

Hitachi develops airframe modeling technology to boost advanced air mobility safety

Modeling drone behavior in the strong winds and sudden gusts of urban environments, contributing to safer infrastructure building

Tokyo, September 4, 2025 Hitachi, Ltd. (TSE:6501, "Hitachi"), has developed modeling technology^{*1} to replicate airframe behavior in response to sudden weather changes, including strong winds and sudden gusts, in anticipation of increasing employment of drones and other advanced air mobility equipment. Conventionally, the use of air mobility has been restricted because weather conditions constantly change, impacted by strong winds and gusts, making it a challenge to expand their use in logistics and surveys of important infrastructure. Hitachi's new technology measures aircraft wind resistance and models airframe response^{*2}, accurately confirming in digital space how the position of an airframe will drift and thereby calculating flight risks. Moreover, by incorporating this technology into the mobility control infrastructure^{*3} that Hitachi has developed, it will be possible to ensure safer flight control through accurate prediction of wind conditions and flight characteristics as well as efficient aircraft operations by proposing detours around risky routes. This should enable the use of air mobility equipment in areas where it was previously difficult, including in cities with clusters of tall buildings and in mountainous areas. In this way, Hitachi will contribute to the development of new air mobility infrastructure that will help achieve sustainable, safe, and secure regional societies through more efficient maintenance and management of infrastructure and swifter recovery operations after disasters.

^{*1}Modeling technology: Technology designed to model airframe response (see definition below) and use computers to replicate and check airframe behavior in specific flight environments.

^{*2}Airframe response: An aeronautical engineering term denoting the movement of drones and other aircraft in response to external forces such as wind, dynamic lift, and gravity.

^{*3}[Hitachi develops mobility control infrastructure to support daily living and recovery in disaster-stricken areas : March 18, 2024](#)

Background and issues

In addition to massive increases in shipping volume, labor shortages in the maintenance and management of key infrastructure, and other issues complicating the effort to keep the social infrastructure operating, recent years have also seen rising demand for swift recovery in disaster zones. In this context, drones, flying cars, and other advanced air mobility equipment have become tools for inspecting important infrastructure, assisting in shipping logistics, and aiding in recovery efforts after disasters. These trends have led Hitachi to provide its Drone Solutions^{*4} service for safe drone operation.

However, small drones and air mobility equipment can be adversely impacted by weather conditions such as strong winds and sudden gusts. Because these conditions make it difficult to

grasp how the airframe will behave and what its flight characteristics will be in advance, the risk of flight cancellation and airframe damage has persisted. Using only conventional flight control technology, it is particularly challenging to effectively control flights in mountainous regions or in urban areas with dense clusters of tall buildings—exactly the kinds of places where drones have strong potential for use.

*4 [Drone Solutions: Hitachi](#)

Features of the developed technology

In addition to the insights gained through its Drone Solutions system, Hitachi developed its mobility control infrastructure to ensure safer operation of air mobility systems by controlling risks through the digitalization of a wide range of environmental data, including information on weather and the communications environment. Now, to ensure even more precise calculation of flight risks, Hitachi has developed modeling technology that can simulate the behavior of specific air mobility equipment by measuring the airframe's wind resistance and modeling its airframe response. (See Figure 1.) Features of this technology are as follows.

1. Airframe response modeling technology

A drone's position is influenced by winds and can shift with sudden changes in wind conditions, such as when gusts arise. A feedback control^{*5} can offset such wind-induced changes to stabilize a vehicle's position. However, if the wind suddenly dies down, the control system may temporarily apply too much force due to time lag that occurs before the control mechanism lowers the force, which may lead to a change in the airframe's original position or may make it difficult to maintain the drone's position entirely, leading to the risk of a collision or crash. Such drift and risks differ depending on the type of airframe and its flight characteristics. To manage these problems, focusing on repeated wind gusts, Hitachi developed its new airframe response modeling technology based on wind tunnel experiments^{*6} and motion capture^{*7} measurement data. Actual airframes were subjected to repeated blasts of wind, and the amount each vehicle moved and the changes in its position were measured; the data gathered in this way was then used to analyze the aerodynamics of specific drones in terms of their response to wind power, aerodynamic lift, gravity, and other forces to generate an airframe response model. This model can be used to analyze a simulation of how the airframe will react to weather conditions on a proposed flight route and then give an accurate assessment of the safety of the route beforehand. The development of Hitachi's airframe response model uses actual drones so that the model can deal flexibly with a variety of airframe and cargo load conditions, thereby aiding route selection under a host of operating conditions and also improving operating efficiency.

2. Enhancing the precision of airframe response modeling

By analyzing airframe behavior in a digital space and comparing the results to data measured in physical space, Hitachi developed an approach to assessing the precision of its airframe modeling technology. It compared measurements of actual airframe behavior under physical testing that involved repeated wind gusts to behavior calculated using the airframe response model in digital space. After calculating the differences between these parameters, it then fine-tuned the response model so that the results would match, thus boosting the precision of its airframe response modeling. In this way, it has become possible to predict changes in an airframe's position with 90% accuracy under exposure to repeated wind gusts. This model can therefore be used in combination with information on real-time weather conditions to check on

flight safety in a digital space before an actual flight—the type of check that has been almost impossible up until now.

