Autonomous UGV Inspection and Monitoring of Electrical Substations

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Power grids, while necessary for the distribution of power billions rely on, face a growing number of threats from climate change and aging infrastructure. There is a strong need for a better, more expansive, and more efficient electrical grid which utilizes the latest technologies. In recent studies, robotic systems have been employed in order to increase the efficiency, safety, and accuracy of grid maintenance. The virtual UGV I developed consists of a Clearpath Jackal UGV simulation equipped with intelligent navigation algorithms, control systems, articulated sensor mounts and manipulators, and LiDAR and camera sensing capabilities. In two custom virtual substation environments, the Jackal UGV successfully monitored and navigated its surroundings using Gmapping, LeGO LOAM, traversability mapping, and the ROS navigation stack. 100% of the non-traversable obstacles present were accurately mapped as not traversable. It was also able to perform optical character recognition with 86% accuracy and collect camera, LiDAR and partial discharge data successfully. The simulation in this study was the first to investigate the suitability of mobile robots to aid in the inspection and monitoring of an indoor electrical substation using this novel design. The first use of a simultaneous mapping and navigation algorithm to navigate throughout the substation made the UGV far more versatile and adaptable than its predecessors, and the overall system had improved situational awareness, perceptual, and inspection capabilities. The study furthers the development of more affordable, successful monitoring and navigation by a robotic system within the setting of electrical grids and presents a practical robotics solution in a real world substation.

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