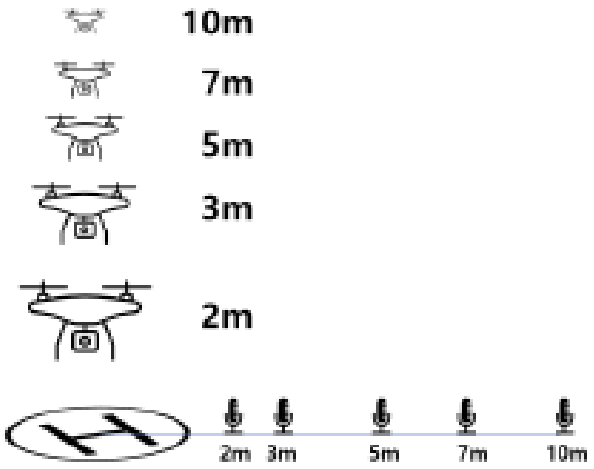
- Atmospheric Absorption
  - ISO 9613 based atmospheric absorption



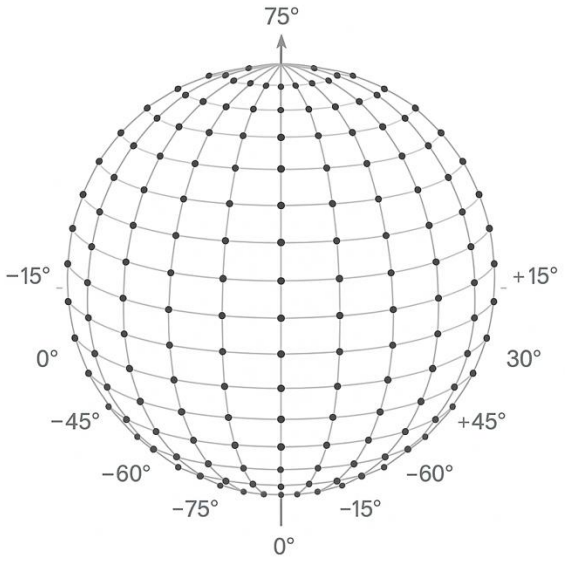
Noise Analysis

Microphone Array

- Linear Array
  - experimentally feasible
  - Assume hover and rotate



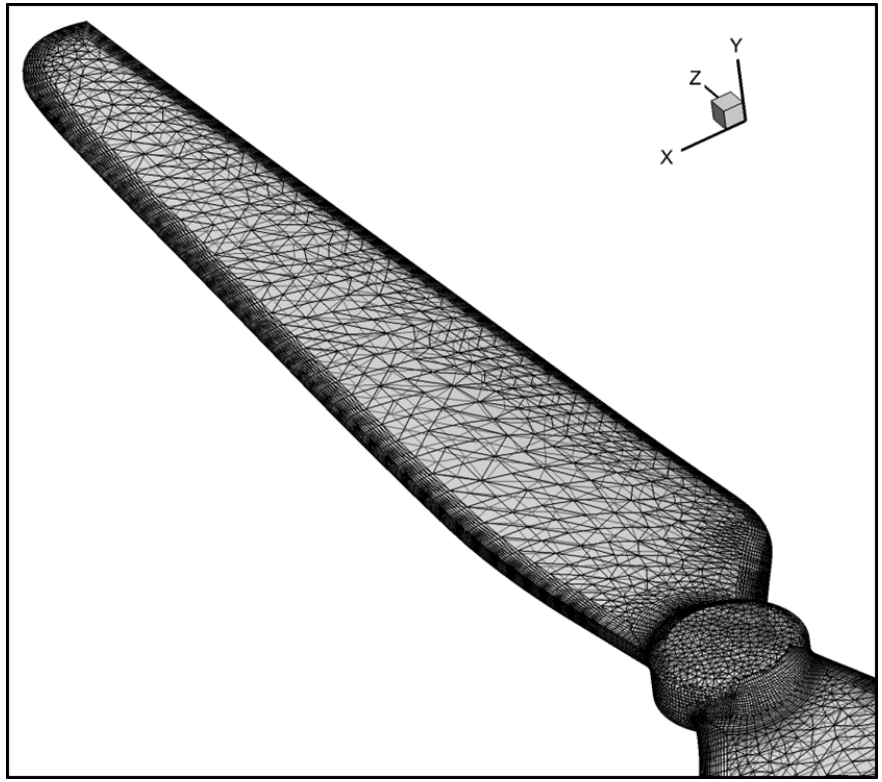
- Sphere Receiver($r = 1,5\ (m)$)
  - Direct acquisition($r = 1(m)$)
  - Back propagation($r = 5(m)$)



