University of Glasgow

Robotics Team Design Project M (ENG5325)

Dr. Euan McGookin MEng PhD MIET MIEEE

Head of Discipline for Electronics &
Electrical Engineering
Deputy Chief Adviser (PGT)
Senior Lecturer
James Watt School of Engineering

Project Supervisor:
Iqra Rasheed (PGR)

RoboCup
Team 8

RoboticsTDP-Team8

University of Glasgow

Abstract:

This presentation covers the Development and Simulation of Two (2) Robot teams and their playing environment, also the methodology to utilize and use of this simulation to design and develop the behavioral algorithms for each team member.

Working Project Facts:

1. Target Robots: NAO V6.
2. Teams: Two & 4-Memebers Each.
3. Pattern: Simulation of Behavioral Algorithm
4. PoC (Proof of Concept): Working Robot on Real Environment (Workspace).

University of Glasgow

Project Management ...

Project Team and Structure:

Project Manager and Cost Controller: Yunhao Huang: 3132056H

Document Controller & CI/CD: Xuanwei Ge: 3129788G

Media and Presentation Coordinator: Zihao Jing: 3122376J

Technical Team Lead & QA Testing: Mena Youssef G. Ramis : 3172685R

Product Design and Python Developer: Lingyu Guo: 3119118G

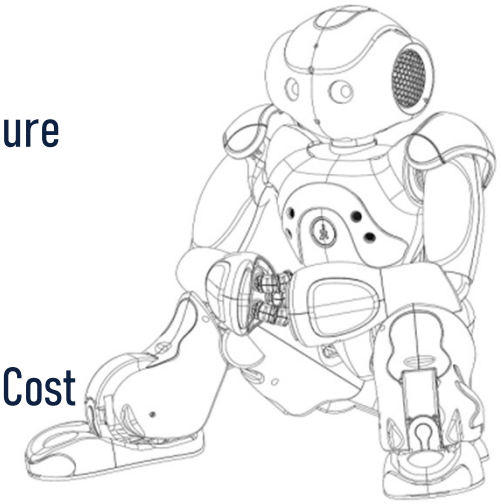
Linux and Choregraphe Design: Kai Niu: 3132433N

