Team Naova
RoboCup Standard Platform League
Team Description Paper 2018

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1. Introduction

1.1. About Us

Naova is a new team composed of 10 engineering students from École de Technologie Supérieure (ÉTS) in Montréal, Québec, Canada. Our team is lead by three students: Jonathan Fortin, Alexandre Doyle and Thierry Pouplier. ÉTS is renowned as the 2nd largest engineering university in Canada, and we are fortunate that they provide us with a private classroom equipped with all necessary materials and technologies needed for this project.
We have been able to acquire some potential partners, although, apart from the university, many of them depend on our success in qualification. We are a team with experience in various division of robotics, and we strive to develop our skills in the SPL division.

The main goal of Naova is to understand not only the physics and mechanics of the sport as it translates to robotic movement, but also to understand the dynamics of game strategy. In short, we want to be a team that offers a dynamic opposition in competition. To achieve this, we have team members who are specialized in understanding other teams' game plans, consequentially a crew will develop in parallel. This method is advantageous because if we would want to implement a new function, code, or feature to help us be more efficient a smaller team is formed made up of one developer and one researcher. The idea is to test and implement functionalities as quickly as possible.

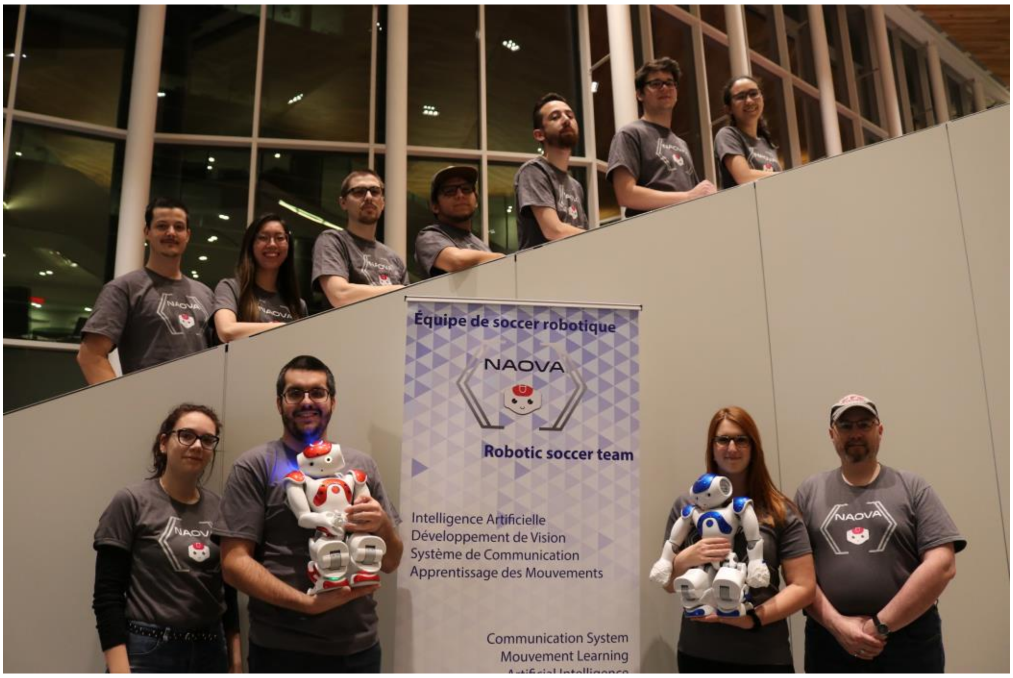
1.2. About the document

The present document details the steps we have taken to achieve our goal: becoming a competitive team in the robotics community. We will explain what our vison is, in the short-term as well as in the long term of this journey. We believe that with determination we can stand out, being new to the competitive scene this year. We will present the basics of our work and the contributions made towards RoboCup 2018.

2. General information

2.1. Team information

Being composed entirely of ETS students, members are offered research/class credits through Naova, but the majority simply list it as extracurricular activity. Our team consists of a pool of diversified and talented engineering students from different backgrounds whom all share the same passion for robotics and its applications.



