N.R.G Team Description Paper for Robocup 2026

Technical Description 2026: N.R.G. TalTech

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Abstract. This paper presents the technical specifications and design philosophy of the N.R.G. Small Size League (SSL) team from the TalTech NRG Institute. The 2026 platform introduces a hybrid chassis architecture utilizing plexiglass and additive manufacturing materials to balance structural rigidity with weight efficiency. A significant departure from standard SSL designs is the implementation of a mechanical spring-trap kicking system, which utilizes potential energy storage to achieve ball displacement. The robot employs a four-wheel omnidirectional drive system powered by independent control modules. This document details the mechanical and electronic integration of these systems for the 2026 competition cycle.

1. Introduction

The N.R.G. team, representing the TalTech NRG Institute, is dedicated to the development of modular and accessible robotic systems for the RoboCup Small Size League. The primary focus of the 2026 development cycle has been the optimization of mechanical efficiency and the exploration of non-electromagnetic kicking solutions. By utilizing a combination of laser-cut plexiglass and high-strength 3D-printed components, the team has developed a lightweight yet durable chassis capable of meeting the rigorous physical demands of SSL gameplay. This paper outlines the hardware architecture, including the drive system and the unique spring-actuated kicking mechanism.

2. Mechanical Design

The mechanical architecture of the N.R.G. robot is designed for rapid maintenance and high maneuverability. The internal layout is optimized to protect sensitive electronics while maintaining a low center of gravity.

2.1 Chassis and Materials

The robot's structural integrity is maintained through a hybrid material approach. The base and top plates are constructed from plexiglass, providing high visibility for internal diagnostics and a high strength-to-weight ratio. Structural supports and motor mounts are manufactured using a high-density 3D printing material, allowing for complex geometries that would be difficult to achieve with traditional milling.

2.2 Omnidirectional Drive System

Locomotion is facilitated by a four-wheel omnidirectional driveconfiguration. To ensure maximum power delivery and responsiveness, each wheel is powered by an individual motor. A key feature of our 2026 design is the use of four independent control boards, one for each motor. This distributed architecture allows for high-frequency PID loops and ensures that the failure of a single driver does not compromise the entire electrical system.

2.3 Kicking and Dribbling Mechanisms

The N.R.G. robot utilizes a unique mechanical spring-trap mechanism for ball kicking. Unlike the standard solenoid-based systems, this mechanism stores potential energy in a high-tension spring. When triggered, the stored energy is released to provide a high-impulse impact. This design reduces the need for high-voltage capacitor banks, simplifying the electronic safety requirements. The ball handling system comprises a silicone-coated roller driven by a dedicated micromotor. The roller features specialized friction zones designed to improve the "grip" on the ball, enabling more stable ball control during high-speed rotation and translation.

3. Electronics and Control System

The electronic architecture of the N.R.G. robot is designed for high-current handling and modularity, ensuring that the four-wheel drive system operates at peak efficiency.

3.1 Power Management and Actuation
The robot's power distribution is managed through a specialized BTS7960 high-current motor driver module for each 12V DC motor. These modules allow for precise Pulse Width Modulation (PWM) control while handling the significant current draws required during rapid acceleration. The system is protected by a custom voltage divider circuit used for real-time battery monitoring, ensuring the longevity of the power cells and the safety of the on-board logic.

3.2 Sensing and Localization
To achieve stable movement and orientation, the robot integrates a 6-DoF (Degrees of Freedom) Inertial Measurement Unit (IMU) consisting of a 3-axis accelerometer and a 3-axis gyroscope. This sensor data is fused to provide the control system with accurate heading and velocity feedback. Additionally, an Infrared (IR) module is utilized for ball detection, providing the "break-beam" logic necessary to trigger the spring-trap kicking mechanism when the ball is securely in the dribbler's possession.

3.3 Communication
Wireless data exchange between the base station and the robots is facilitated by a 2.4 GHz transceiver system. This link handles high-frequency command packets, including velocity vectors and kicker trigger signals, ensuring low-latency response times during active gameplay. We also have a second solution that is based on WiFi connection just in case the main thing doesn't work properly.

4. Software Architecture

The software stack is designed to translate high-level strategic commands into low-level motor signals.

4.1 Control Loop

The firmware implements a distributed PID control scheme. By utilizing the feedback from the 6-DoF sensors, the robot can compensate for mechanical slippage and maintain a precise heading. The 2.4 GHz communication protocol is optimized to prioritize movement commands, ensuring that the robot remains responsive to the SSL-Vision global coordinates.

5. Conclusion and Future Work

The 2026 N.R.G. TalTech platform represents a successful integration of hybrid material manufacturing and mechanical energy storage. By moving away from traditional solenoid systems toward a spring-actuated kicker, the team has reduced electrical complexity while maintaining competitive performance. Future development will focus on refining the 3D-printed components for even higher durability and implementing more advanced path-planning algorithms to fully exploit the power of the BTS7960 drive system.

References

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