Rescue Robot Innovations

Earthquakes cause buildings to collapse and alter the environment in similar ways, leading to many people being trapped in caved in structures. These effects can be relieved by the usage of rescue robots. While today's rescue robots are often bulky or heavy, new innovations on existing smaller robot designs can help more effectively accomplish rescue tasks. I made a robot model (the Rubble Rescue Bot) from a Micro:bit and the Elecfreaks robot kit, which has capabilities of avoiding obstacles and following sound, but these capabilities can be expanded to include future innovations.

I was inspired to make the Rubble Rescue Bot when I read about the HyQ2Max Earthquake Rescue Robot. This robot is also designed to operate during earthquake crises, and save those in danger. I was inspired by its mission, as many earthquakes result in a profuse amount of mortalities. However, this robot was modeled to be large and bulky in order to withstand the impact of falling debris. Unlike the HyQ2Max, the Rubble Rescue bot is small, making it less prone to being hit by falling debris and making it easier to get through collapsed buildings.

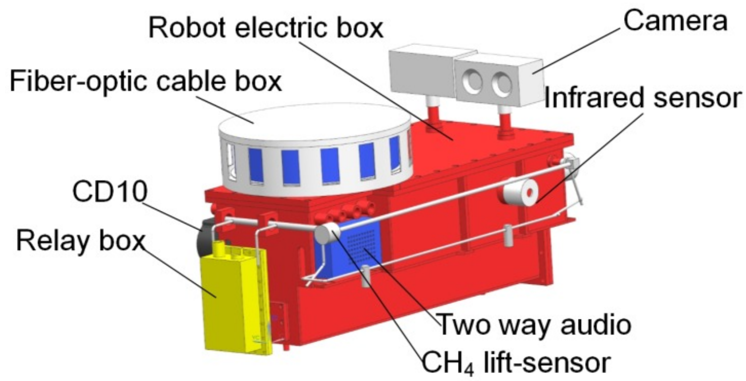
Rescue robots today come in a multitude of designs, which have different purposes, like spill-cleaning, movement detections, and mapping. These include robots like TRADR, iRobot, and the CENTAURO Robots, and are divided into terrestrial, marine, and aerial rescue robots. Not all robots are specifically rescue robots, but they do have implemented features which can aid in a rescue mission. For example, the mapping techniques of the SLAM can be used to track the robots and draw a map of the rescue site, allowing for better knowledge of the dangers during rescue. SLAM stands for simultaneous localization and mapping, which means that they map out terrain that they're in while tracking something inside the area of the map. Terrestrial bots, the main subject of conversation, were found to have limitations and disadvantages when in a rescue mission. For a larger robot, it may not be able to get into small areas as effectively, which is vital to search-and-rescue missions in environments with large amounts of debris. In addition, many are expensive to produce, so many countries or areas that need them cannot afford them. In order to combat the size limitation, developers made the "cockroach robot," which is able to compress under pressure and still function, as it is modeled off of the anatomical structure of a cockroach (https://www.google.com/search?q=cockroach+robot&rlz=1C5CHFA_enUS895US895&oq=cockroach+robot&aqs=chrome..69i57j0j0i20i263j0j0i22i30i457j0i22i30l5.2453j0j4&sourceid=chrome&ie=UTF-8). However, due to their size, it is not possible to fit as much machinery in or completely as many functions like distributing medication or communicating with people.

Current rescue robots are typically bulky and large. There are many disadvantages to this commonly found design. One disadvantage is how they cannot travel through tight spaces or be flexible in how they move. This means that if they have to move through collapsed buildings or debris they will have to find a way to travel over the debris, which can not only be slow and time consuming, but dangerous. However, there are still some advantages to this design. An advantage is how these large robots are designed to be heavy and robust, and are able to withstand impact of falling debris. Though bigger robots can withstand impact, smaller robots can use their built in sensors and cameras to detect and avoid falling debris, getting away quickly because of their small size. There is an example of such a bot invented by David Zarrouk at Ben Gurion University in Israel. Contrasting the typical large and heavy machines, these robots are roach-inspired and extremely small in comparison. They can move through collapsed tunnels and pass through tight spaces unreachable by humans, and some can even climb and go up stairs. Their inventor said that these inexpensive robots are able to help with multiple tasks, such as looking for survivors after earthquakes, examining contaminated tunnels, and aiding in rescue missions. It is called TRADR, which stands for Human-Robot Teaming for Robot Assisted Disaster Response. These bots work as a team, while communicating with a team of humans to map the area after an earthquake, and note possible dangers and cleanup progress.