Top Row: (Left to right)

Co-captain	Alexandre Doyle
Member	Proulx Anaïs
Co-captain	Thierry Pouplier
Member	Ramos Humberto
Member	Brulard Benjamin
Member	Lussier Marc-Antoine
Member	Lim Gabrielle

Bottom Row: (Left to right)

Member	Beaudry Ariane
Captain & founder	Jonathan Fortin
Member	Lacerte Stéphanie
Member	Boulay David

As a new team, we will not necessarily partake in the mixed team competition as we prefer to focus on the main event. However, we would be interested in future as it would be a rewarding experience. Additionally, our school offers student exchange programs for each trimester, thus students can come study and join us for 4 or 8 months.

2.2. History

Although we are new to the concept of robot soccer, we are confident that we can compete amongst the best. Our school having a very strong background in international competitions and we will be well supported as we start improving with the NAOs.

The Naova team has some members who were previously part of Walking Machine, another team from our school who has been competing in Robocup @Home division since 2016 in Leipzig, Germany. Their previous experience is invaluable as they will be able to effectively lead is to better observe and learn for the years to come; the first competition is always an adjustment and our main objective is to observe and learn. By immersing ourselves completely in the competition and with a desire to surpass our current capabilities, we are driven to prove ourselves at the international level.

2.3. Impact of our participation

ÉTS acts as a pioneer in providing experienced and talented engineers who wind up working internationally. They have a focus on applied learning, focusing on practical aspects rather than solely testing on theoretical situations. Through this practical approach they encourage students to learn through experiences, such as competing in SPL, and return with new knowledge to pass on to other students. As the university is already renowned in many international engineering and robotics competition, it would be our turn to step up to the challenge. Naova would join ranks with Walking Machine as we work together to represent our school in two different divisions of competition. As far as our team, our main goal this first year is to observe, learn, and apply the new techniques and applications that other teams have been able to develop. This new knowledge at our disposal would further push our team towards success as we would be able to effectively recruit new members and contribute to the Canadian robotics community with our developments on this project.

Robocup 2018 being hosted in our hometown of Montréal provides an added perk, given that the visibility of the competition will encourage others who are interested in this field to come join our team as well as any other Canadian teams present.

2.4. Code Usage

Embarking on this new project, our team needed to decide on a base programming platform, and then plan out future development. Having members with a functioning knowledge of ROS, we oriented our research towards being able to implement ROS in our NAOs. The ROS platform provided simulation through Gazebo, but we were unable to use these simulations while running Kinetic. This compounded with the absence of soccer specific packages pushed us to explore different solutions.

With more in-depth research we were able to conclude that many teams, if not the majority, use a platform that implements B-Human. The B-Human 2016 code release already contained most of the functionalities that would be necessary to quickly get our team of NAOs up and running, meanwhile still leaving room for further development. Most of our current code is sourced from the B-Human team of Bremen University (Bremen

Universität, Bremen, Germany). This code will be a strong start to developing our own version of a NAO code base.

One of our future goals will be to eventually try to expand our platform to also be able to implement ROS. While B-Human can be quickly deployed, the learning curve has proven to be considerable. As many other teams in our university use ROS, we would have more support in our future projects if we were to conform. Any improvements we implement using B-Human in the mean-time will be very easily translated in ROS as we are much more comfortable with the platform. We aim to achieve this goal as soon as the 2019 competition in Australia.

3. Behavior Control

3.1. Ball Seeking Behavior

Knowledge of the location of the ball is imperative to accomplish every task in a soccer game, and it must be done quickly and often. We have added a functionality to the NAO which has them turn their heads periodically to scan the field for the ball. Should the prediction of the trajectory of the ball be beyond the NAO's field of vision, it will automatically turn its head in that direction first to ascertain the position of the ball more efficiently.

3.2. Roles

Two predominant player roles have been developed through the understanding of the mechanics of the sport. Others will come more easily as we have developed these as a base, but further improvements in this regard have been put on hold as we focus on the communication and team strategy of the NAOs as a team. We have worked to ensure that every NAO chooses their role in accordance with their surrounding teammates. To accomplish this, they account for positioning on the field, and proximity to the ball. The team will be able to constantly reconfigure itself dynamically to react in case of penalties or unplanned game configurations. We plan on completing our roster by adding a defender and supporter role.

3.2.1. Striker

Strikers have not seen any major changes excepting the ball seeking behaviour mentioned above. The intent is to divide this role to have defenders and strikers work together more harmoniously in future. Thus, defenders would have complementary code to the strikers, and some NAOs would be defined to stay back and examine the other team.

3.2.2. Keeper

The keeper role has been separated into three key aspects: normal state, penalty state, and save state.

