Survey current state of the art of different search and rescue robots
-what kind of robots
-what kind of scenarios have they have been deployed in?

Really unique robot from stanford
https://youtu.be/oRjFFgAZQnk

Kind of what our robot will look like
https://youtu.be/tf7IEVTDjng

Another snake robot
https://youtu.be/L9j52vjhb18

A very good robot
Leonardo: The Skateboarding, Slacklining RobotYouTube · caltech59 seconds7 Oct 2021

Another video on leonardo

https://youtu.be/H1_OpWiyijU

https://emerj.com/ai-sector-overviews/search-and-rescue-robots-current-applications/

https://youtu.be/tf7IEVTDjng

Comparison of advantages and limitations of different rescue robots

- How will we be comparing water-based with aerial rescue robots
- Comparison between robots which operate on the same terrain

Prioritise quality over quantity, comparing 4 land robots

Independently compare each of our own 2 robots, then compare all 4 robots together at the end

Interesting ideas below (try categorise as best as we can to improve efficiency when searching):
https://www.research-collection.ethz.ch/bitstream/handle/20.500.11850/358005/Delmerico2018jfr.pdf;jsessionid=D9FE4D0BBE19A0E6A0E7C6C936E2E4FE?sequence=1

Legged vs tracks/wheeled robots:

- Legged has more mobility, but require more sophisticated approaches to control
- Versus robots with wheels which are more stable, and offer straightforward navigation, but at the cost of needing a smooth continuous path, which is not always available in a disaster site

Adaptability of robots:

- Inspired by the trial-and-error behavior of animals to adapt to injuries, learning algorithms can be used to enable a robot to rapidly adapt to damage (Cully et al., 2015), for example to the loss of a limb in a legged robot or to reduced range of motion in one of its joints.

Studies that we'll look into:

- Guowei et al., 2014 - narrow gaps to free victims trapped in rubble
- Ohashi et al., 2017 - autonomous stair climbing

## Neil research

### Stanford vine robot

The vinebot is a tube of soft material that grows in one direction. *(Image credit: L.A. Cicero)*

Inspired by natural organisms that cover distance by growing – such as vines, fungi and nerve cells – the researchers at Stanford have made a proof of concept of their soft, growing robot which can traverse extremely challenging situations.

Lets look at the robot in action

The basic idea behind this robot is straightforward. It's a tube of soft material folded inside itself, like an inside-out sock, that grows in one direction when the material at the front of the tube everts, as the tube becomes right-side-out.

This can be both controlled by using either air or a liquid.

Stanford researchers develop vine-like, growing robot
Play from 1:09 - 1:29
What are the advantages of a robot like this?

- One of the greatest advantages is traversing through difficult environments as you don't need to worry about it getting damaged or stuck as it explores.
- An example of this is when the robot was punctured through sharp nails, however as the area that was punctured didn't continue to move and, as a result, self-sealed by staying on top of the nail.
- A primary advantage of soft robots is that they can be safer than hard, rigid robots not only because they are soft but also because they are often lightweight. This is especially useful in situations where a robot could be moving in close quarters with a person.

The purpose of this robot is to locate victims and provide water, or to locate certain hazards like fire and extinguish them.

It also useful in mapping terrains and hence informing search teams of potential dangers.

Spot by Boston dynamics


A robot very similar to the one we have with us.

Unlike tracked or wheeled robots, Spot can handle nearly any terrain and its mobility is its greatest advantage.

While most robots have only front-facing cameras, the Spot CAM+IR provides a 360-degree view of Spot's environment, displayed in real time on a tablet. Operators can pan, tilt, and zoom the camera to get up to 30x magnification of any angle, and the high-resolution thermal imaging capabilities allow rescuers to search for people who are trapped or objects that are radiating heat—even if Spot's surroundings are obscured by smoke.

The spot robot has assisted new york fighters to survey a dangerous situation and plan the rescue mission that's safer for both rescue victims and the fire fighters.

There are many stories of spot being used to investigate bomb threats, in hostage situations, examining drug labs etc.

### Dexterity

The Spot Arm offers a full range of motion with 6-degrees of freedom, a capable gripper, and an almost one meter reach.

### Strength

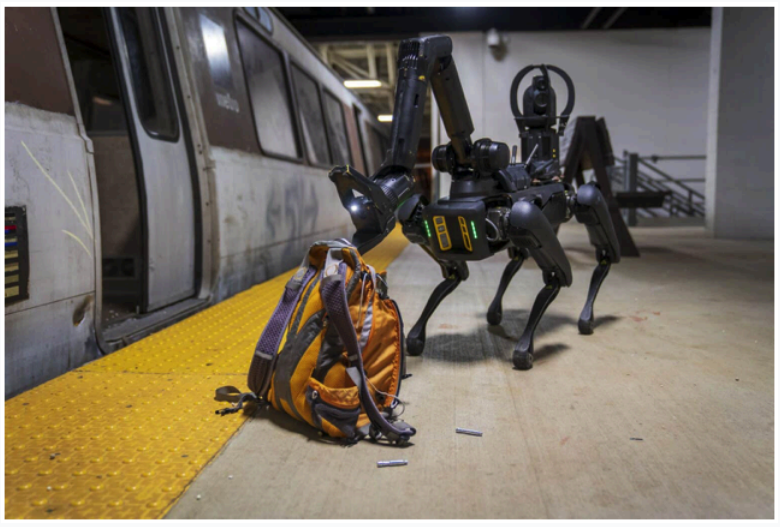
Lift up to 11kg and drag up to 25kg with the arm. Spot uses its whole body to enable manipulation tasks.

### Sensing

Integrated sensors include time of flight (ToF) and inertial measurement unit (IMU) sensors to enable actuate control, as well as a 4k RGB camera in the gripper.

### Customizability

The Arm API allows developers to create custom applications, with both joint-space control and end-effector control.



[Arm | Boston Dynamics]

Advantages over snake:

- Greater manipulation of objects and can handle packages and threats using the arm.
- Can transport more resources
- Faster and more accurate traversing
- Mount various sensors for different tasks
    - “ Dutch police are using Spot to assist with drug lab investigations, and the robot can be equipped with integrated sensors for chemical, biological, radiological, or explosive detection—allowing public safety officials to create maps of danger zones and collect site samples.
- Better mapping and can communicate with victims using speakers and microphones.

~~Path finding algorithm comparison~~

~~The dynamic objects arising from these disasters, including flooded areas, debris from collapsed structures, vision-obscuring smoke, and obstructive fires, are deemed impassable obstacles for regular human beings, emergency responder vehicles, and UGVs~~

~~Scenario 1:~~

- ~~Serves as baseline by having no dynamically spawning objects~~

~~Scenario 2:~~

~~Scenario 3:~~