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Searching for a solution

As weather and climate events intensify, search and rescue (SAR) missions are becoming more and more dangerous for the rescuers [1]. Using Boston Dynamic's robot SPOT as a SAR team member reduces the risk to human rescuers by scouting unfamiliar terrain, scanning heat signatures, and communicating data to rescuers remotely.

Modern search & rescue is a rewarding but dangerous job. As human activity continues to push into more remote and difficult geographic terrains, SAR teams must adapt. Rescue missions have become more complex and rely increasingly on the use of technology [2] [3]. Climate change is causing extreme weather events which have increased the risk for victims and rescue workers [4]. Drones and UAVs have been used in search and rescue missions for more than a decade. These technologies have been used to search for victims inside collapsed buildings, collected disaster data, detected dangerous materials and conditions. and delivering first aid kits [6].

This proposal briefly discusses the increasing risk to rescue workers and how the use of SPOT can improve their safety. There is a technical description of SPOT and how specific features will improve outcomes. Finally, there are recommendations for areas of further research into SPOT's applications for future SAR missions.

Rescuing the rescuers

Modern search and rescue teams are equipped with the most current technologies which help to keep their lives safe while they save lives [1]

There are many instances when it is too dangerous for these teams to work. Certain accident sites can be too unstable for rescue workers and create more risk for recovery operations [2]. There is also a heavy mental and emotional toll on rescue workers [3].

Figure 1: Search & Rescue Crew Training

With the increase in severe weather instances due to climate change, and aging infrastructures all over the world, search and rescue will become more necessary and more dangerous [4] [5].

Using the Boston Dynamics' robot SPOT for search and rescue missions can reduce rescuer risk in volatile missions and also reduce risk in future missions. This robot can be controlled at a distance, can collect data about a site, and traverse difficult terrain, refining searches and

reducing the need for human intervention [6]. Spot can lift or move materials up to 14kg [6]. SPOT has an arm attachment allowing it to move and access hard-to-reach areas. SPOT can record data and information about a mission and apply it to predictive modelling for future missions.

SPOT

SPOT is an agile mobile robot created by the company Boston Dynamics (see figure 2). Agile mobile robots can adapt quickly to new tasks or environments, which makes them ideal for search and rescue missions where the climate and terrain change constantly. Many of SPOT's features could help SAR missions [7]:

- Mobile manipulation
- Capable of handling up to 14 kg payloads
- 3D vision system with SLAM and obstacle avoidance
- Bioinspired dynamic control. Omni-directional walking and multiple walking and trotting gaits. Can climb and descend stairs. Balances and adjusts to physical disturbances.
- Ingress protection IP54 – electrical components protected from dirt, dust, oil, and other non- corrosive material
- Operating environment -20C to 45C

SPOT is remotely controlled with a typical range of 50m if the controller is paired to SPOT's Wi-Fi access point. It can be controlled by a human operator while also being able to navigate and perform some tasks autonomously.

How can spot help?

Spot is a four-legged robot that can map its environment, sense, and avoid obstacles, climb stairs, and manipulate basic mechanisms, like latches or handles. It can also move or carry objects over diverse terrains faster, and sometimes more efficiently, than humans.

In a SAR mission, SPOT can be sent into places or spaces humans cannot enter due to safety concerns or physical limitations. SPOT can be programmed to detect sensory input from its camera, such as heat signatures, hazardous material detection and removal, or even detection of noxious gasses.

SPOT could carry supplies or aid to victims, or record video of a site which could provide rescuers valuable data about a situation. Rescuers are primarily focused on their safety and the safety of their crew, so having a team member entirely focused on the victim's well-being could improve everyone's safety.

Spot's features

SPOT has multiple functions which make it optimal for SAR.

Agility

SPOT has omni-directional walking and multiple walking and trotting gaits. It can climb and descend stairs or balance and adjust to physical disturbances (see Table 1).

In environments with more difficult terrain such as those with inclines or rocks, SPOT's performance may be improved using the Crawl gait.

Sensory inputs

SPOT's perception sensors include stereo and depth cameras, 3D vision system with SLAM and obstacle avoidance, inertial measurement units (IMU), and position/force sensors in its limbs [6]. These sensors would help SPOT understand and adapt to each working environment. There is also the possibility of bespoke sensors being added, such as infra-red heat signature detection, or touch sensitivity for human interaction.
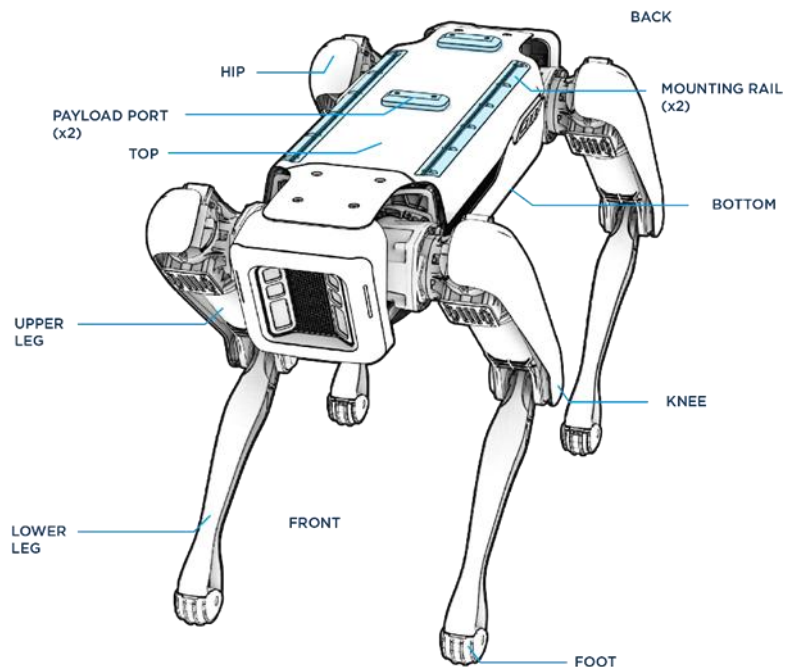

Figure 2: Spot Diagram

Record data

Using the 3D visual system, SPOT can track activity with precision, speed, and consistency. This consistency also ensures data quality, rendering collected data points optimally comparable and allowing teams to construct accurate and reliable mission models. These models, which may combine environmental conditions, human behaviors, and other variables, predict how well a mission will be executed and perhaps allow rescuers to anticipate problems even before they occur [8]. SPOT has 16 GB SO-DIMM DDR4 2666 RAM and 512 GB M.2 22x60 SSD for storage [7].

Spot is the right solution

SPOT is a rugged and agile robot that can be a valuable member of any SAR team. SPOT's features, such as 3D vision system, agility in diverse terrains and its ability to record valuable data make it an essential tool for rescuers.

Recommendations for further research

There are many more features that could be applied to this situation. SPOT can also be programmed for specific tasks and equipped with technologies not offered in the standard specifications. Each rescue mission could have its own reconnaissance robot.

References