A keeper in normal state will remain within the penalty zone and continually adjust itself to be positioned between the ball and the net. Our decision to have the keeper within the penalty boundaries was to avoid any unwanted penalties, as we continue to develop we would like to explore cases in which the keeper will exit the penalty zone.

A keeper in penalty state will do everything within their power to kick the ball away from the goal.

Finally, a keeper in save state will examine and predict the trajectory of the incoming ball and either dive should the trajectory be a fair distance from its current location or spread its legs if the ball is predicted to pass close by.

4. Motion control

4.1. Special action creation

The documentation provided of B-Human was sufficient to aid in understanding special actions dictated by the *.mof* file. While we cannot yet create a special action of our own, members of our team were able to apply this new knowledge to obtain a *choreography* file which enumerated the joints in a similar manner and provided joint values to be able to recreate the motion. At this point, our team is capable of manually populating a *.mof* file using values from the *choreography* file.

This manual file creation is time intensive, so we managed to create our own converter. We are convinced that soon we will have many special movements to test, and so the time spent creating our converter and understanding how these files interact will have an enormous worth. It has already begun to be invaluable as we have been able to test the effectiveness of our keeper's special actions.

4.2. Torque Control

As previously explained, the *.mof* file enumerates poses, each of these poses containing 26 joint values for the NAO to attain. We observed that the source for the *.mof* being the *.xar* there were many values that were not defined in the *.xar* that were further defined once in the *.mof*. We postulated that to have more control over the fluidity of the NAO's movements, including joint stiffness and torque, we would need to have control over three unknown variables being: the speed of movement between two poses, the moment of force (strength) created by each joint movement, and their respective stiffness.
As this information was not states in any of the files, we set experimental parameters to observe their effects on the movements of our NAOs. For the past few weeks we have been working closely with professors to develop two possible solutions to find the optimal stiffness value. We believe that by discovering the range of optimal stiffness, we will have more efficient and fluid movement and improved consumption of power to conserve batteries.

5. Vision

Ball perception being imperative to all actions, we set out to discover if there were newer methods of techniques to be able to accomplish the detection of the ball more quickly. The ball being black and white offers a contrast that is easily detected should the vision be well implemented. We decided to work on a pilot project aiming at coding a program using python and OpenCV that will detect the ball more quickly.

We began experimenting with deep learning using vision, but quickly learned that NAOs is unable to parse entire images. For this reason, we changed strategies and began too look for segmentation and object isolation strategies to parse smaller images. We observed that the SPQR team has already developed a similar module and have used this as inspiration.

We are aiming to be able to use external compilation to be able to assure to only use the optimal model in our NAO. We will be applying segmentation by identifying positive space with the ball and negative space without the ball.

6. Machine learning

Our objective from the beginning has been to implement machine learning. Before this could be accomplished, a more profound understanding of the B-Human code, the NAO, and the SimRobot code had to be reached. As we inch closer and understand the inner workings more and more, we plan to begin implementing the capability to train neural networks. We are hoping this development would be useful to anyone using SimRobot, and to achieve this we will need a new controller. Controllers are sections of code that bridge the NAO and the SimRobot code. This new controller would be implemented along side the already existing RoboCop controller.

This would have the added advantage of setting the state of the game and training as needed. We would be able to implement an existing training architecture such as OpenAI Gym or create our own. While this has no been decided, we continue to explore both options. OpenAI Gym offers a large and active community, but the NAO's control code is written in C++ and so interaction between the two would be very complicated. Once we have made a definite decision as to our direction, the next step will be to develop a team strategy.

7. Closing Statement

We look forward to our potential participation at RoboCup 2018 in our home town of Montréal, Québec, Canada. We may be a young team, but the students that we are composed of are all passionate and willing to work hard to climb the ranks in competition. The opportunity to compete would help in improving robotics programs in our university as well as give more students opportunities in future to be able to explore more robotics applications,

To make our mark, we understand that it will be a long journey. Our team, Naova, is ready to begin showing the results of our projects and represent our country with our heads held high no matter the outcome. Being fortunate enough to have three captains that have already experienced the RoboCup competition, our team will be effectively lead into the unknown of competition. With this opportunity we would be able to assure the continued development of our team, meeting other teams from around the world and being able to discuss developments with them to further push our learning. The plan is not to come out swinging the first year, but instead to gather our bearings and take on a challenge head on.

References

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