A firefighter drone that flies and crawls up walls

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The Fireproof Aerial RObot System (FAROS) is a wall-climbing scout drone developed to conduct explorations into the site of skyscraper fires. It has an ability to climb walls in smoky, narrow spaces inside buildings. Credit: KAIST

The 1974 American disaster film Towering Inferno depicted well the earnest struggles of firefighters engaged in ending a fire at a 138-story skyscraper. To this day, fires at high-rise buildings are considered one of the most dangerous disasters.

Skyscraper fires are particularly difficult to contain because of their ability to spread rapidly in high-occupant density spaces and the challenge of fighting fires in the buildings' complex vertical structure. Accessibility to skyscrapers at the time of the fire is limited, and it is hard to assess the initial situation.

A research team at the Korea Advanced Institute of Science and Technology (KAIST) led by Professor Hyun Myung of the Civil and Environmental Engineering Department developed an unmanned aerial vehicle, named the Fireproof Aerial RObot System (FAROS), which detects fires in skyscrapers, searches the inside of the building, and transfers data in real time from fire scenes to the ground station.

As an extended version of Climbing Aerial RObot System (CAROS) that was created in 2014 by the research team, the FAROS can also fly and climb walls.

The FAROS, whose movements rely on a quadrotor system, can freely change its flight mode into a spider's crawling on walls, and vice versa, facilitating unimpeded navigation in the labyrinth of narrow spaces filled with debris and rubble inside the blazing building.

The FAROS can endure the heat of over 1,000° Celsius from butane gas and ethanol aerosol flames for over one minute. Credit: KAIST

The drone "estimates" its pose by utilizing a 2-D laser scanner, an altimeter, and an Inertia Measurement Unit sensor to navigate autonomously. With the localization result and using a thermal-imaging camera to recognize objects or people inside a building, the FAROS can also detect and find the fire-ignition point by employing dedicated image-processing technology.

The FAROS is fireproof and flame-retardant. The drone's body is covered with aramid fibers to protect its electric and mechanical components from the direct effects of the flame. The aramid fiber skin also has a buffer of air underneath it, and a thermoelectric cooling system based on the Peltier effect to help maintain the air layer within a specific temperature range.

The research team demonstrated the feasibility of the localization system and wall-climbing mechanism in a smoky indoor environment. The fireproof test showed that the drone could endure the heat of over 1,000° Celsius from butane gas and ethanol aerosol flames for over one minute.

Professor Myung said, "As cities become more crowded with skyscrapers and super structures, fire incidents in these high-rise buildings are life-threatening massive disasters. The FAROS can be aptly deployed to the disaster site at an early stage of such incidents to minimize the damage and maximize the safety and efficiency of rescue mission."

The research team has recently started to enhance the performance of the fireproof design for the exteroceptive sensors including a 2-D laser scanner and a thermal-imaging camera because those sensors could be more exposed to fire than other inside sensors and electric components.

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