Autonomous Motion Planning for Hyper-Redundant Modular Robotic Systems using State Estimation, Obstacle Avoidance, and Intelligence Locomotion Algorithms

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A successful robot is defined as one that is able to sense the characteristics of its environment, plan autonomous motions, and perform these actions. Thus far, research in Modular Snake Robots, a subclass of Hyper-Redundant Modular Robotic Systems, has primarily focused on improving snake locomotion capabilities, as such research allows for the exploitation of the system's highly articulate and maneuverable nature, characteristics that stem from its many internal degrees of freedom. However, the acts of sensing the environment and planning autonomous motions for the snake are remarkably under explored topics. This project proposes the novel use of a visual sensor retrofitted to the snake robot, allowing it to conduct three-dimensional motion planning, a control scheme first proposed as future work in my previous year's research. The advancement of autonomous behavior is tremendously important as it allows for maximally efficient control of a large number of degrees of freedom in the high-pressure situations snake robots are deployed in: search and rescue, recon, inspection, etc. In this study, I propose a novel integrated motion-planning algorithm that can effectively perform autonomous obstacle avoidance, feature recognition, and intelligent locomotion for hyper-redundant modular robotic systems in real time. The proposed algorithm can be broken down into three components: State Estimation conducted through the fusing of the robot's redundant internal proprioceptive sensors into Complementary Filters, Obstacle Avoidance through the use of visual and motor current feedback, and autonomous manipulation of the robot's environment through the utilization of Pointcloud Processing Algorithms, Forward Kinematics, Inverse Kinematics, and Sinusoidal Motion Models.

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