Researchers test novel drone navigation technology in an active Japanese tunnel construction site

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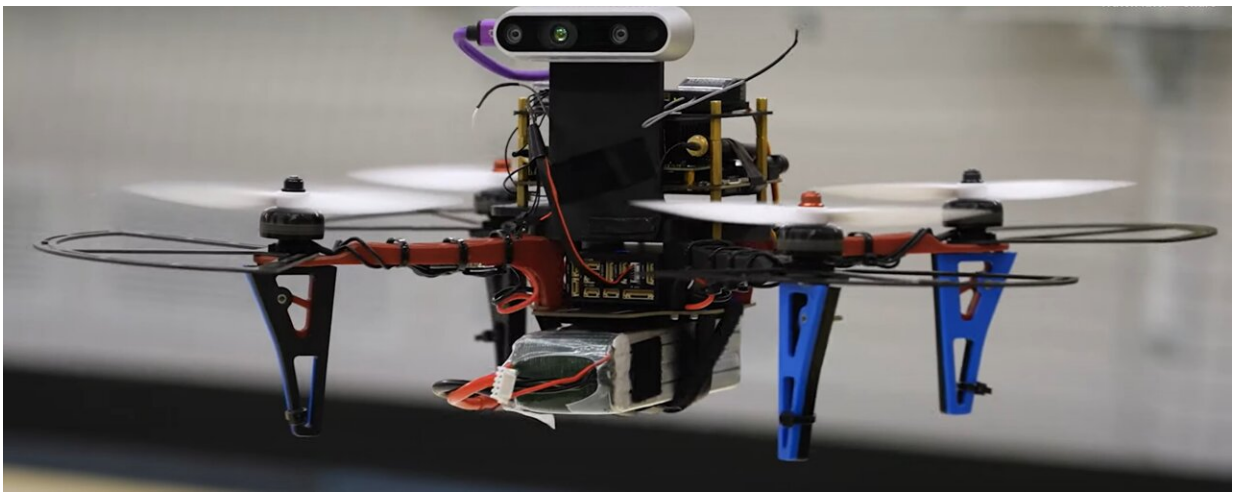

Credit: Carnegie Mellon University Mechanical Engineering

For drones to save lives in search and rescue missions, or even reliably deliver our packages, they need to navigate dynamic environments without accident. Unmanned aerial vehicles (UAVs) have had success steering through open spaces time and time again, but the unpredictability of moving obstacles has been a challenge, especially in indoor environments with no GPS signals. Kenji Shimada and his students leaned into this problem to develop new technology that enables autonomous flights in indoor dynamic environments.

The novel technologies, drone navigation and obstacle avoidance, and dynamic obstacle tracking and mapping, were put to the test last winter. Shimada's drones were tasked with navigating an active Japanese tunnel construction site while avoiding collisions with moving human workers as part of a project sponsored by industry partners, Toprise Co., Ltd. and Obayashi Corporation.

"Companies have recognized that young people don't want to do dangerous, physical work anymore, so they are investing in robotics to fill the gap," explained Shimada, a professor of mechanical engineering.

Shimada's drones were able to measure the 3D geometry of the excavation front of the tunnel. This information, when compared to design data, tells builders what parts of the tunnel are complete and what parts need to be scaled further, without putting people at risk.

"To our knowledge, this is the first time 3D scanning with an autonomous drone has been done in dynamic, under-construction tunnel environments," said Zhefan Xu, the lead Ph.D. student of the drone project.

In order to predict the path of moving objects, like people at work in the tunnel, the team introduced the first real-time system that uses a 3D hybrid map to account for the static environment while simultaneously tracking dynamic obstacles. With this technology, the team refined their previous algorithm to account for the real-time planning required by in-motion drones to prevent collisions. The combination system allows the drones to approximate where a collision may occur and prevent it.

"The idea for this project stemmed from a scene in a sci-fi movie where a robot flew around inspecting an underground structure. After a decade of research on drones and three years on this project, I'm excited that we've made it a reality. I think that this technology will have a large

impact on improving the safety of workers on construction sites," said Shimada. This research was presented at the 2023 International Conference on Robotics and Automation (ICRA) organized by the Institute of Electrical and Electronics Engineers (IEEE).

Provided by Carnegie Mellon University Mechanical Engineering