Noise Analysis

Analysis Setting

- Pressure Bases N-S Equation
- $k-\omega\ SST$ turbulence Model
- FW-H Acoustic Equation
- Flow field converged w/ MRF
- Develop Turbulence & Acoustic w/ Unsteady Sliding Mesh method



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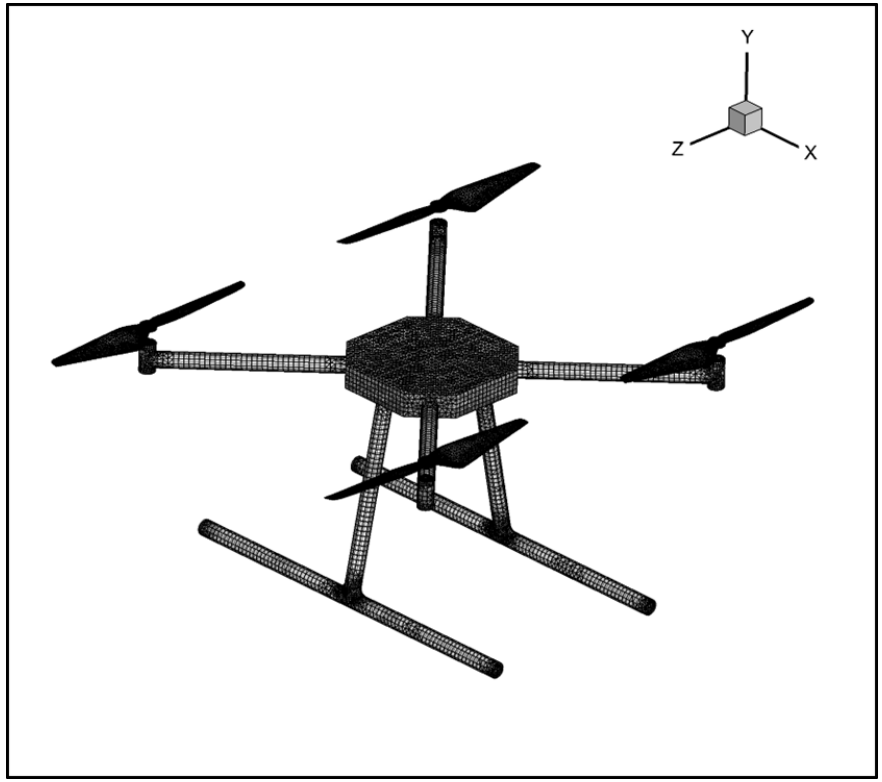
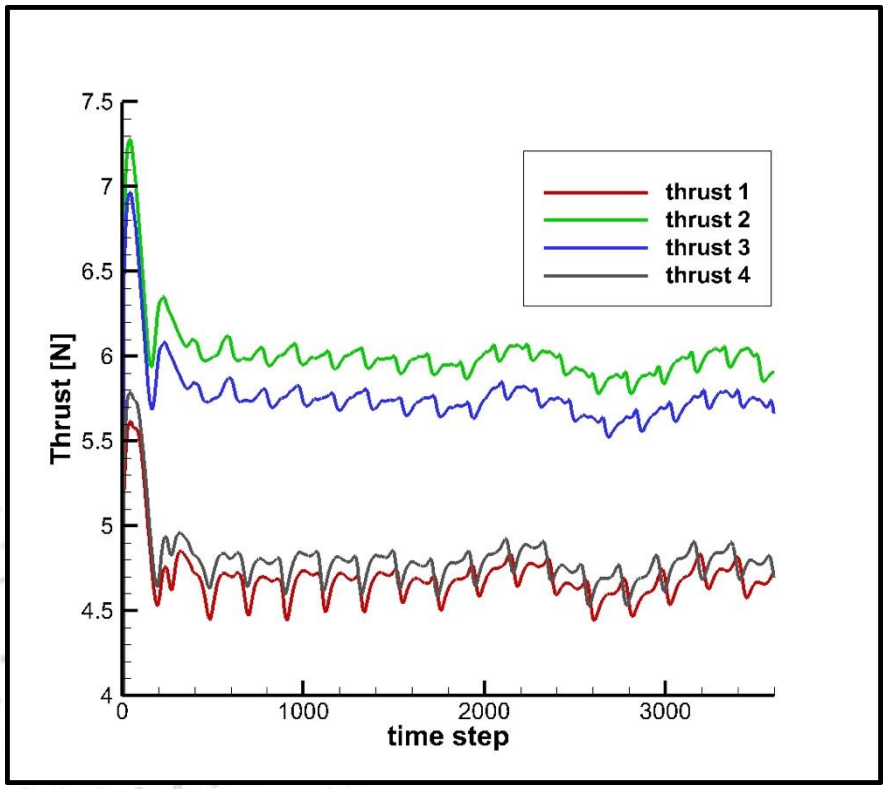
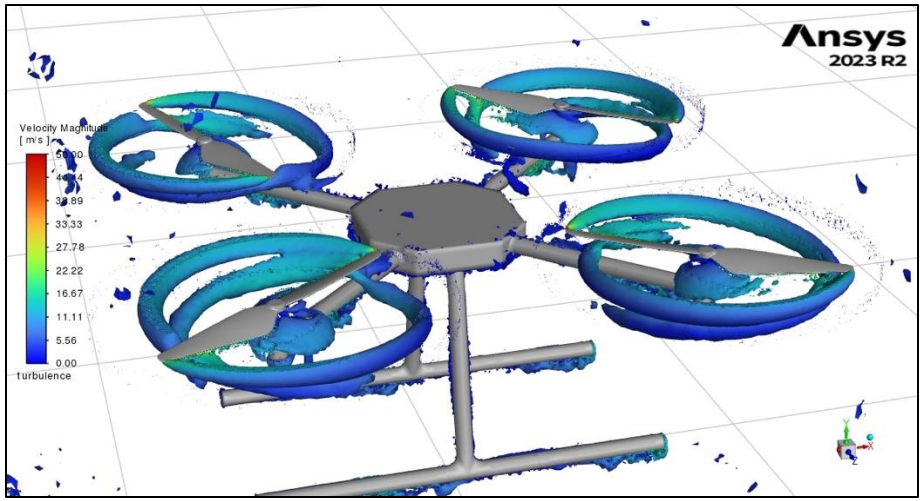