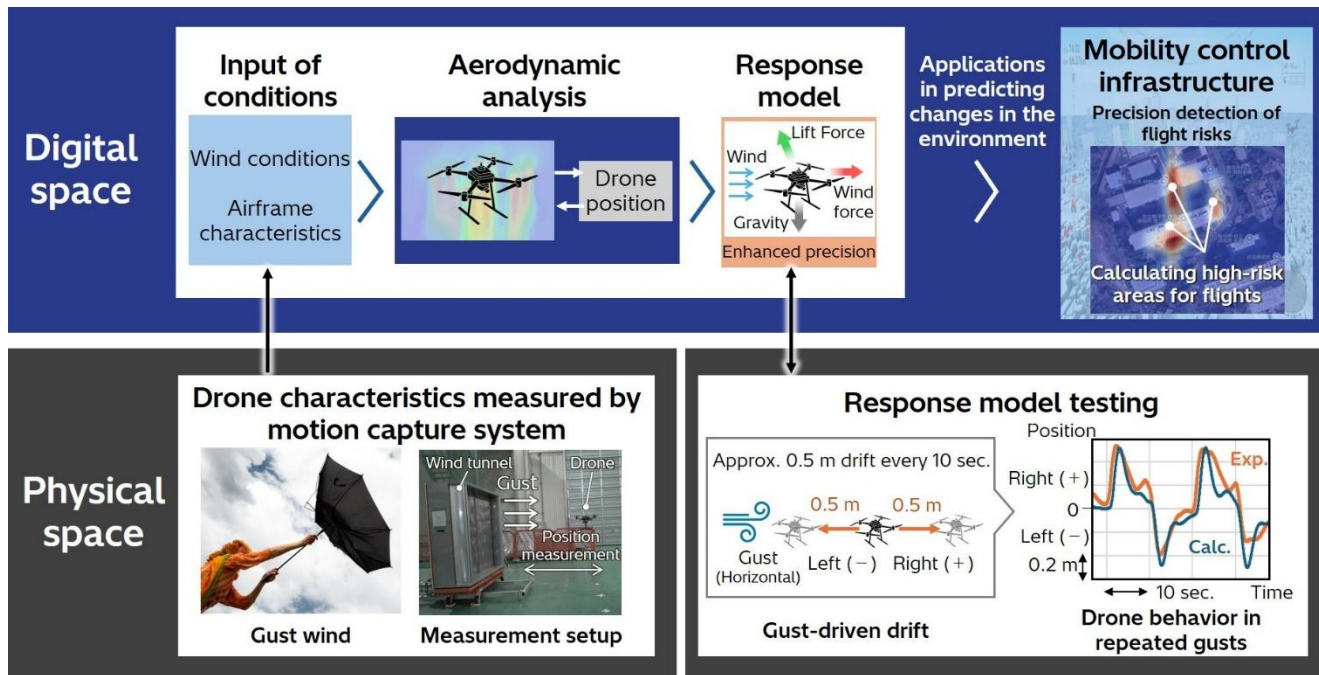


Figure 1: Airframe modeling technology

- *5 Feedback control: A control mechanism designed to correct deviations detected in measurements of an airframe's position, etc., using its power and position control equipment to offset these deviations.
- *6 Wind tunnel experiments: Experiments designed to test the impact of wind on objects using equipment (a wind tunnel) to artificially generate wind.
- *7 Motion capture: Technology that digitally records measurements of an object's movements made using sensors and cameras.

Looking ahead

Hitachi is moving forward with plans to strengthen the support this new technology lends to our Lumada 3.0 and, by taking advantage of accumulated knowledge in the social infrastructure domain, developing a new digital service to promote the efficient use of drones and other advanced air mobility equipment in this sector. Based on this new technology, we plan to develop a new system to digitally gather, compile, and manage airframe data and data on air mobility system operations, utilize AI to enhance the control and safety of air mobility equipment, and also provide automated operation and other advanced services. In addition to enabling drone use in urban areas, this will boost efficiency in the management of a wide range of important infrastructure, including dams and waterworks, rivers, levees, bridges, power transmission lines, railroads, and highways, thereby contributing to the development of a harmonious society in which the environment, human happiness, and economic growth coexist in a peaceful balance.

Details of this new technology will be presented at the annual meeting of the Japan Society of Mechanical Engineers to be held from September 7 through 10, 2025.

About Hitachi, Ltd.

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and the Strategic SIB Business Unit for new growth businesses. With Lumada at its core, Hitachi generates value from integrating data, technology and domain knowledge to solve customer and social challenges. Revenues for FY2024 (ended March 31, 2025) totaled 9,783.3 billion yen, with 618 consolidated subsidiaries and approximately 280,000 employees worldwide. Visit us at www.hitachi.com.

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