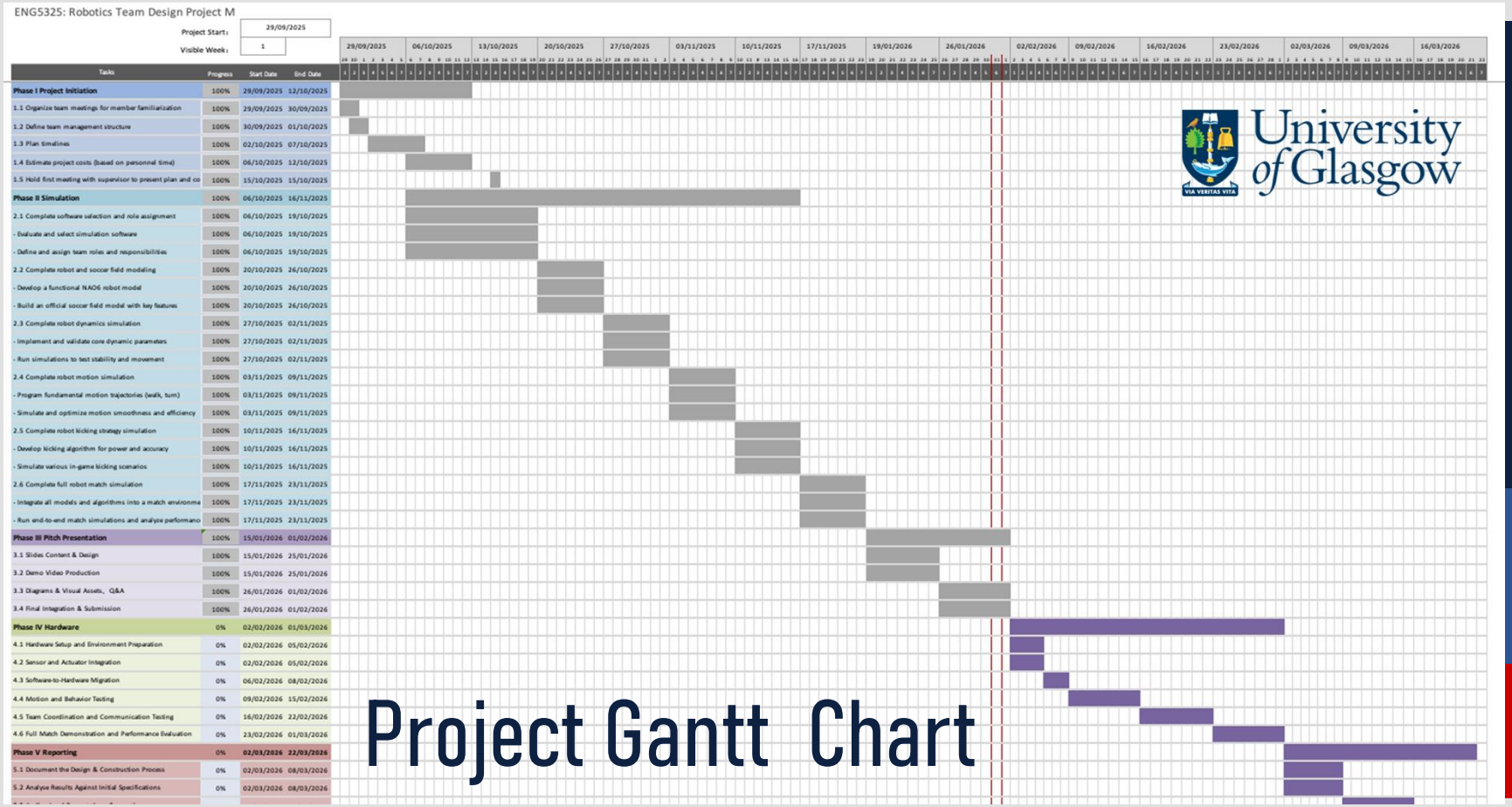
Team Structure

Gantt Chart

Project Est. Cost

TAR (Time Allocation Record)




ENG5325: Robotics Team Design Project M
Project Start: 29/09/2025
Visible Week: 1
Tasks | Progress | Start Date | End Date
Phase I Project Initiation 100% 29/09/2025 12/10/2025
1.1 Organize team meetings for member familiarization 100% 29/09/2025 30/09/2025
1.2 Define team management structure 100% 30/09/2025 01/10/2025
1.3 Plan timelines 100% 02/10/2025 07/10/2025
1.4 Estimate project costs (based on personnel time) 100% 06/10/2025 12/10/2025
1.5 Hold first meeting with supervisor to present plan and co 100% 15/10/2025 15/10/2025
Phase II Simulation 100% 06/10/2025 16/11/2025
2.1 Complete software selection and role assignment 100% 06/10/2025 19/10/2025
- Evaluate and select simulation software 100% 06/10/2025 19/10/2025
- Define and assign team roles and responsibilities 100% 06/10/2025 19/10/2025
2.2 Complete robot and soccer field modeling 100% 20/10/2025 26/10/2025
- Develop a functional NAO6 robot model 100% 20/10/2025 26/10/2025
- Build an official soccer field model with key features 100% 20/10/2025 26/10/2025
2.3 Complete robot dynamics simulation 100% 27/10/2025 02/11/2025
- Implement and validate core dynamic parameters 100% 27/10/2025 02/11/2025
- Run simulations to test stability and movement 100% 27/10/2025 02/11/2025
2.4 Complete robot motion simulation 100% 03/11/2025 09/11/2025
- Program fundamental motion trajectories (walk, turn) 100% 03/11/2025 09/11/2025
- Simulate and optimize motion smoothness and efficiency 100% 03/11/2025 09/11/2025
2.5 Complete robot kicking strategy simulation 100% 10/11/2025 16/11/2025
- Develop kicking algorithm for power and accuracy 100% 10/11/2025 16/11/2025
- Simulate various in-game kicking scenarios 100% 10/11/2025 16/11/2025
2.6 Complete full robot match simulation 100% 17/11/2025 23/11/2025
- Integrate all models and algorithms into a match environme 100% 17/11/2025 23/11/2025
- Run end-to-end match simulations and analyze performanc 100% 17/11/2025 23/11/2025
Phase III Pitch Presentation 100% 15/01/2026 01/02/2026
3.1 Slides Content & Design 100% 15/01/2026 25/01/2026
3.2 Demo Video Production 100% 15/01/2026 25/01/2026
3.3 Diagrams & Visual Assets, Q&A 100% 26/01/2026 01/02/2026
3.4 Final Integration & Submission 100% 26/01/2026 01/02/2026
Phase IV Hardware 0% 02/02/2026 01/03/2026
4.1 Hardware Setup and Environment Preparation 0% 02/02/2026 05/02/2026
4.2 Sensor and Actuator Integration 0% 02/02/2026 05/02/2026
4.3 Software-to-Hardware Migration 0% 06/02/2026 08/02/2026
4.4 Motion and Behavior Testing 0% 09/02/2026 15/02/2026
4.5 Team Coordination and Communication Testing 0% 16/02/2026 22/02/2026
4.6 Full Match Demonstration and Performance Evaluation 0% 23/02/2026 01/03/2026
Phase V Reporting 0% 02/03/2026 22/03/2026
5.1 Document the Design & Construction Process 0% 02/03/2026 08/03/2026
5.2 Analyse Results Against Initial Specifications 0% 02/03/2026 08/03/2026
29/09/2025
06/10/2025
13/10/2025
20/10/2025
27/10/2025
03/11/2025
10/11/2025
17/11/2025
19/01/2026
26/01/2026
02/02/2026
09/02/2026
16/02/2026
23/02/2026
02/03/2026
09/03/2026
16/03/2026
University of Glasgow
VIA VERITAS VITA
Project Gantt Chart

