A robot that can help firefighters during indoor emergencies

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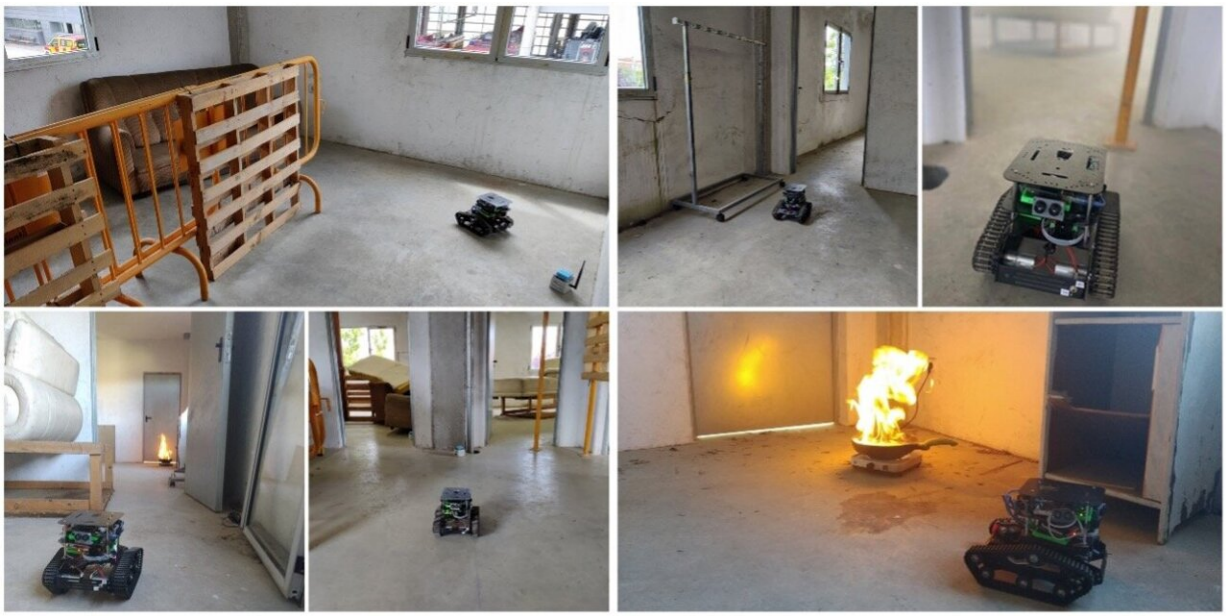


Credit: Fernández Talavera et al

Robots could be valuable assistants for most first responders, as they could help them to remotely monitor or intervene in areas that are inaccessible or life-threatening for humans. Firefighters, who are at high risk of getting injured during their missions, would undoubtedly benefit from the assistance of reliable mobile robots.

Researchers at Universidad Rey Juan Carlos and Universidad Autónoma

de Madrid recently created an autonomous ground robot that could assist firefighters when they are tackling emergencies in indoor environments. Their system, introduced in the *Journal of Field Robotics*, could allow agents responding to fire emergencies to plan their interventions better, clearing safe paths for them to access affected areas and supporting them during evacuations.

"This work is part of a project called HelpResponder, which aims to reduce the accident rates and mission times of intervention teams," Noelia Fernández Talavera, one of the researchers who carried out the study, told Tech Xplore. "This is achieved using fixed beacons, drones, and ground robots. The ground robot was developed as part of a BSc project and supports emergency teams by acquiring environmental parameters in real-time."

Recent studies exploring the evolution of fires in Spain highlighted the need for new technologies that could better assist firefighters. These works collected data about accidents that affected responding agents who tackled missions in indoor environments, such as the collapse of structures or the contraction of diseases associated with the inhalation of toxic gases.

Credit: Fernández Talavera et al

"These statistics reveal the need for firefighters to know the environment before intervening," Talavera said. "All the information about the location of the fires, the presence of harmful gases, and the possible paths is relevant to carry out more effective and safe interventions."

The robot created by Talavera and her colleagues can monitor its surrounding environment, sharing the data it collects with human agents. This is achieved using various sensors that can measure the temperature, humidity and air quality in an indoor setting, as well as its position and the position of other objects. This data is then saved in a database that can be remotely accessed by firefighters through a smartphone application.

"The robot has three operational modes to tackle different scenarios," Talavera explained. "The manual mode allows an operator to remotely control it using a keyboard, joystick, or joypad to generate speed commands. The operator can also control the robot from a direct view or by a graphical user interface. In this last case, the interface must provide enough information to keep their situational awareness, such as the scene map, accurate location of the robot, images of its camera, and so forth."

The robot's second operation mode, dubbed the autonomous mode, allows it to independently explore an indoor environment while avoiding potential obstacles. To achieve this, it relies on a coverage path planning algorithm that uses data collected by the integrated sensors to locate the robot, detect and identify obstacles in its surroundings, and guide it through a set of waypoints.

