

# Naova Extended Abstract 2026

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**Abstract.** This paper presents Team Naova, a RoboCup humanoid soccer team affiliated with the École de technologie supérieure (ÉTS), Montreal, Canada. It describes the team composition, software architecture, and main technical contributions in locomotion, behaviour, communication, and perception. Particular emphasis is placed on the transition from the NAO platform to the Booster K1 robots, which defines the primary development objectives for the 2026 season.

## 1 Team Information

**Team name:** Naova

**Team leaders:** Jérémy Thu-Thon (B.Eng), Kerian Devillers (B.Eng), and Christine Yang-Dai (B.Eng)

**Team contact email address:** Naova@ens.etsmtl.ca

**Team website URL:** <https://clubnaova.ca/>

**Country of origin:** Canada

**University/company affiliation(s):** École de technologie supérieure

**Members:** Alexandre Bédard (B.Eng), Adem Bessam (B.Eng), Romain Boiret (B.Eng), Aissa Bouaraguia (B.Eng), Phan Tung Bui (B.Eng), Gabriel Chartier (B.Eng), Amine Fanid (B.Eng), Benjamin Joinvil (B.Eng), Adylbek Kadyraliev (B.Eng), Mohammadsam Karimi (B.Eng), Aymane Laghrieb (B.Eng), Kaced Mayas (B.Eng), Le Khai Pham (D.Eng), Jean-Philippe Roberge (D.Eng), Jean-Baptiste Vanherpen (M.Eng), Nicolas Weill (M.Eng)

Team Naova is affiliated with École de technologie supérieure, located in Montreal, Canada. The team was founded in 2017 and has since participated in seven RoboCup competitions. It is composed of fifteen bachelor students, two master's students, and two PhDs.

## 2 Prior-Year Results and Plans for 2026

In previous years, the team learned that when ambitious ideas fail to materialize, reconsidering system foundations can be necessary. Since the 2023–24 season, Team Naova rebuilt its project based on B-Human's 2021 code release. This fresh start allowed the team to make significant progress and regain confidence

in developing advanced algorithms. In the past season, the transition from an in-house vision system to B-Human’s framework allowed several members to focus on improving the line detector, resulting in notable gains in robot self-localization performance.

Following the league merger, the team decided to adopt the Booster K1 platform due to its affordability and the manufacturer’s openness to collaboration. Although one K1 robot has been acquired, administrative delays have postponed physical development, leading the team to focus primarily on simulation-based work using Webots and preliminary experiments with Isaac Sim. Current efforts concentrate on porting the existing software stack to the new platform.

### 3 Code Usage

Since 2017, Team Naova has built its development on the B-Human code base, progressively extending it to address its challenges. Early work was based on the 2017 code base [1] and focused on improving the WalkEngine [2]. These efforts continued in the following years, alongside further refinements to walking [4] and learning methods [3,5].

After RoboCup 2023, the team forked the B-Human 2021 [1] code base to improve localization, particularly line and robot perception, while reintegrating communication strategies and perception modules.

With the K1s, the team plans to build the new code base on the Booster 3v3 demo code, bringing over the logic of certain parts of the NAO code while redesigning others.

## 4 Team Contributions

### 4.1 Walk Controller

In 2019 and 2020, work focused on modifications to the WalkEngine, with speed and stability as the main priorities. These improvements laid the foundation for a more reliable and efficient robot in matches since then.

For 2026, with the K1 platform, the immediate goal is to get the robots fully set up and operational. In parallel, the team plans to explore reinforcement learning to improve walking performance and, if time permits, develop enhanced kicking behaviours to provide more options during gameplay.

To develop and refine advanced motor skills, a learning-based approach will be adopted, supported by Booster’s training and deployment pipeline. This framework provides an efficient and structured workflow for experimentation, optimization, and deployment. In addition, close collaboration with university professors allows the team to benefit from expert feedback, ensuring robust training procedures and high-quality motor behaviours.

## 4.2 Behaviour

In 2024, using the forked B-Human code base [1], the team adopted the tactics and card system and introduced several improvements, including a new dynamic positioning module inspired by the 2022 B-Human release. In 2025, the team built upon this work with a stronger focus on the dynamic positioning of defending robots to improve passing and ball clearing. Dribbling behaviour was also enhanced, transforming it from a simple fallback option into a more strategic component to strengthen gameplay.

