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PRESS RELEASE (2026/11/12)

An AI system that reconstructs aerodynamic shapes and predicts their performance

New AI system links performance predictions to geometry, and could help engineers compare aerodynamic designs more efficiently

Fukuoka, Japan—The efficiency of an aircraft wing or a wind turbine blade depends on how air flows around it. Finding an optimal shape involves testing numerous designs and can be a burdensome and time-consuming process. Now, researchers at Kyushu University have developed a new artificial intelligence (AI) system that can predict the aerodynamic performance of different shapes. The AI system may allow engineers more time to explore and compare designs more efficiently.

When designing aerodynamic components, engineers generate different geometric designs, simulate airflow around them, and compare their aerodynamic performance to identify promising shapes. However, evaluating each potential design individually involves numerous detailed features and can be time-consuming and computationally expensive.

Researchers led by Professor Koji Shimoyama of Kyushu University's Department of Mechanical Engineering and Thanasak Wanglomklang, a researcher from the LTDS Laboratory at École Centrale de Lyon and a JSPS Research Fellow, have developed PI-GAE (physics-informed geometry-embedded graph autoencoder), an AI-based system that can predict the aerodynamic performance of different shapes, potentially reducing the need for repeated, computationally expensive simulations during the design process. The paper was published on October 28, 2026, in the journal *Computer Methods in Applied Mechanics and Engineering*.

"Today, engineers need to test many shapes one by one using detailed computer calculations. Our method makes it easier to compare many options by estimating how a shape may perform and linking each estimate to the shape. This could shorten early design work and help identify parts that create less air resistance or are energy efficient," explains Shimoyama.

Aerodynamic components are typically represented as computational meshes containing thousands of connected points. Modifying the positions of these points to explore different designs can be computationally intensive.

Instead of working with the mesh points individually, PI-GAE describes each shape using a smaller number of variables. These variables are then used to recreate the original shape and predict its aerodynamic performance. The researchers trained the AI system using data on the shapes and performance of the wings and blades. They tested it on four datasets covering two-dimensional and three-dimensional wings and compressor blades.

PI-GAE accurately predicted how much drag a wing would generate and how efficiently blades could compress air. Its predictions closely matched the results of detailed calculations, with coefficients of determination ranging from 0.946 to 0.992 across the four tests.

Unlike AI systems that only predict performance, PI-GAE can also reconstruct the original shapes. In three of the four datasets, the reconstructed shapes had an average deviation of less than 0.3% from the originals. This capability could help engineers compare different design options by showing both how a shape looks and how it is expected to perform. This may make the early stages of designing aircraft wings, engine blades, and other aerodynamic components more efficient.

"*This research could help engineers improve aircraft wings, jet-engine blades, and other parts that move air. For example, it could help compare different wing shapes to find designs that create less air resistance and may reduce fuel consumption. It could also help improve engine blades that compress air more effectively, potentially making engines more efficient. Beyond aviation, similar approaches could be useful for fans, pumps, wind turbines, and air-conditioning equipment,"* says Shimoyama.

The researchers caution that the system has so far been tested on wings and blades similar to those used for training. They plan to further develop it to handle unfamiliar and more complex shapes. These improvements could bring the technology closer to practical applications in aircraft, wind turbines, and other aerodynamic components.

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For more information about this research, see " A physics-informed geometry-embedded graph autoencoder for shape reduction, reconstruction, and surrogate modeling", Thanasak Wanglomklang, Frédéric Gillot, Sébastien Besset, Koji Shimoyama, *Computer Methods in Applied Mechanics and Engineering*, https://doi.org/10.1016/j.cma.2026.119534.

About Kyushu University

Founded in 1911, Kyushu University is one of Japan's leading research-oriented institutions of higher education, consistently ranking as one of the top ten Japanese universities in the Times Higher Education World University Rankings and the QS World University Rankings. Located in Fukuoka, on the island of Kyushu—the most southwestern of Japan's four main islands—Kyushu U sits in a coastal metropolis frequently ranked among the world's most livable cities and historically known as Japan's gateway to Asia. Its multiple campuses are home to around 19,000 students and 8,000 faculty and staff. Through its VISION 2030, Kyushu U will "drive social change with integrative knowledge." By fusing the spectrum of knowledge, from the humanities and arts to engineering and medical sciences, Kyushu U will strengthen its research in the key areas of decarbonization, medicine and health, and environment and food, to tackle society's most pressing issues.

