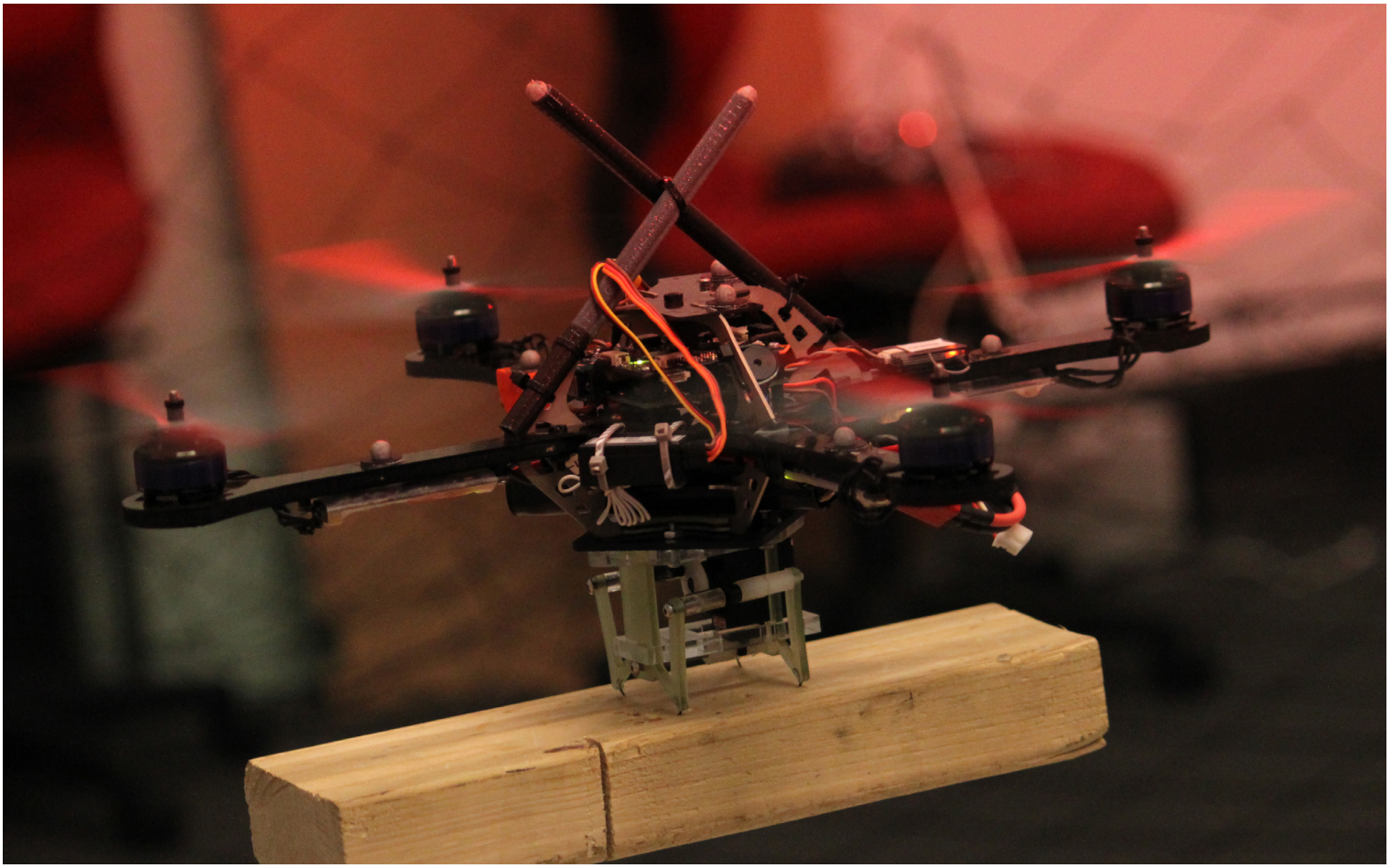
VICON

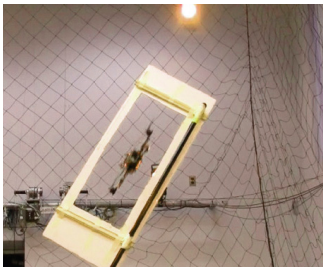
University of Pennsylvania
GRASP Lab

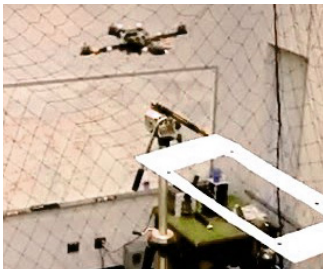


"Vicon's motion capture system allows us to focus on one part of the problem – the dynamics and control. That is a big advantage in projects of this scale."
Daniel Mellinger, School Of Mechanical Engineering

VICON | Case Study

University of Pennsylvania GRASP Lab


Accurate Manoeuvrability


Precision Hovering


Transporting Objects

By using Vicon motion capture systems to track position in space, the University of Pennsylvania is achieving highly precise flight maneuvers with Quadrotor Unmanned Aerial Vehicles (UAVs).

The GRASP lab at the University of Pennsylvania's Department of Mechanical Engineering is conducting research that aims to achieve computer-driven quadrotor UAV flight that is precise enough to someday be applied practically in scenarios including search and rescue operations in which human entry inside buildings damaged by earthquakes or fires is too dangerous.

Each quadrotor is equipped with an IMU (Inertial Measurement Unit) sensor to measure its angular velocity, and affixed with four passive optical markers that are tracked by 20 Vicon MX T40 cameras set up in a 5 X 5 X 5 meter volume. The Vicon motion capture system feeds the position in space of a quadrotor into the lab's computer-driven navigation system. The lab has achieved this successfully with up to eight quadrotors flying simultaneously. Highly precise navigation, including flying through windows with less than three inches of clearance, is driven using algorithms designed by the GRASP Lab's research team consisting of Dr. Vijay Kumar, Daniel Mellinger and Dr. Nathan Michael.

"Vicon mocap is in use on a day-to-day basis on the project. Developing agile robotic systems requires a way of measuring position and orientation in real-time at high rates and the Vicon system gives us that reliable data. We push the system to the limit on a daily basis, the quadrotors fly very closely to each other and we can't afford to make errors or we get spectacular crashes," explained Dr. Vijay Kumar.