For the K1 platform and RoboCup 2026, the primary focus is on migrating and adapting behaviour and decision-making systems. Reimplementing the behavioural logic from the old codebase is particularly challenging: the previous system relied on a card-based architecture with clear priority hierarchies and modular strategy components.

A migration plan maps essential legacy cards (priorities, triggers, and actions) to dedicated subtrees within a behaviour-tree structure. A top-level “BehaviorControl” layer handles health, camera, battery, and penalty gating, while a priority selector restores deterministic ordering. Explicit role-assignment and coordination subtrees maintain team strategy depth. The overall objective is to achieve coherent and effective team behaviour on the new platform, ensuring coordinated gameplay and reliable decision-making, while deferring major optimizations and advanced strategy development to future years.

## 4.3 Communication

In 2023 and 2024, the team focused on transitioning robot communication from a time-based to an event-based approach, introducing a scoring system to optimize packet usage under strict bandwidth constraints. This work continued in 2025 with a redesign of packet content using a dynamic structure, where a header implemented as an integer bitmask adapts to external conditions to transmit only relevant information, thereby freeing space for additional strategic data.

In 2026, communication is not a primary focus due to the robot migration to the K1 platform. The main objective is therefore to deploy a communication system on the K1s similar to the previous implementation, ensuring system stability and continuity.

## 4.4 Perception

The biggest contribution last year was a new line detector designed to improve robot localization, particularly in situations where painted lines caused difficulties for the previous code. The detector leverages OpenCV functions and is built around a Hough transform core. Skeletonization isolates the center of the lines and enhances detection accuracy. The primary goal of this line detector is to ensure robustness to lighting variations, which are increasingly common in RoboCup matches.

The transition to a new robot platform poses the main challenge for perception, requiring a custom dataset to fine-tune the YOLOv11n-based model to detect robots with diverse morphologies rather than a single NAO type. A hybrid strategy is planned: initial annotations will be generated using two teacher models—the former YOLOv3-inspired model and a YOLOv11n model pre-trained on COCO—retaining only consistent or high-confidence detections. Complex samples such as occlusions, small objects, or ambiguities will be manually corrected, and the dataset will be enriched with simulated images adapted to real-world conditions using domain-shifting techniques. Data augmentation (motion blur, horizontal flipping, brightness variations, random rotations) and semi-supervised student-teacher fine-tuning will further improve generalization, with evaluation performed on a test set including robot types unseen during training.

## 5 Impact

### 5.1 RoboCup contributions

Following the platform transition to the K1 robots, the impact this year will primarily consist of the public release of the updated codebase developed for the K1 platform, along with the publication of a new vision dataset. This dataset, built using the K1 Booster vision system, is designed to detect humanoid robots with diverse visual appearances, aiming to support research in robust perception and multi-robot environments. Last year, a scientific paper detailed the research and development of a novel line and center circle perception module, which significantly improved robot localization robustness. Prior to this work, research focused on locomotion, particularly on the development and optimization of the WalkEngine, leading to scientific publications in 2020 [2] and 2022 [4].

### 5.2 Community

The RoboCup is still a long-term objective and a strong motivator for Team Naova, providing a goal that pushes the team to continuously improve its software and robotic systems. Competing against various teams allows the team to evaluate its performance and define clear objectives for the following season. The RoboCup also offers a valuable opportunity to discuss the future of robotics and learn from different approaches.

Naova also plays an active role in its local and university communities through outreach activities aimed at promoting robotics and STEM beyond the engineering sphere. The team regularly organizes workshops, participates in public events, and carries out student recruitment activities, where it presents its robots and demonstrates their applications. These initiatives allow Naova to share its passion for robotics with children and the general public, making technology fun and inspiring future interest in science and engineering.

## References

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5. Poirrier, G.: Conception de l'intelligence artificielle régissant le comportement d'un robot gardien de soccer. (2019). <http://publicationslist.org/data/a.april/ref-677/Rapport%20POIRRIER-Naovav1.1.pdf>