

Fact sheet: The Center for Autonomous Systems and Technologies (CAST)

What is CAST? CAST is a new 10,000-square-foot research facility on the southeast side of Caltech's campus. Primarily located on the first floor of the Guggenheim Aeronautical Laboratory, it includes a three-story aerodrome that was built by enclosing a space between Guggenheim and the adjacent Kármán Laboratory of Fluid Mechanics and Jet Propulsion in the Graduate Aerospace Laboratories of the California Institute of Technology (GALCIT).

CAST is a collaboration among Caltech's Division of Engineering and Applied Science (EAS), Division of Geological and Planetary Sciences (GPS), and NASA's Jet Propulsion Laboratory, which is managed by Caltech. Bringing scientists and engineers together, it seeks to unite experts from the fields of machine learning, aeronautics, controls, and robotics.

Including the lead sponsorship of Raytheon Company as well as the support of JPL and corporations such as AeroVironment, strategic partnerships will help fund CAST and the development of the next generations of autonomous systems and help bring the resulting products to market faster.

Key facilities:

- **Aerodrome:** The tallest indoor drone arena of its kind, covering more than 2,500 square feet, and 41 feet high. It includes a custom-built 10-foot-by-10-foot wall of 1,296 fans capable of generating wind speeds of up to 35 mph, with a side wall of 324 fans to create a crosswind. The wall is capable of creating a nearly infinite variety of wind conditions for drones to learn to react to—everything from a light gust to a stormy vortex, simulating the real-world conditions that flying autonomous aircraft may encounter. The entire wall can also be tilted 90 degrees to simulate vertical take-offs and landings. The space is monitored by 48 cameras that track the motion of drones with a resolution of 100 microns.
- **Assembly Room:** A 1,200-square-foot room with work benches and a modular design for flexibility of setup. The room includes an 85-foot-long oval track for walking robots, where researchers can design and test out new gaits.
- **Space Robotics Lab:** A 2,300-square-foot lab featuring a spacecraft fabrication space with a clean room and a spacecraft motion simulation facility with a high-precision flat floor, with imperfections smaller than a thousandth of an inch. This allows researchers to fly "spacecraft" that have been engineered to hover through high-pressure jets (like a reverse air hockey table) and simulate the frictionless motion of space flight on a two-dimensional plane.
- **Advanced Mobility Lab:** A 2,500-square-foot lab equipped with multiple tracks—both circular and straight—for walking robots and a custom, 15-foot-long treadmill capable of reaching speeds of up to 40 miles per hour. The floor of the facility includes multiple types of surfaces for robots to traverse, such as grass and spongy gym floor.

Mission statement: CAST promotes interdisciplinary research and the exchange of ideas in the expanding area of autonomous systems. These systems include, but are not limited to, drones and robots for use in science, industry, and medicine. The research conducted by the center addresses sensing, control, vision, and other emerging areas. The center promotes a synergic environment where machines and humans share the workplace. It also serves as an arena where ideas can be translated into reality and be demonstrated to academic researchers as well as to the general public through educational outreach.

Research focus: Research at CAST will focus on developing autonomous systems that improve everyday life and help humans respond to emergencies in five main categories:

- **Explorers:** Autonomous terrestrial and aerial robots that work together to explore areas that are difficult to reach or operate in, such as underwater or on other planets.
- **Guardians:** Robots that can monitor and respond to emergency situations.
- **Transformers:** Swarms of robots capable of changing shape to form a single unit; for example, flying in a formation that allows them to act as a single space telescope.
- **Transporters:** Flying autonomous vehicles for medical emergencies and safe battlefield evacuation.
- **Partners:** Robots that are capable of helping and entertaining people.

Moonshots: CAST is uniquely focused on a series of big-picture challenges that will unite all of the facility's researchers. CAST Director Mory Gharib will address these challenges with what he describes as "moonshots" — proofs of concept to help pioneer new facets of autonomous technology. These moonshots, which CAST hopes to achieve within two to five years, include:

- **Autonomous flying ambulance:** CAST is developing an autonomous flying ambulance for urban applications. The autonomous ambulance would have vertical take-off/landing capability, an anticipated range of about 15 miles, and a maximum speed of about 150 miles per hour. Swarms of these autonomous vehicles could soar over gridlocked traffic to reach the sites of medical emergencies.
- **Robot hiker:** CAST is developing a bipedal robot that will hike the Pacific Crest Trail from Mexico to Canada, supported by a swarm of automated flying drones that will scout the territory ahead and report changes in terrain or other factors to the robot, which will then adapt to those new conditions. The walking robot will pave the way for an autonomous probe that could one day explore other planets.
- **Swarm imaging system:** CAST will engineer swarms of flying robots that each carry cameras to work together to create a single large-scale aperture for imaging.

People: CAST is directed by Morteza (Mory) Gharib, Hans W. Liepmann Professor of Aeronautics and Bioinspired Engineering and director of Caltech's Graduate Aerospace Laboratories (GALCIT).

The members of the CAST Steering Committee and the Scientific Advisory Committee can be found online at <http://cast.caltech.edu>. For more information, contact Robert Perkins of Caltech's Office of Strategic Communications at 626-395-1862 or rperkins@caltech.edu.