Noise Analysis

Analysis Result





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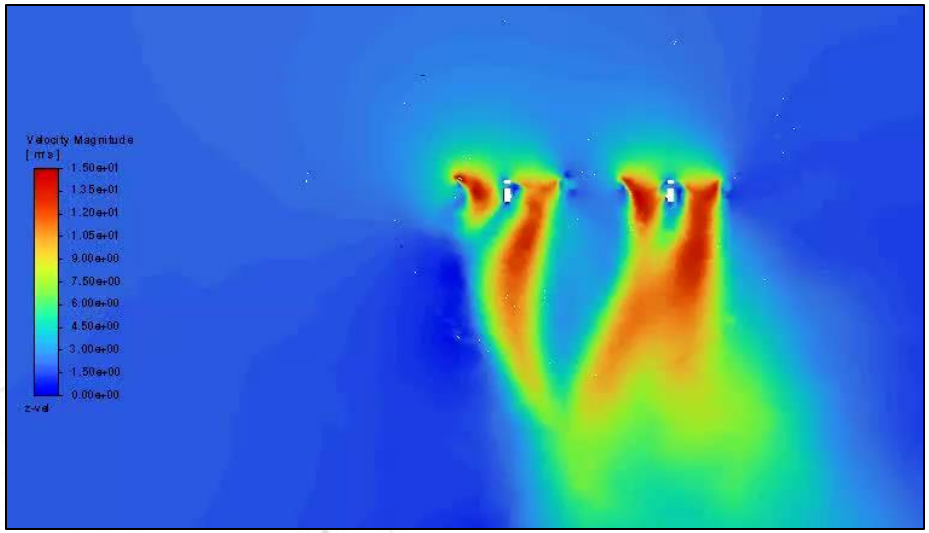
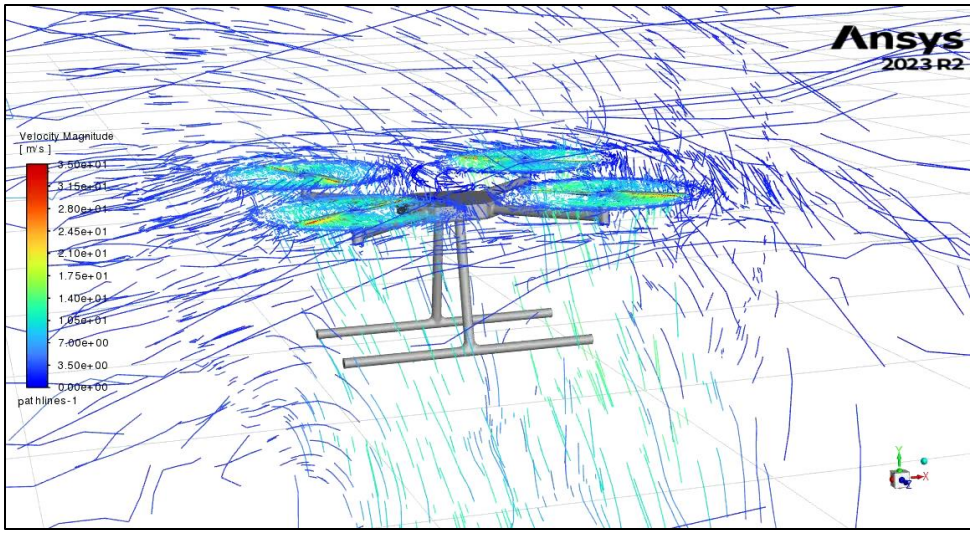
Analysis Result

