A framework for robot path finding in unstructured environments

August 9 2021, by Ingrid Fadelli

Different snapshots of the robot following the human leader across an environment with various static obstacles. The robot remains on the measured path at a safe distance from the human operator. Credit: Antonucci et al.

In recent years, computer scientists have developed mobile robots that could be introduced in a variety of settings. To efficiently navigate unstructured environments, however, these robots should be able to plan safe paths to reach their desired destinations.

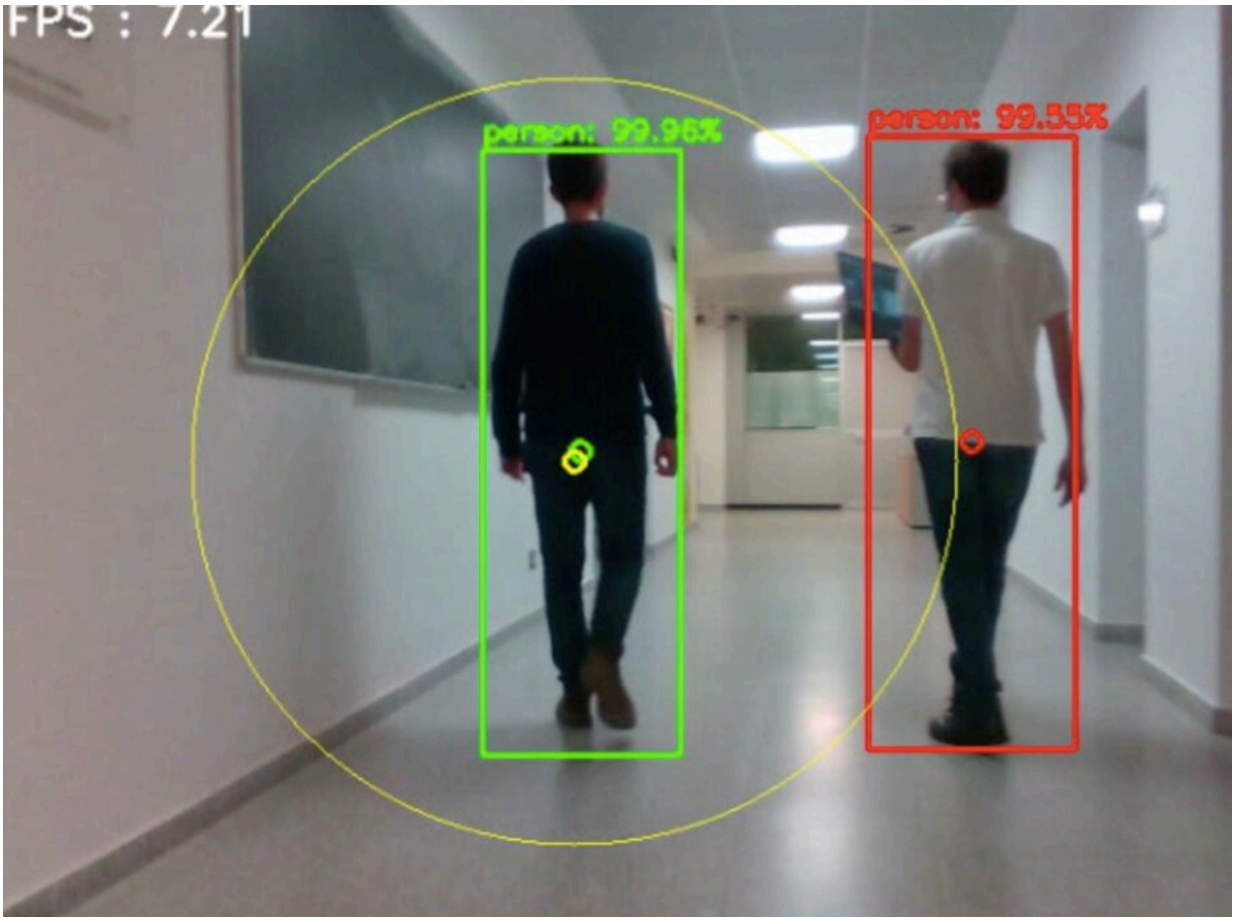
Existing approaches to plan safe paths for robots fall into two broad categories. The first type entrusts the control of the robot entirely to trained human users, who are expected to monitor the movements of robots and determine their trajectories.

The second type of planners are those that try to train robots to plan their own paths and move autonomously. While some of these planners have achieved promising results, they can be unreliable, particularly when a

robot is navigating complex environments that are also populated by humans or animals. To achieve satisfactory results, these planners typically require expensive hardware and sensors.

Researchers at University of Trento have recently developed an alternative framework for robot path planning. This new framework, presented in a paper pre-published on arXiv, allows robots to identify and learn safe paths towards a desired destination simply by following a human operator walking in front of them.

"In human-robot interactions where a robot has to follow a human operator by navigating in unstructured and human-populated work environments, safety is obviously of primary importance," Alessandro Antonucci, one of the researchers who carried out the study, told *Tech Xplore*. "The main objective of our work was to delegate the path planning routine of the robot to the human, who must however concentrate only on the path to take. The robot for its part is able to memorize the path traveled and reuse it in future missions."



How the robot detects and recognizes its human leader (green box) and other persons (red box) from its onboard camera. Credit: Antonucci et al

The approach developed by Antonucci and his colleagues greatly simplifies the task of path planning, thus it does not require particularly expensive sensors or highly advanced software components. Essentially, the framework allows robots to recognize a human 'leader' (or 'path-finder'), to then locate and track his movements.

"The particular sensor fusion based on a laser scanner and a depth camera, which is a peculiarity of our work, and mounted on the robot chassis, allows the robot to distinguish the leader from other people in its

surroundings, thus ensuring tracking robustness," Antonucci said. "Moreover, the high accuracy of the distance of the entities around the robot ensures its safety, as the robot can stop in time before colliding with static obstacles and other people."

The researchers' approach utilizes a combination of state-of-the-art techniques. In addition, their framework is highly modular, which means that it can be adapted, modified and improved by adding or removing modules, without changing its overall design.

Antonucci and his colleagues evaluated their framework in a series of experiments. They found that it performed remarkably well despite its low complexity and the low price of the sensors they used.

In the future, the new approach devised by this team of researchers could aid the development of low-cost mobile robots that can navigate unstructured environments safely and more efficiently. As it does not require expensive sensors, hardware and software, the framework should be easy to implement in real-world settings.

"Our next studies will focus on improving the interaction between the robot and the human," Antonucci said. "At present, if the robot notices an obstacle on its way, it can only respect the safety and stop. We are thinking for instance to add wearable devices with which the robot can communicate in advance to the human leader that the path that the latter has taken is not actually appropriate for the robot."

More information: Humans as path-finders for safe navigation. arXiv:2107.03079 [cs.RO]. arxiv.org/abs/2107.03079