

# Coursework Final Report: NAO Robot

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## Abstract

This is Control Theory coursework final report, so this paper provides answers to the following questions:

*What project I was be working on?*

*What are goals in completing this project?*

*What is my motivation for working on this project?*

*Why should others care about this project?*

*Literature review: How this project is related to existing work?*

*Description of development process.*

*Evaluation of the results.*

*How project can be updated?*

Useful links and repository with the results is also provided.

## Keywords

*Robotics, NAO Robot, Choregraphe*

## 1 Introduction

There are often there are often many guests in Innopolis city, a lot of them are also interested in the life of the University, its' laboratories. Robotics Laboratory is not an exception. Its main attractions are, of course, robots,

one of them is little NAO - autonomous, programmable humanoid robot developed by Aldebaran Robotics[1].

We assume that a situation is possible where specialists in these robots are absent, and it is required to demonstrate NAO the presentation of the lab is more illustrative and interesting. With the goal to prevent this problem, you need to write a manual on using the NAO, so anyone could easily use NAO in such occasions after reading this manual. But there is another issue: NAO has few default features that is of interest to everyone, therefore it is difficult to compose an interesting performance having only them, so it is worthwhile to work on developing and inventing new poses and gestures for it.

## 2 Goals

During the work on the project goals were evaluating so fast, but general idea was the same all the time. The main idea was to apply knowledge got from the course in the real project and to develop a new motion for NAO robot.

To implement this idea Choregraphe[3] was chosen, that is a multiplatform desktop application, that allows users to:

- Create animations, behaviors and dialogs,
- Test them on a simulated robot, or directly on a real one,
- Monitor and control your robot,
- Enrich Choregraphe behaviors with your own Python code.

Also this is official application for working with NAO developed by the same company. This characteristics were considered as advantages and platform was chosen as a tool for **developing and analyzing robots behaviour on simulated and real robots. Which was actually my first goal.**

As a movement to implement I have chosen warrior pose from yoga. So besides the fact that the robot will have a larger range of movements, which can be presented in some events, in the future, perhaps someone will continue working in this direction and will make NAO the instructor of yoga.

Also there was a request for Robotics Lab to describe main features and functionality of NAO robot, that can be used by anyone, who even have never worked with robots or especially with NAO.

So, **User Guide** was my second goal.

### **3 Personal Motivation**

Besides that goals I had my personal aims and motivation. I was encouraged to work with robot, as you always get visual results. My personal aims were:

- To get to know robotics.
- To improve my programming, writing and analytical skills.
- To learn new tools
- Expand my purview to be a versatile specialist

### **4 Necessary background information to assess this project**

To understand and assess the work done within the project, a person must have experience in robotics. It would be good if person have ever worked with NAO robot.

Accordingly, person must also know the basics of work in simulators and platforms like V-Rep[4], MATLAB/Simulink[5], Gazebo[6], but especially Choregraphe[3].

An essential advantage will be the some knowledge of physics. This will help to understand and evaluate project's applicability.

Understanding the game industry will help in the valuation of this project.

### **5 How This Project Related to Existing Work**

Since 2011, over 200 academic institutions worldwide have made use of the robot, including the University of Hertfordshire and their Bold Hearts RoboCup Team, the Indian Institute of Information Technology, Allahabad, the University of Tokyo, the Indian Institute of Technology Kanpur, Saudi Arabia's King Fahd University of Petroleum and Minerals, University of South Wales and Montana State University. In 2012, donated NAO robots were used to teach autistic children in a UK school; some of the children

found the childlike, expressive robots more relatable than human beings. In a broader context, NAO robots have been used by numerous British schools to introduce children to robots and the robotics industry.

By the end of 2014, over 5,000 NAO robots were in use with educational and research institutions in 70 countries.[1]

We see that NAO was used in variety of projects[7][8], what means that a lot of researches were already conducted, and a lot of movements implemented. And this is a great opportunity to make contribution to such project.

The other part is strongly related to NAO official documentation.

## 6 Development

### 6.1 Methods to Achieve Proposed Goals

Everything is clear in terms of the User Guide development goal. I had to read the official documentation about NAO, check its operability in robots from Lab and write down actual and useful information, so it is easy to understand and apply for everyone using these robots.

There was several possible ways to develop the second part. I could do this using animation mode, timeline[9] or just write python script.

As I took default Tai Chi movement a basis for the new one(Figure 1), I have chosen the second way - to implement it using timeline(Figure 2) and set values of each joint in every keyframe manually(Figure 3).