The Rubble Rescue Bot will have many features in order to save people during earthquakes, which can be used for other functions as well. For example, the arms that were originally designed can also have many other purposes. Purposes include cleaning up messes, moving items, and medical care. As the bot is small and lightweight, it can easily get into compact spaces to clean up dust and spills. Considering that the bot is also designed to save people, it should have no trouble picking up and moving similar weight objects. Along with that, it can also carry medical supplies if need be, and deliver medical supplies (such as small first-aid kits) to different locations.

During the rescue, the robot will also need to collaborate with human first responders and to understand signals and body language. Research investigates development of a robot companion, in order to develop social rules for robot behaviour which is acceptable to humans. Such robots are also discussed as possible educational or therapeutic toys for children with autism. In order to save a person, the team of Rescue Rubble Bots will need to be able to recognize the body language/signals of the person it's saving, to see their condition and if they have any injury. In the case that they are severely injured, the bot will have to move the person without hurting them further.

The following sensor/robot system's purpose is to collect information and observe the environment of a coal mine, through remote control. This system can then be regarded as a multifunction sensor, which realizes remote sensing.



SLAM is used in a variety of settings and situations. Large improvement in computer processing speed and increased availability of inexpensive sensors has caused it to be much more accessible. SLAM is now used in many different situations, such as being used in robot vacuums. These vacuums map out the area they clean within a room in order to navigate through it. SLAM utilizes sensors to find how many wheel rotations it needs to finish cleaning, which is localization. The robot is able to track where it has already gone and what obstacles are in their way. Visual SLAM utilizes images that the robot has collected through camera sensors, and uses these to develop an accurate representation of the environment around them. The cameras used for this can be inexpensive, which makes SLAM affordable and practical, while also having a variety of uses.

In order to create the Rubble Rescue robot, a general design was first needed. The initial design was a robot with four wheels, four motors, and an arm controlled by servos. However, much of the design was limited by which supplies I had access to. Because of Covid-19, the only supplies that I could get was supplies from Amazon. In order to make do with what I had access to, I decided to go with the ElecFreaks Cutebot Set. This set already came preassembled, but it only had two wheels. The ElecFreaks Cutebot also came with an ultrasonic sensor, which was going to be used to detect and avoid obstacles in the environment. I also got a Micro:Bit in order to power up the robot. The servos to control the arm, unfortunately, never arrived. If this bot was to be put to use, it would definitely follow the original design of having an arm.

Modern day rescue bots are designed to be heavy and to withstand impact from debris and rocks instead of avoiding it. This could prove to be difficult when trying to get through uneven patches of rubble and debris, as well as when debris falls on the robot. Saving people requires enough speed to get to them on time. On the contrary, the Rubble Rescue Bot is designed to be small and lightweight, in order to get through rubble and maneuver around obstacles. Through a robotic arm controlled by servos, the robot is able to pick up and move objects. It is planned to be modelled so that if there was to be a team of Rubble Rescue Bots, they could collectively move a person together in the future. The team of robots would be too small to individually move the weight of a person, but after sending signals to one another to help them navigate to the person, the bots can move the person together using their combined strength.

The impact of earthquakes is able to collapse heavy buildings. As there are currently not many precise ways to track when earthquakes will occur and how strong they will be, the impact earthquakes can have is not only devastating, but sudden. The victims of earthquakes will often not know beforehand, which increases the need for a Rubble Rescue Robot in order to save those in destroyed buildings. Benefits of having a smaller sized robot than most modern rescue robots include speed and flexibility. If the robot is able to maneuver around obstacles, it is able to get to the targeted location faster, and to save the person in time.

With access to more supplies and with more time, I plan to implement many more features. An example is changing the current wheels to something more flexible and stable. I also plan to alter its structure so that it is more spider-like, with three rotating points controlled by servos, able to climb surfaces and move better. I would also add cameras, so that it can sense falling debris and also send images of the surroundings to a team of people who might be using the Rescue bot at the time. In order to function as a team of bots, the Rubble Rescue bot would also need to have Bluetooth communication in order to send signals to other bots in the vicinity and alter their code. Fortunately, this can be done by connecting a Micro:Bit to another Micro:Bit. However it would also require another program which would allow the code to be altered by nearby bots.

Bulky rescue robots have multiple disadvantages. They cannot get through small spaces, and are rather slow in doing so. However, newer robots with smaller designs can be used to efficiently save people during post-earthquake situations. Packed with a variety of sensors and machinery, not only are smaller bots more flexible, but they can also utilize SLAM. Creating smaller rescue robots can lead to great improvements in the rescue of humans after earthquakes, and they are a monumental step in the robotic industry.

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