Naova extended abstract 2025

Olivier St-Pierre, Jérémy Thu-Thon, Marc-Olivier Bisson

https://clubnaova.ca/
Naova@ens.etsmtl.ca
École de technologie supérieure, Montréal QC, Canada

1 Team information

Team name: Naova
Team leader(s): Olivier St-Pierre, Jérémy Thu-Thon and Marc-Olivier Bisson
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

1.1 Team Members

Naova's team is affiliated with the École de technologie supérieure university, located in Montreal, Canada. The team was founded in 2017 and has since participated in six RoboCup competitions. It is composed of seventeen bachelor students, one master's student, and two PhDs.

1. Team leaders: Olivier St-Pierre (B.Eng), Jérémy Thu-Thon (B.Eng), and Marc-Olivier Bisson (B.Eng)
2. Members: Christine Yang-Dai (B.Eng), Liliana Palma-Espinoza (B.Eng), Catherine Ouimet (B.Eng), William Hébert (B.Eng), Annie Tremblay (B.Eng), Harry Phan (B.Eng), Stacy-Linsay Octave (B.Eng), Mohammadsam Karimi (B.Eng), El Mehdi Tabet (B.Eng), Nadir Kaciousalah (B.Eng), Liza Benkadoum (B.Eng), Aissa Bouaraguia (B.Eng), Kerian Devillers (B.Eng), Louis Le Lay (M.Eng), Félix Boyer (B.Eng), Luc Duong (D. Eng), Camille Coti (D.Eng).

Fig. 1: The majority of the current Naova team members for the 2025 RoboCup season.

2 Code usage

Since 2017, team Naova has been using the B-Human release 2017 code base [1].
In 2019, the team modified the WalkEngine to add a module that makes speed walking more stable [2]. We also performed our first tests on Q-Learning [3].
In 2020, we continued our work on the WalkEngine [4] and Q-Learning [5].
In 2022, we started to use our own machine-learning models to perform ball detection.

After the 2023 RoboCup, Naova decided to fork the B-Human code base from 2021 [1] to mitigate our localization problems such as line and robot perception. We still integrated our communication strategies, and ball perception into the new code base for the 2024 RoboCup. For RoboCup 2025, we will use B-Human's ball perception and may incorporate their referee gesture detection. However, we are still developing our own gesture detection system and will attempt to use it at RoboCup.

3 Team contributions

3.1 Walk controller

In 2019, we decided to modify the WalkEngine. Since one of the most important parts of football is speed, we looked for a way to control the motors with a higher torque while maintaining sufficient stability for the robot.

With the tests performed during the 2019 RoboCup, we concluded that our motors were faster with the torque-controlled motors than without them. However, the given commands caused the robot to shake, affecting its stability. Thus, in 2020, we prioritized new instructions to remedy the stability issue. After the 2021 RoboCup, we continued to perfect it and played with this engine at the 2022 RoboCup.

3.2 Behavior

In 2024, after forking B-Human 2021, we used the tactics and cards from the 2021 B-Human code release [1] framework. We developed a new dynamic positioning module influenced by the 2022 B-Human code release [1]. With this new module, it will be easy to increase the number of players on the pitch to 7v7 in the future.

Furthermore, we implemented an algorithm inspired by B-Human's smash or pass algorithm [6]. The purpose of our version of this algorithm is to calculate a score between two points to determine the best direction to shoot or pass. This approach will enable more dynamic gameplay than specifically hard-coded states. We also decided to reuse our old keeper diving motions to stop the ball and improve our old kicking motion.

For the 2025 RoboCup, we have built upon the new behavior developed last year. Our focus is on improving the dynamic positioning of robots when not in possession of the ball. Defenders now adjust their positions to cover passing and shooting lanes more effectively.

Additionally, we are integrating dribbling into our decision-making process, ensuring that it is no longer just a fallback option but a fully considered alternative alongside passing and shooting. This enables a more dynamic style of gameplay that relies more on the robots' perception and less on hard-coded behavior. In our initial tests with the new system, we observed improvements in passing play and decision-making.