### 6.2 Results

On the Figures 4-7 I wanted to show you the main stages of the resulting movement:

Simulated robot does every movement without failures, so we can consider results as success.

In User Guide I covered topics, that I consider the most important to get enough knowledge to be able , there is a list of them:

1. Turning NAO on/off
2. Charging
3. Chest Button

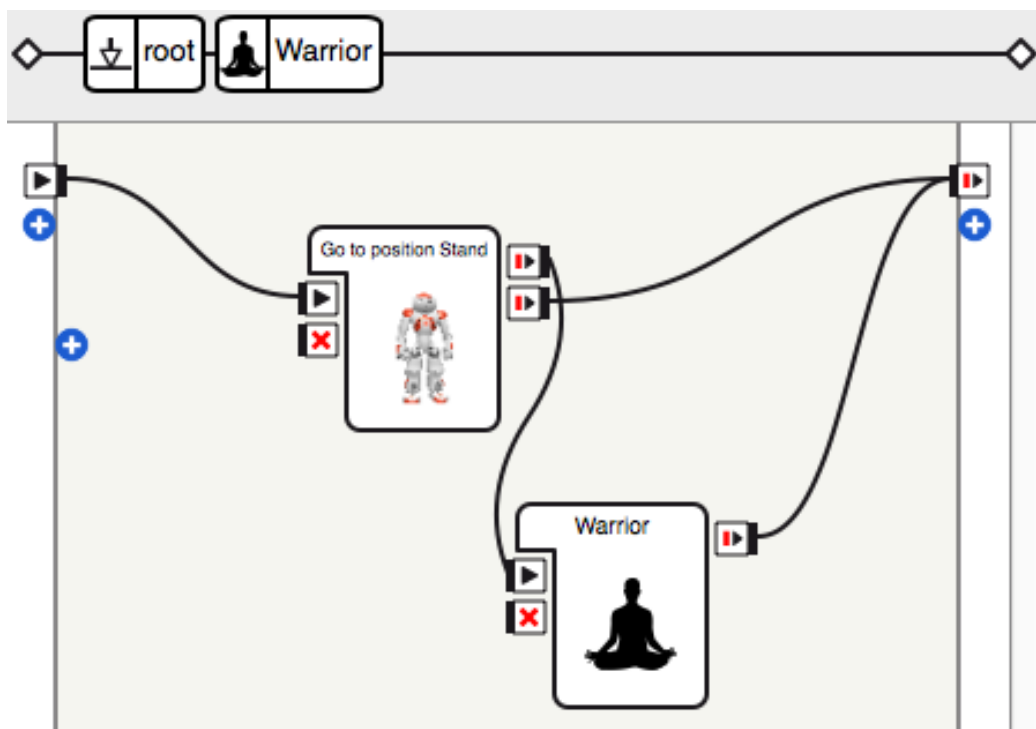


Figure 1: Flow diagram of Warrior movement

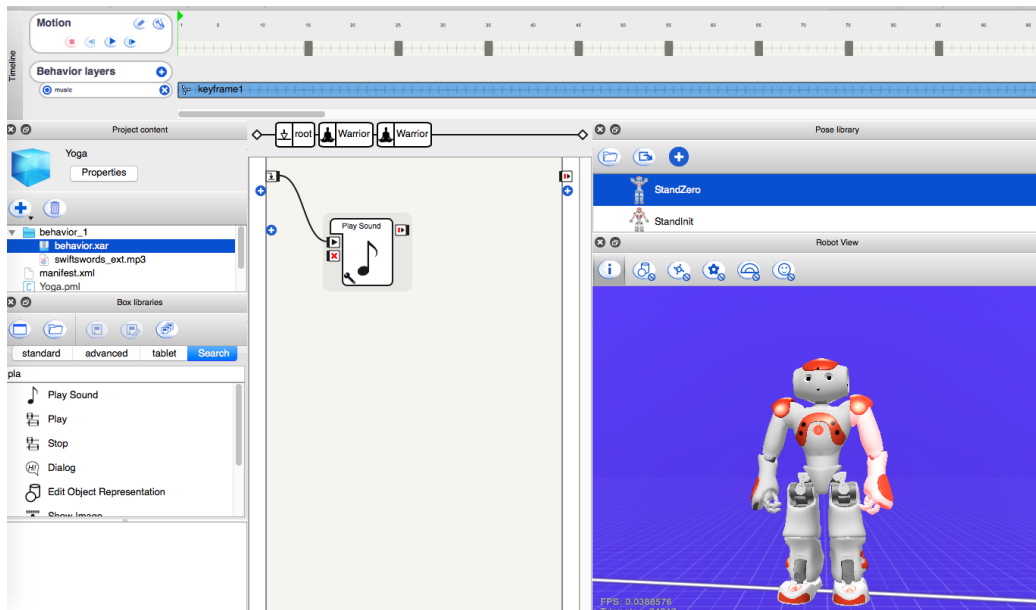


Figure 2: Content of timeline

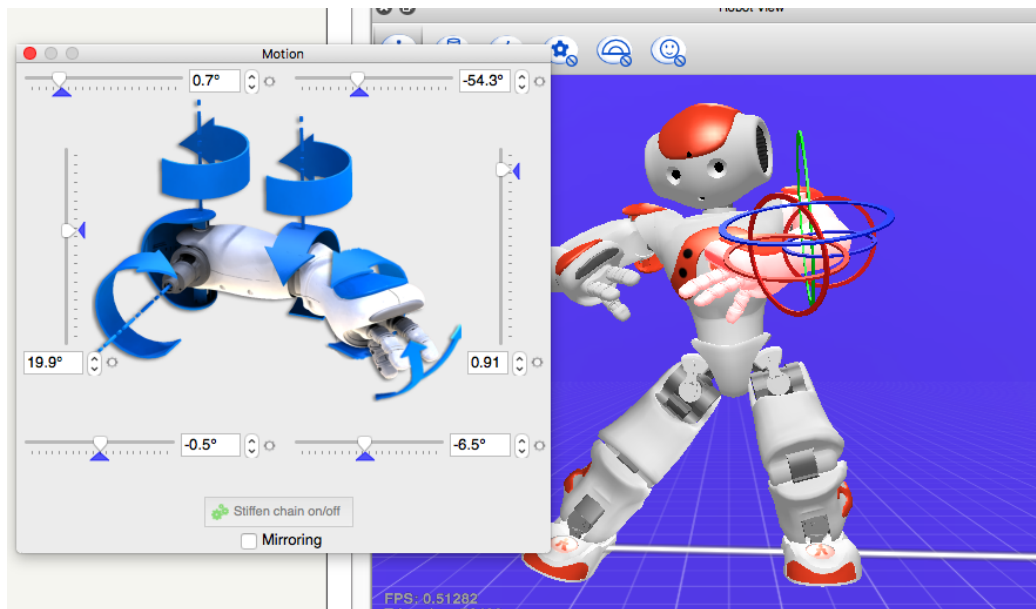


Figure 3: Configuring left hand joints

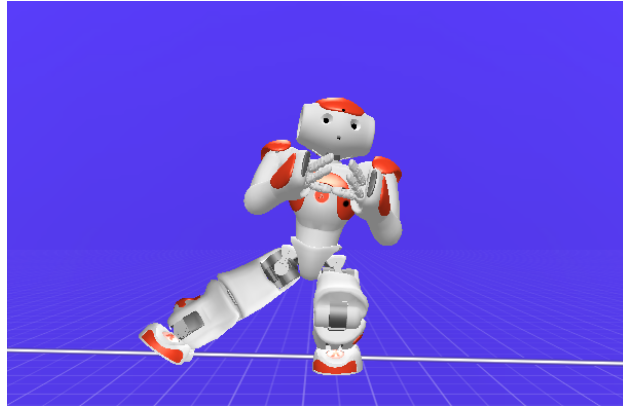


Figure 4: Warrior: Stage 1

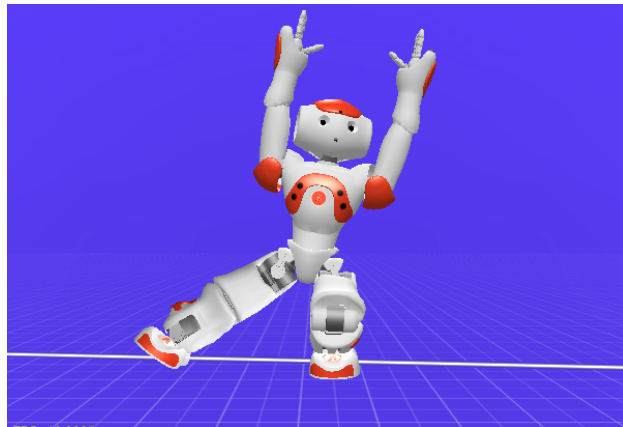


Figure 5: Warrior: Stage 2

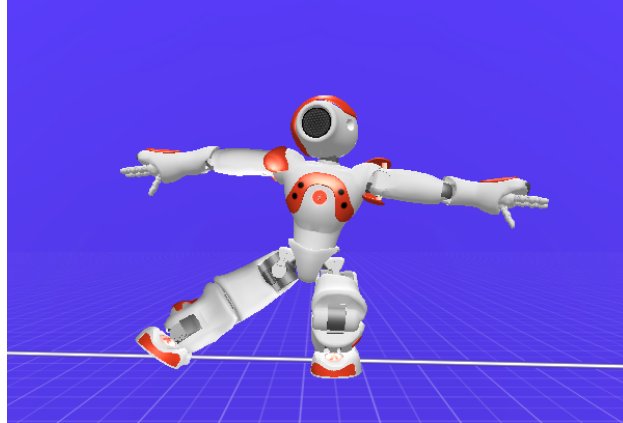


Figure 6: Warrior: Stage 3

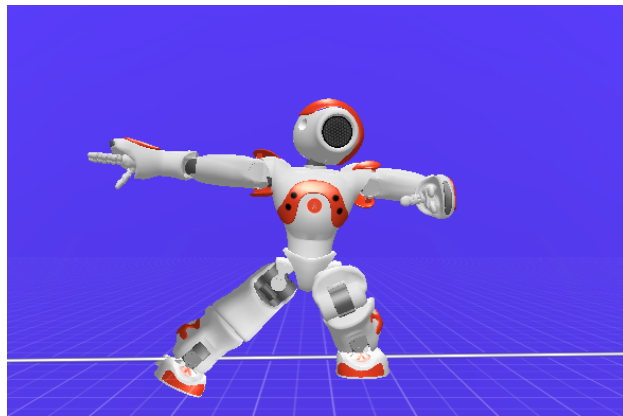


Figure 7: Warrior: Stage 4



4. Notifications
5. Talking with NAO
6. Accessing Web page
7. Working with Choregraphe
8. Working with Mobile Application
9. Detected problems

During of work on the project, many problems with robots were revealed, like problems with motors, internet connection, charging, which eventually became an obstacle for not completing part of the work at the proper level. Hence it is necessary to conclude that in addition to documentation and new movements, robots need full technical diagnostics from the specialists.

