Talos Humanoid Soccer Robot Team Description Paper

Humanoid Middle Size Robocup Incheon 2026

Teles, J. G. R., Chagas, L. R., Olives, L., Queiroz, M. P. C. M., Silva, J. R. B. F., Peixoto, E. D., Ruotolo, G. P. O., Lima, L. R., Sousa, M. C. C., & Santana, A. C.

Electrical, Mechanical and Computer Engineering School
Federal University of Goiás, Goiânia, Goiás, Brazil
taloshumanoidteam@gmail.com
humanoid-ufg.github.io

Abstract. This document presents the team's history, and the challenges faced during the development of a fully autonomous humanoid robot, as well as the objectives achieved and what's still in development too.

Keywords. Humanoid robot, ROS, signal conversion

1 Introduction

The Talos team was founded by members of the Pequi Mecânico Robotics Group and engineering students from the Federal University of Goiás, with the purpose of researching, developing, and training students in humanoid robotics. The motivation to compete in humanoid robot soccer stems from the interest of experienced members in the field, while also serving as an engaging and accessible entry point for newcomers. Focusing on the study, research, and development of software for autonomous humanoid robots, the team employs the Booster Humanoid T1 as its primary development platform. The work encompasses topics ranging from the safe operation of humanoid robots to autonomous behavior and decision-making, motion execution, computer vision and audio-based interaction.

2 History and Platform

The team's development trajectory began with experimentation using open-hardware platforms, which provided the initial technical and practical foundation for studies on humanoid systems. Since 2023, this process has evolved into a continuous cycle of improvements like physical revisions, developing electronic architecture, the refinement of control algorithms, and the search for more efficient integration between hardware and software. This progressive maturation, built steadily since then, has allowed the team to overcome the technical limitations of earlier platforms and consolidate the multidisciplinary knowledge necessary for the conception of Marta.

Marta represents a central stage in the technological maturation of the Pequi Mecânico Humanoid team and serves as the direct precursor to the team's current transition toward the TALOS humanoid platform. After years of experience with earlier humanoid systems and successive incremental upgrades, the team identified in 2022 the need for a new robot designed from the ground up, not only to improve competitive performance, but also to establish a more robust experimental platform for perception, control, and autonomous decision-making research. The Marta project emerged from this need, consolidating the team's accumulated knowledge into a single, fully redesigned platform that would later guide architectural and software decisions in the migration to TALOS.

The formation of the Talos Humanoid Robotics Team, originating from the experienced 'Núcleo de Robótica Pequi Mecânico' at the Federal University of Goiás, brings distinct insights from previous participations in Open Hardware categories with Marta[1], which provided the initial technical and practical foundation for studies on humanoid systems. Since 2023, this process has evolved into a continuous cycle of improvements like physical revisions, developing electronic architecture[2], the refinement of control

algorithms, and the search for more efficient integration between hardware and software[3]. This progressive maturation, built steadily since then, has allowed the team to overcome the technical limitations of earlier platforms and consolidate the multidisciplinary knowledge necessary for the conception of Marta . Upon transitioning to the Humanoid League utilizing the Booster T1 platform, our initial analysis and preliminary integration tests highlighted critical areas for software adaptation. We learned that the standard open stack provided with the platform, while functional, requires significant refinement in tactical intelligence to be competitive. Specifically, we identified that static positioning logic is insufficient against dynamic opponents. Consequently, our focus shifted to correcting deficiencies in the goalkeeper's defensive positioning and the coordination of defenders near the penalty area. Furthermore, we observed that basic path planning often resulted in fouls or instability; thus, the necessity for active collision avoidance systems and the restructuring of our Behavior Trees to mitigate unfavorable decision loops became a priority lesson for the team's inaugural roadmap.

3 Software

Team Talos utilizes an adapted ROS2 Humble software stack for the Booster T1 platform, a 1.18-meter humanoid robot n. The architecture integrates data from a ZED stereo camera, joint encoders, and inertial sensors to generate robust environmental mapping. Visual perception employs YOLOv8 accelerated by TensorRT for real-time detection of balls and robots, converting pixel coordinates into spatial field positions. In compliance with league regulations, depth perception is obtained exclusively through passive stereo vision.

Centralized decision-making synthesizes visual detections, match states from the official GameController, and motor feedback to coordinate autonomous behavior. Low-level control directly manages actuators to execute walking, kicking, and stabilization routines. Odometry data is fused with visual perception to track the global position of the robot and maintain strategic formations. During matches, the system dynamically adapts to competition phases, ensuring the robot locates the ball, aligns with the goal, and executes movement commands only when stability conditions are verified. This closed-loop architecture ensures a continuous flow between perception and action for fully autonomous play.

For the RoboCup[4] 2026 roadmap, the Talos team is prioritizing the development of cooperative intelligence and tactical refinement. The primary major change involves the implementation of coordinated 'set plays' (e.g., kick-offs and free kicks). The team anticipates deploying a system based on cost map generation to identify optimal passing corridors in open spaces, coupled with a communication protocol that directs allied strikers to position themselves for ball reception. Parallel to this offensive strategy, the team plans to overhaul the defensive logic by introducing a state-based positioning system for the goalkeeper. This system will dynamically adjust the goalkeeper’s location based on ball possession states and field zoning, aiming to minimize the opponent's scoring probability by covering critical angles relative to the active section of the field.

At the time of submission, the core algorithms for the planned changes have been developed and are undergoing rigorous validation. The code regarding coordinated set plays is in the advanced testing phase, demonstrating functional passing logic, with current engineering efforts focused on refining obstacle avoidance parameters to ensure safety during execution. Regarding the defensive strategy, the state-based goalkeeper behavior is fully implemented and is currently being evaluated in match scenarios. The team is in the process of collecting empirical data to establish a statistical baseline, aiming to validate the reliability and success rate of these tactical adjustments before final competition deployment.

4 Community

The Talos team actively fosters a collaborative ecosystem among national teams utilizing the Booster T1

platform. Our primary contribution to the league focuses on software reproducibility: we are establishing a standard for encapsulating robotic applications using Docker containers. By documenting safe operation protocols and game logic, and committing to open-source our codebase, we aim to lower the entry barrier for new teams in the league.

At the Federal University of Goiás (UFG), the team serves as a pivotal bridge between theoretical coursework and practical engineering. We work closely with faculty to integrate robotics challenges into the curriculum, attracting and training undergraduate talent. Furthermore, the project acts as a validated testbed for academic research, directly supporting the production of undergraduate theses, scientific papers, and open-source frameworks that are scheduled for public release.

5 Further Researches

Our research roadmap targets a significant contribution to the intersection of biomechanics and AI: the creation of a high-fidelity humanoid motion dataset captured via motion capture suits and connection with a VR Headset. Specifically focusing on complex maneuvers and head-ball-feet coordination, such as goalkeeper saves and tackling, this dataset will feed a pipeline designed to train Reinforcement Learning policies, bridging the gap between simulation and reality. Additionally, the team is advancing the field of Human-Robot Interaction (HRI) through voice and text command interfaces for autonomous agents. On the perception front, we are refining ball trajectory estimation using Kalman Filters to optimize real-time cost map updates, ensuring that navigation in unoccupied areas is both safe and strategically advantageous.

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