The quadrotors perform a variety of maneuvers, including single, double and triple flips, flying through space with any reasonable velocity or pitch angle, flying through windows at various angles with less than three inches of clearance on all sides, flying between other quadrotors, and ascending or descending through a narrow horizontal slot. Additionally, with appropriate claws or perching aids, the UAV can perch directly onto a flat, vertical or inverted spot within a space.

"Figuring out position, or localization, is one of the most challenging problems for engineers working with UAVs," says Daniel Mellinger, PhD student at the School of Mechanical Engineering at the University of Pennsylvania. "But by using a Vicon system, we can very accurately determine where the UAVs are in space at a very high rate." The onboard IMU on each quadrotor measures angular velocity, however determining where the quadrotor resides in space is the tricky part. According to the GRASP Lab team, that's where the Vicon system and Tracker software come in. "With any big engineering problem, it's helpful if you can parse out portions of the problem and solve those individually," shares Mellinger. "Vicon's motion capture system allows us to focus on one part of the problem - the dynamics and control. That is a big advantage in projects of this scale."

For now this remarkable achievement lives in the lab, but in the future, the University of Pennsylvania hopes to recreate these scenarios in real-world outdoor settings and is researching technologies to make this possible. For more information, visit youtube.com/vicon100 to watch the Quadrotors in action.

Technology Profile

Vicon MX T40 20 Camera System
Vicon Tracker Software

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