Low-Cost Quadruped Robot With Rough Terrain Traversal, Obstacle Avoidance, and Autonomous Navigation

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Walking robots are an important part of the future. Agile, adaptive, and able to walk almost anywhere. They have advantages in hazardous terrain exploration, search and rescue, domestic assistance, and a lot more. One of the most famous examples is Spot from Boston Dynamics. However, the purchasing cost of Spot (approximately $75,000 USD) is a financial barrier for many organizations. This project aimed to create a low-cost walking robot capable of autonomous navigation and movement throughout a variety of terrain types while only using limited and inexpensive sensors. The robot's vision system incorporates a stereo camera that outputs depth images, which is put into an augmented ground detection algorithm consisting of v-disparity, SLIC, and hough line transform. Depth images are converted into a panoramic point cloud. A novel fast voxel accumulation algorithm is employed, turning the point cloud into a set of solid voxels. The system infers the height of objects which are obscured, and incorporates the LiDAR data to help detect close objects. The robot generates a 2.5D height map, and places where the slope is too steep are marked as obstacles. The system uses an enhanced A* algorithm to pick the most optimal path, and uses a custom-written gait generation algorithm to walk along it, balancing between stability and speed. Both integrated and real-world testing have been performed. The robot can effectively plan its own paths without any help, avoiding obstacles and walking over stairs and slopes, reliably both indoors and outdoors. With an overall cost of less than $700 USD, such smart robots have a great potential to enter our future daily lives.

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