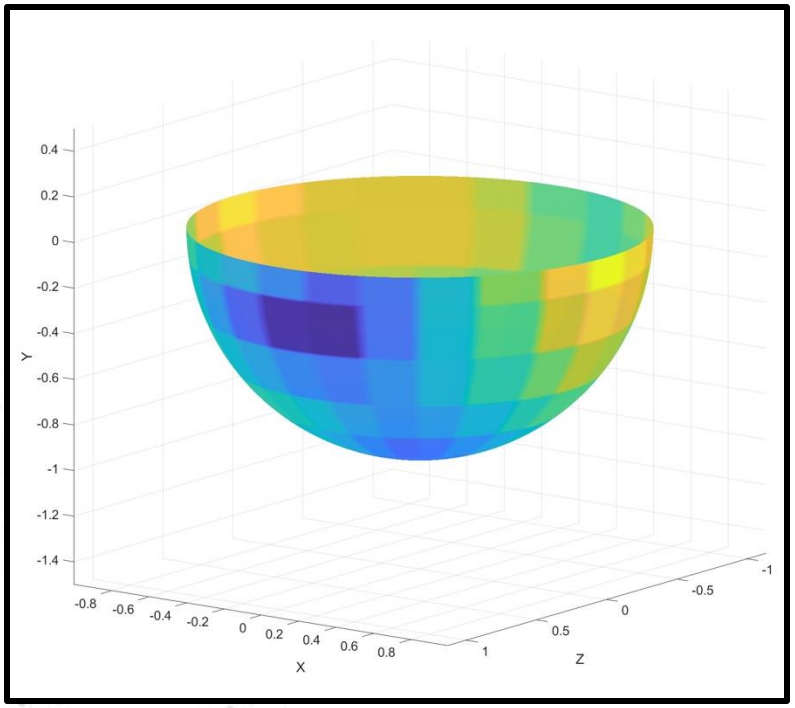




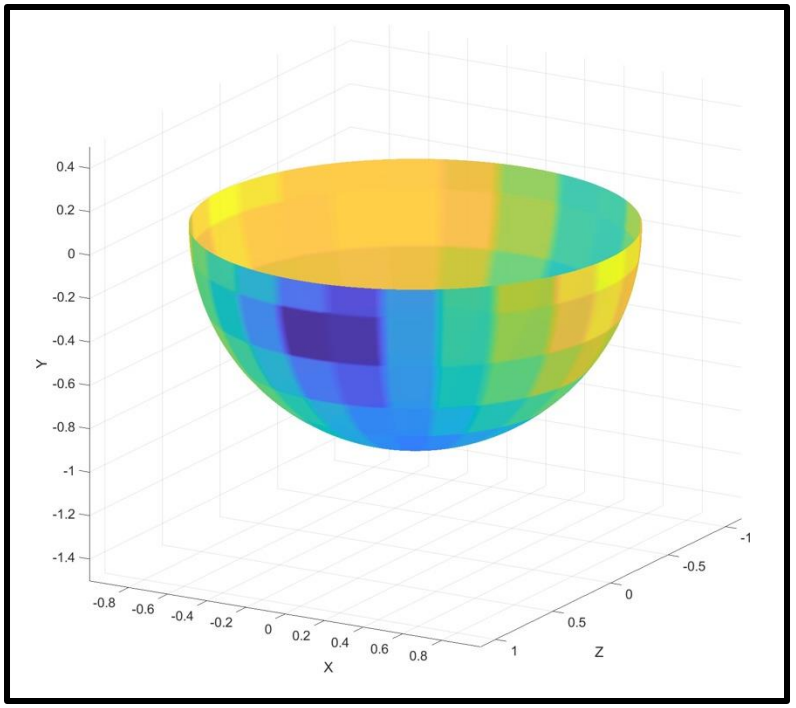
Noise Analysis

Analysis Result

- Direct Hemisphere



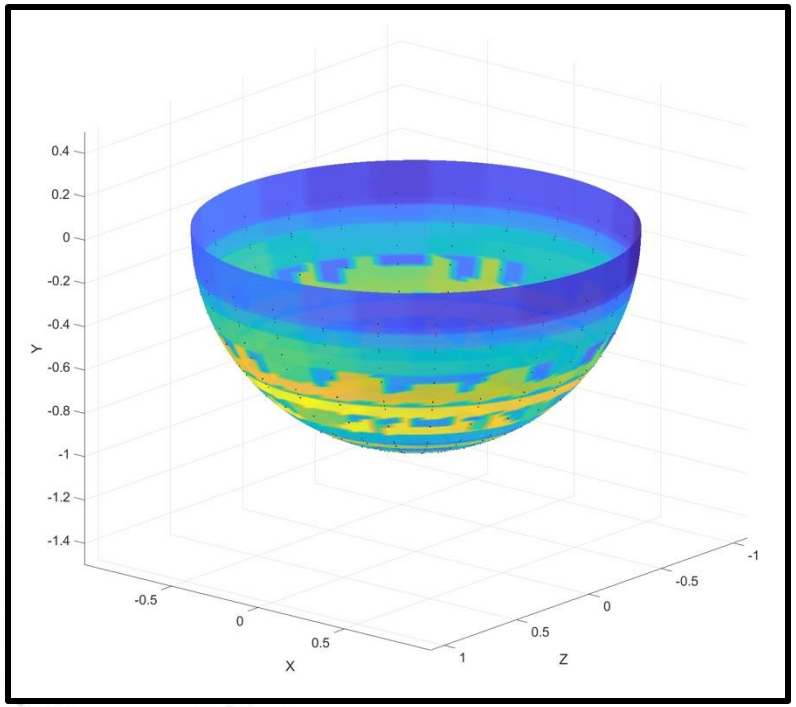
- Hemisphere Back propagation(5m)

