A Differentially-Geared, Omnidirectional Robotics Platform With Autonomous Jerk-Limited Navigation

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Problem: Wheeled robotics research and commercial application development is inhibited by the lack of a powerful, durable, and accessible robotics platform that can operate omnidirectionally in constrained spaces. Solution: A differentially-geared robotics platform that combines the strengths of three traditional wheeled chassis (tank, mecanum, and swerve) while eliminating their weaknesses. This platform includes custom software with autonomous, 3rd-derivative jerk-limited navigation. It is built using off-the-shelf and easy-to-manufacture parts, which increases usefulness and attainability. Process: Our CAD-centric, iterative mechanical engineering design process and hardware/software integration testing initially uncovered challenges preventing us from meeting our performance criteria. In addressing these problems, our solutions included: 1. Implementing an NVIDIA Jetson and Arduino based control system 2. Creating an asynchronous, binary, CRC error-checked communication system to enable a loop period of 6ms 3. Redesigning the gear train to increase the robot velocity to meet the requirements (> 1 m/s) 4. Creating a fast and accurate navigation system that uses jerk-limiting to address the non-instantaneous nature of swerve drives Results and Conclusion: Our differential swerve drive platform is omnidirectional, has more power on average than mecanum drives, and is 50 percent lighter than traditional swerves with the same power delivery. Its easy-to-use, versatile software enables both human and autonomous control. It allows the robot to smoothly navigate along paths to a goal position with an accuracy of 1 cm while traveling at its top speed of 1.4 m/s.

Awards Won:

Fourth Award of $500

Central Intelligence Agency: First Award: $1000 award