Prototyping project

Group Members

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What our product achieves

1. Assist in the rescue after environmental disasters, mostly:
    - Earthquakes
    - Tsunamis
    - Cyclones
    - Hurricanes
2. Traverse through rubble and find survivors. It maps out terrains.

Target group

- Governments
- First responders
- Non-government organizations (Doctors without borders, etc…)

How our bot works

It uses a combination of sensors to pinpoint the location of a victim. Using IR and Temperature sensors to produce a heat map of an area that allows the user to identify points of danger. In addition, it incorporates a speaker and microphone to directly communicate with a survivor, allowing the user to assess their condition.

What our product consists of

- PIR, IR (Temperature sensor)
    - Used for detecting people under rubble by heat radiated
- Sound sensor
    - Used for sonar for underwater purposes, such as seabed mapping
- Light + Camera
    - Useful for navigation underwater
- GPS, Barometric pressure for altitude
    - Used underwater
- Gyroscopes in all segments
    - Used for orientation awareness
- Microphone and Speaker
    - Used for communication with the victim

- Antenna for radio communication

The designs considered

1. Spider design: This design would enable wall climbing and the ability to go over large pieces of rubble, however, It wouldn't be able to support most of the requirements stated, one of the reasons would be due to its larger build, it will not be able to fit through cracks and therefore will not be flexible.
2. Boston dynamics like- dog (black mirror nightmare killer dog) design: The Boston dynamic robot is one of the most developed robots today, it is used by construction companies, however, this design did not meet our requirements also due to its larger build.
3. Snake Body design: This design will be able to fit through cracks and small spaces due to its small diameter but long build, this feature will also allow many electronics and sensors to be placed on the body of the snake, as the body can always be extended to support more components, The design is also compact making it robust enough to withstand large amounts of pressure in case of heavy rubble falling on it, The ability to go into water bodies is also supported by this design.

The requirements considered:

- Robust
- Able to carry electronics
- Flexible
- Amphibious

After evaluating all our requirements, the Snake Body approach appeals more to us as it ticks all the boxes.

Mechatronics (initial ideas)

- Snake designed in parts - main segments and joints between them
- Segments are cylindrical and house either electronics or ballasts for submerging underwater
- Ten segments in total, varied ballast control for submerging different parts at different times (i.e. tail with antennae at the surface, while head with sensors deep underwater)
- Rollers on all four outer sides of the segments for crawling-like movement

- Joints are the connections between segments using a rolling ball design, controlled by four hydraulic pistons on four sides
- They are covered by a flexible material to allow bendability, but also to protect the pistons from dust and water

Snake physical design constraints and boundaries

- Waterproofing may be hard, especially in the joints between segments, same for dust proofing.
    - This could be fixed by the aforementioned isolation around every joint, meant to protect the hydraulic pistons. It can be connected to the segments' endings and sealed with a strong adhesive. The parts where adhesive will be used are the rubber elements (with the function of protecting the pistons) and the main exoskeleton of the robot.
- Cannot bend very much (depending on the size of segments).
    - The snake should be able to make a circle as a flexibility requirement. The ends should be able to touch each other. This is one of the goals to ensure enough flexibility during operation.
- Small segment housings do not allow a lot of room for electronics.
    - This can be calculated precisely once the size of every PCB is determined. They can be spread across multiple segments (or joints) to distribute free space, and therefore weight. This is as opposed to having everything in the head.
- Ballasts for submerging take up further valuable space.
    - Joint spaces can not be used as ballasts as the joints will lose flexibility.
- Combined design for rubble/dust and water traversing makes components for each action exclusive.
    - For example, the water ballasts are of no use in a dry environment.
- Having an estimated size of the product there is a weight goal that needs to be met so the ‘’Serpent’’ can function properly in water and dry environments.
- Some materials that need to be used like: steel and titanium are heavy which are a constraint on how many components can be used.

How Snakebot will meet user's needs:

- Track and Locate survivors faster than typical first responder time
- Access hard to reach areas under rubble and water
- A communication link between victims and first responders
- Determining the state of the survivors
- identify points of danger

Our product is targeted towards government bodies and front line entities. It is made to function in high danger areas which are sealed off to the general public.

The bot consists of individual components that are connected to a central microcontroller. The system architecture is Embedded. The components with their required constraints and boundaries are stated in the SysML Diagram.

The system achieves the user's requirements by traversing the environment through its flexible and sturdy design. It can detect, locate and transmit the victim's location directly to the user.