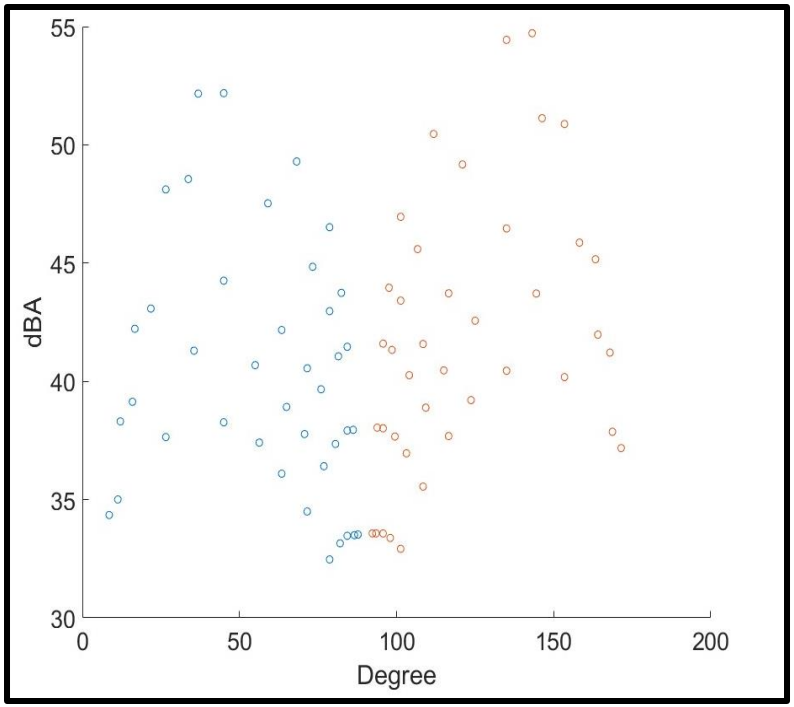


Noise Analysis

Analysis Result

- Line Array Back Propagation





Conclusion

Conclusion

- Compare of Back propagation and direct hemisphere method
- Compare of Field test microphone array and analysis method
- **Back propagation process is also considered in analysis method**
- Based on the current compare, the field test array will be updated

Future work

- Computational Analysis validation with field test
  - Back propagation w/ surface reflection
  - Analysis consider humidity
  - Additional noise sources (e.g. structural vibration …)

- Generate Database for acceleration algorithm
  - Analysis base data – field test data

Acknowlegement & References

Acknowlegement

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Reference

1. Farassat F (2007) Derivation of Formulations 1 and 1A of Farassat. NASA TM-2007-214853
2. ISO 9613 (1993) Acoustics - Attenuation of sound during propagation outdoors
3. Kwon J, Choi D, Son Y, Kim H, Joo C, Lee S, Kim S (2024) analysis of Current Traffic Noise Metrics for UAM Noise Evaluation. Proceeding of the 2024 KSAS Fall Conference :1135–1136
4. Choi D, Ryu S, Kim YH, Kim S (2024) Overview of Noise Studies for UAM Corridor Evaluation. Proceeding of the 2024 KSAS Fall Conference :589–590
5. Ryu S, Choi D, Kwon J, Lee S, Kim S, Tark H, Kim S (2025) Overview of Noise Prediction Model Framework based on Standards and Regulations for UAM Corridor Evaluation. Proceeding of the 2025 KSAS Fall Conference
6. Jo Y, Cho HI, Jeon W (2022) Development of A Community Noise Assessment Code for Rotorcrafts using A Noise Hemisphere. Proceeding of the 2022 KSAS Spring Conference :192–194

Thank you for your attention

Q & A