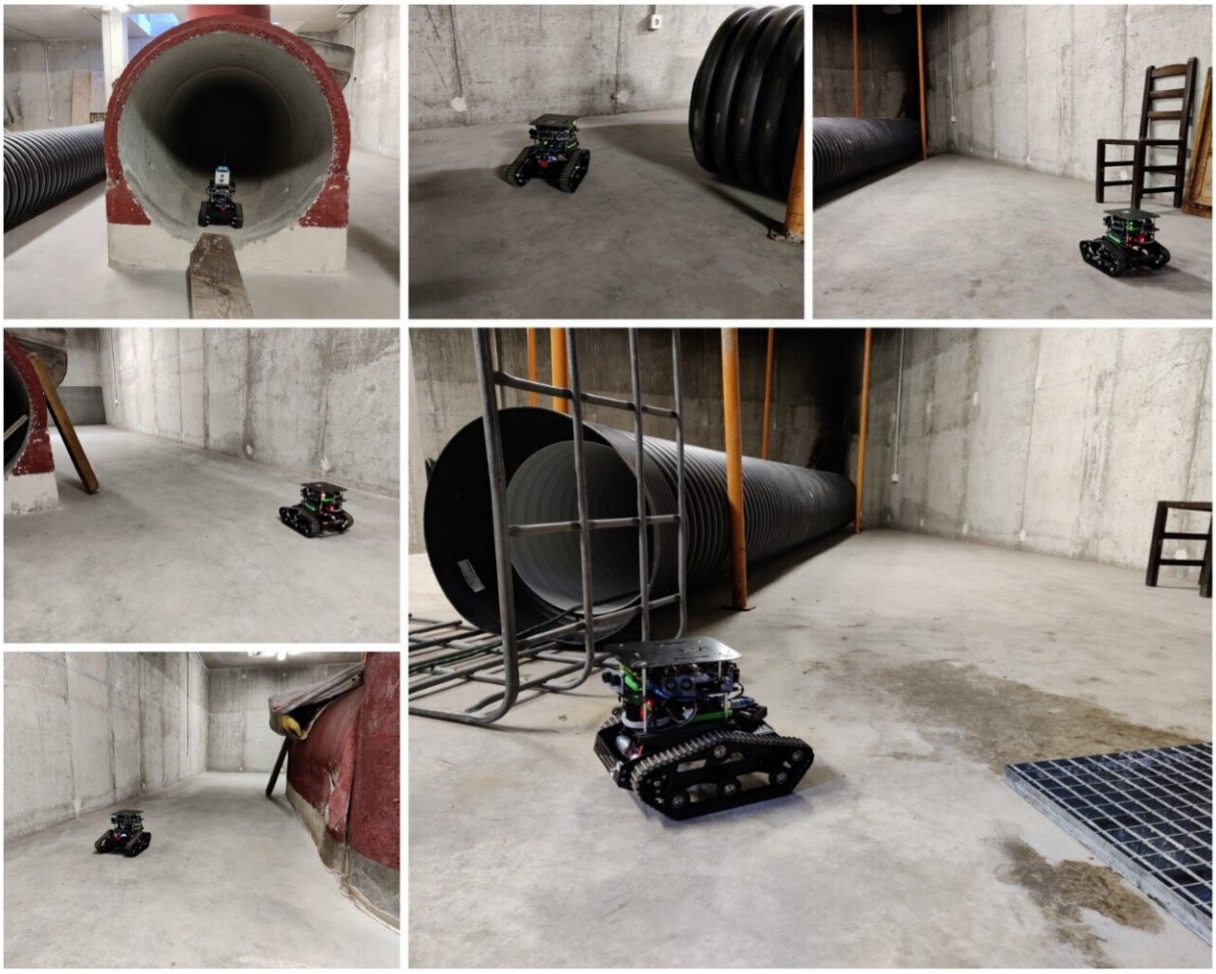
Credit: Fernández Talavera et al

"While in autonomous mode, the robot can cover entire rooms and corridors, providing local information on the environmental conditions," Talavera said. "Finally, the evacuation mode creates fast and safe routes toward targets. This mode uses the prior knowledge of the scene to compute the shortest path from the current position to the target one. This target position can be the exit of the building or the location of a victim, among other things."

The researchers' robot has a modular design, which means that other components (e.g., thermal cameras or other sensors) can be added to it without altering its core configuration. In addition, the robot is small and based on affordable components. This allows it to reach areas that are inaccessible to human agents, while also facilitating its large-scale deployment.

Telavera and her colleagues tested their robot in a series of tests, including both simulations and real-world trials. Their results were highly promising, as the robot could effectively tackle different tasks, while autonomously dodging obstacles and offering valuable support to firefighters.

In evaluations, the robot could tackle different missions in a day, thanks to its robust components and good battery autonomy. The team also created simulations of the robot that could also help firefighters to prepare for future interventions in indoor settings, helping them to identify the most efficient and safe paths to reach a desired location or simply practice using the robot.



Credit: Fernández Talavera et al.

"We developed our system in collaboration with its end-users and validated it in highly realistic scenarios," Talavera said. "The real tests were carried out in the Unified Safety Center of Alcorcón, in collaboration with the Fire Department of that city. The results demonstrated the prototype can work under harsh conditions and locate hot and toxic foci within the intervention map. The effectively covers scenarios and dodges obstacles, so that firefighters can make quick decisions based on the data obtained and generate an intervention

strategy."

The robot created by Talavera and her colleagues could soon be employed and tested by other fire departments. In addition, it could inspire the creation of similar robotic systems designed to assist other first responders, including police officers or teams completing search and rescue missions.

"The next steps in our research will be to improve the autonomous navigation system by integrating ROS and enhance the simulator to reproduce dynamic scenarios where fire and smoke advance in the same way as they would in real situations," Talavera added. "A web platform is also being developed that encompasses different technologies so that the data collected by the robot, drones and beacons can be analyzed simultaneously. This way the system will become easier to use and more valuable for the emergency."

More information: N. Fernández Talavera et al, An autonomous ground robot to support firefighters' interventions in indoor emergencies, *Journal of Field Robotics* (2023). DOI: 10.1002/rob.22150

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