3.3 Communication

For the 2022 RoboCup, we implemented a first attempt at switching the communication from time based to event based. Unfortunately, this implementation did not work as intended. However, in 2023 the team succeeded in creating the first version of event-based communication. In 2024, we iterated on the 2023 version to maximize the information sent per packet and the relevancy of the information sent using a scoring system that can be modified.

For 2025, we are developing a new system that allows dynamic allocation of packet content. For instance, if the ball has not moved significantly, the space typically used for ball information can be repurposed to transmit more relevant data in real time. This optimization enhances team coordination by enabling the exchange of additional strategic information that would otherwise not fit within the packet constraints.

3.4 Line Perception

Following RoboCup 2024, we decided to develop a new line detector to address persistent localization issues from previous years, primarily caused by our detector's difficulty in handling painted lines. To overcome this, we implemented a new system for detecting both lines and the center circle. The line detector primarily relies on OpenCV functions, with the Hough transform as its core component. Another key step is skeletonization, which helps isolate the center of the lines to improve detection with the Hough transform afterward. The goal of our new line detector is to be robust to changes in lighting, which are becoming increasingly prevalent in RoboCup games.

We plan to submit a paper on our line and center circle detector to the 2025 RoboCup Symposium.

Here is the abstract: This paper introduces a novel real-time approach for detecting painted field lines and the center circle in RoboCup matches using NAO robots. The proposed method addresses the challenges posed by outdoor environments—where lighting conditions vary rapidly due to natural light and field lines fade over time—as well as the transition from high-contrast adhesive tape to low-contrast painted lines. The detection framework leverages a series of OpenCV functions, including adaptive thresholding, Gaussian blurring, and a custom skeletization process to refine thick line segments into their medial axes. These preprocessed images then serve as input to a probabilistic Hough Transform, which efficiently identifies line segments that are later grouped and merged to reconstruct complete field lines. For center circle detection, the approach uniquely treats detected lines as tangents, generating candidate circle centers that are clustered to pinpoint the circle's location. Evaluation against the 2021 B-Human detector using metrics such as precision, recall, and F-score demonstrates robust performance under variable lighting conditions with minimal manual calibration, despite increased processing times due to intensive OpenCV operations. Limitations include occasional false positives and performance constraints, with future work focusing on further optimization and adaptive image resizing to enhance detection of distant lines.

4 History

GORE 2023	Swiss round	R-ZWEI KICKERS	1:5
		NomadZ	1:1
		Bembelbots	0:0
		HTWK Robots	0:8
		HULKs	0:5
		Nao Devils	0:7
	Quarterfinals	B-Human	0:10
German Open	Swiss round	Dutch Nao Team	7:0

2024		B-Human	1:8
		R-ZWEI KICKERS	2:6
		Bembelbots	3:0
		Hulks	0:2
		HTWK Robots	0:3

Naova plans to participate in the 2025 German Open in March.

5 Impact

5.1 Line perception

As mentioned earlier, we plan to submit a scientific paper detailing the research and development of our new line and center circle perception module.

5.2 WalkEngine

Since 2019, we have done a lot of research on the walk engine. This research was documented and published in two scientific articles, one in 2020 [7] and another one in 2022 [8].

5.3 Community

Participating in the RoboCup competition motivates the team a lot. In fact, it is the main reason why the team members keep working hard and try their best to make the NAO more performant each year. When we participate in the competition, it allows us to really demonstrate where all the team's efforts of the past year were invested and test the main improvements in games while competing against other teams. RoboCup also gives us the opportunity to talk and exchange about our vision and knowledge with other teams.

Naova is also a major element in our university as a recruitment tool. The team is involved in a lot of events and has a major impact on the university community. We participated in over a dozen events in the past year to represent the university on and off campus.
Naova also has the mission of passing on their passion for research to future generations by giving presentations and demonstrations to younger audiences.

6 References

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