My personal aims were absolutely accomplished during this project. I tried to work with robot for the first time in my life and, most of all, tried an opportunity of working with a supervisor, which is good preparation for thesis next year.

## 7 Possible Further Improvements

Of course working on such project just around two months is not enough to get high results and there are a lot of things that can be improved and added. There are some of them:

- Improve NAO's yoga skills with new movements and poses.
- Create a thematic mobile application in which you can collect movements and poses of the robot from different areas, such as my theme - a yoga instructor, or a topic of my colleague - a fight.
- Documentation can be completed with several other aspects, that could be useful for deeper understanding the subject.

## 8 Github Repository

Following this link you can see all material related to this work: archives with projects from Choregraphe, it contains all behaviours and necessary attached files. To check its operability and correctness you should have this tool on your machine. Also this repository contains NAO User Guide and both mid-semester and final reports about working process.

<https://github.com/Irina112583/CTCoursework>

## 9 Conclusion

In this document we have seen proposal and results of coursework: new movement for NAO robot implemented and tested in Choregraphe, User Guide for NAO robot. Also possible improvements were proposed and proved.

## References

- [1] Article about NAO in Wikipedia

[https://en.wikipedia.org/wiki/Nao\(robot\)Academic\\_and\\_scientific\\_usage](https://en.wikipedia.org/wiki/Nao(robot)Academic_and_scientific_usage)

- [2] NAO documentation

<http://doc.aldebaran.com/1-14/nao/index.html>

- [3] Choregraphe main info

<https://community.ald.softbankrobotics.com/en/resources/faq/developer/what-choregraphe>

- [4] V-rep main page

<http://www.coppeliarobotics.com>

- [5] MATLAB main page

<https://uk.mathworks.com/products/matlab.html>

- [6] Gazebo main page

<http://gazebo.org>

[7] NAO soccer

<https://www.youtube.com/watch?v=N8bqzjZvSmc>

[8] Dancing NAO

<https://www.youtube.com/watch?v=n8-SSwKM GnY>

[9] Timeline Editor

[http://doc.aldebaran.com/1-14/software/choregraphe/panels/timeline\\_editor.html](http://doc.aldebaran.com/1-14/software/choregraphe/panels/timeline_editor.html)

[10] Animation Mode

[http://doc.aldebaran.com/1-14/software/choregraphe/animation\\_mode.html](http://doc.aldebaran.com/1-14/software/choregraphe/animation_mode.html)