Title: <u>ViperProbe: An Elongated Snake Robot for Mapping and Victim Recovery in Collapsed Structures</u>

Rationale

Natural disasters can serve as great neutralizers of conflict. During these unfortunate events, tense relations are often nulled, and ethnicities, nationalities, agencies, groups, and governments mobilize to assist their fellow compatriots, revealing the humanity in all of us amid times where predefined ideologies dominate. With conflict being an inherent characteristic in the world, it's remarkable how mother nature asserts her overarching dominance when the ground shakes and man-made structures are brought to their knees. Earthquakes range in intensity, from the weak and imperceptible, to ones that cause widespread damage to infrastructure, propel objects and people, and cause far-reaching destruction. When they occur, rescuers mobilize.

The complex process known as search and rescue commences. The most devastating results of earthquakes take place in urban and high-density areas, resulting in the commencement of an urban search and rescue operation. Rescuers start by creating sectors and conducting a rapid search through each sector to maximize the potential for locating survivors. Unfortunately, rapid searches are the best chance of finding a survivor alive, and many survivors are likely overlooked due to being in areas of entrapment, unknown to rescue teams. These areas of entrapment are called voids, and one or more victims are often found in these areas, whether it's by chance or an effort in self-protection (e.g. entering a shower or closet). Existing technologies such as fiber optic snake cameras are able to be navigated through small voids for a better image. However, fiber optic snake cameras fall short of providing an immediate method of supporting life to located victims, and the manual process of snaking the cable through locations is time-consuming to an inconvenient extent for rapid searches. The manual process of snaking a fiber-optic camera through small voids also doesn't give the operators the benefit of gaining information about the overall structure's integrity. The objective of this project is to design an agile ground robot capable of entering small voids of collapsed structures to map the collapsed structure, identify locations of victims, their condition, and deliver initial life-saving aid to those entrapped victims.

Engineering Goal

To build an agile bio-inspired ground robot capable of entering small voids of collapsed structures to;

- map compromised areas,
- identify locations of victims, and
- identify the condition of entrapped victims.

Materials:

- ZED Camera: A stereovision camera to be used for computer vision and mapping the environment.
- NVIDIA Jetson Nano Developer Kit: A single-board computer to be connected to ZED Camera and run the ZED SDK.
- 10000mAh Portable Power Bank: A power bank commonly used for charging mobile devices on the go, to be used for powering the single-board computer at 5V and up to 2.4A.
- Arduino Uno: A microcontroller for motor control.
- Robot Servo (6x): Motors for locomotion of each segment, along with twelve brackets to connect motors.
- 9V Battery and Cable: Power source for microcontroller board.
- 7.4V Lithium-Ion Battery: Power source for motors.
- Keyfob Remote Control: Physical interface for controlling the movements of the robot.
- RF Receiver: To receive the commands from the keyfob over 315MHz frequency.
- databot™ 2.0: All-in-one environmental sensor suite for electronics education to be used for gathering data points on environmental metrics.

Methods/Preliminary Design

1. Investigate and implement prior snake biomimicry robot design literature for the overall robot. Having a linkage mechanism actuated by a servo that connects a series of segments simulating the undulatory movement of a snake.
2. Assemble servos together using two C-brackets for each servo in a series, and attach 3D printed tail and head.
3. Connect robot servos to the Digital Pin Block on the sensor shield that is connected to the microcontroller, for the ability to programmatically control the movement of the robot. Install the microcontroller in the head of the robot. Enable remote control using a radio frequency receiver connected to the microcontroller to receive commands from the keyfob.
4. Mount a stereovision camera on the front of the robot for mapping its environment using adhesive. Ideally, LIDAR would be used due to its accuracy and range, however stereo vision is used due to budget constraints. Additionally, common computer vision and robotics libraries can be used with the ZED SDK.
5. Connect a single-board computer capable of running the ZED SDK to the ZED camera, and mount on the robot with a 5V power bank.
6. Mount an electronically independent sensor module on the robot to collect data points on carbon dioxide, air pressure, humidity, etc.
7. Test assembled robot's ability to move rectilinearly and in concertina, along with electronic data collection systems.

Risk and Safety

This project will involve working with electrical currents. To avoid any harm or damage to components, standard safety precautions for working with electronics will be taken. The robot will have a switch to power off the harness, removing the microcontroller's power source and in turn, the servo motors.

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