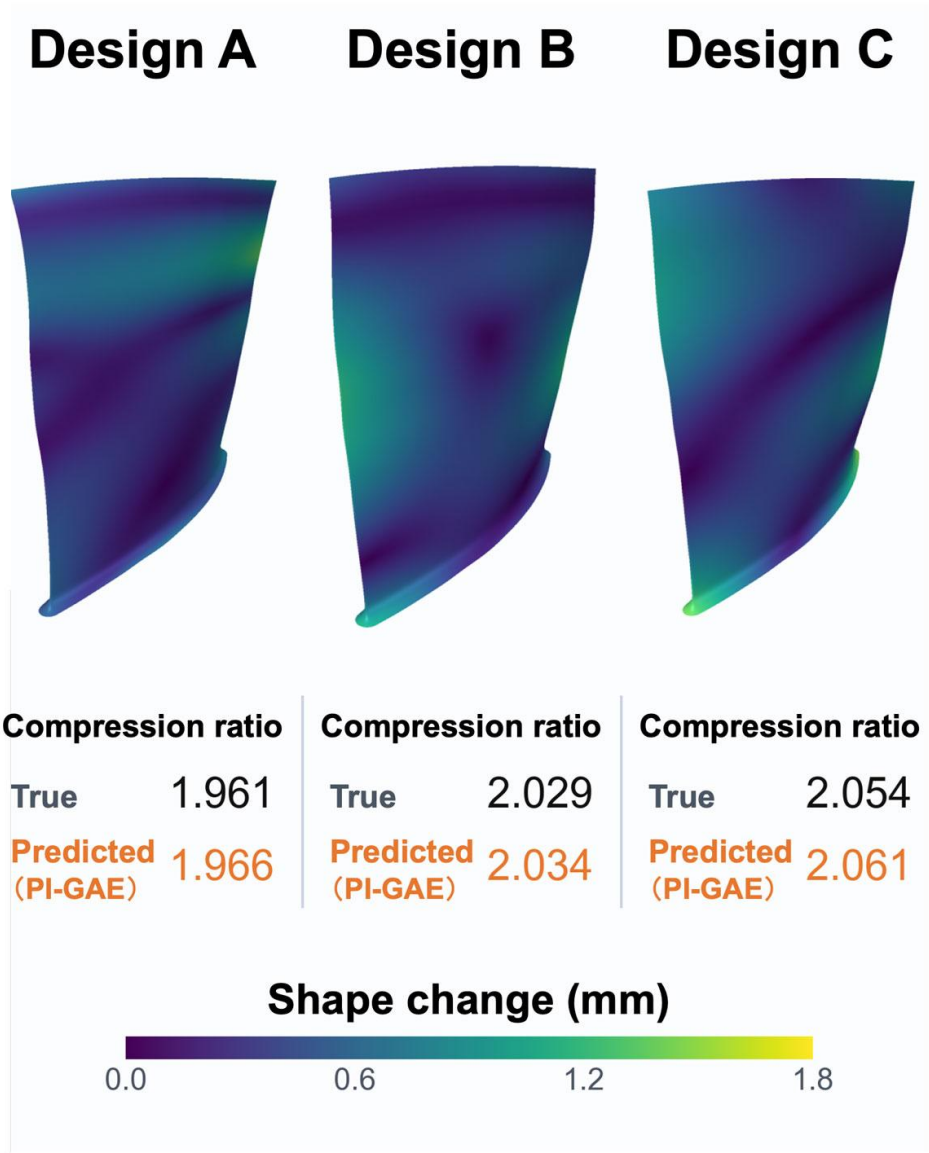


FIG.1 An example of predicted blade shape and performance with compression ratio. Researchers have developed an AI system called PI-GAE that can predict the shape and performance of 100 new design candidates with high accuracy. The three models shown here represent the compression of the mesh. The AI's predicted values are close to the calculated values of the shape. (Koji Shimoyama/Kyushu University)

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