University of Glasgow

Costing ...

Item	Time (h)	Hourly Rate (£/h)	Amount (£)
Budget - papering	51	250	12,750
Budget - simulation	765	250	191,250
Total Budget	**816**	**250**	**204,000**
Spend - semester1-week2&3	120	250	30,000
Spend - semester1-week4&5	120	250	30,000
Spend - semester1-week6&7	240	250	60,000
Spend - semester1-week8&9	240	250	60,000
Total Spend	**720**	**250**	**180,000**
Remaining Budget	**96**	**250**	**24,000**
Budget Utilization	**88.24%**		

Cost Estim

Task Item					
Team Formation & Kick-off	Team member familiarization & ice-breaking meeting				
	Establish team communication norms & tools				
Project Management Framework Setup	Define team management structure & role responsibilities				
	Develop internal team meeting protocols				
	Create project management templates (initial TAR)				
Project Planning & Definition	Analyze project specification & requirements				
	Determine tech stack & software environment				
	Create Work Breakdown Structure (WBS)	All Members	6	6	£1,500
	Develop preliminary Gantt chart / project timeline	Project Manager	1	6	£1,500
Cost Estimation & Kick-off Preparation	Detailed person-hour & cost estimation	Project Manager	1	2	£500
	Prepare materials for initial supervisor meeting (plan, cost)	All Members	6	4	£1,000
	Conduct initial supervisor meeting (1 hour)	All Members	6	1	£250
	Post-meeting plan revision & confirmation	Project Manager	1	2	£500
Technical Preparation	Configure shared development environment (Git, MATLAB, etc.)	All Members	6	4	£1,000
Subtotal				**51**	**£12,750**
Weeks 1-2: Basic Modeling	NAO6 Robot Dynamics/Kinematics Modeling	Robot Model Developer	1	30	£7,500
	Football Physics Model & Motion Simulation	Environment & Ball Developer	1	25	£6,250
	Simulation Architecture Design & Environment Setup	Simulation Lead	1	25	£6,250
	Project progress tracking & coordination	Project Manager	1	10	£2,500
Weeks 3-4: Core Algorithm Development	Basic robot locomotion, turning motion control	Motion Control Developer	2	60	£15,000
	Kicking, balancing motion control algorithms	Motion Control Developer	2	50	£12,500
	Path planning & obstacle avoidance algorithms	Motion Control Developer	2	40	£10,000
	Striker behavior state machine design	Behavior Algorithm Developer	2	50	£12,500
	Defender behavior state machine design	Behavior Algorithm Developer	2	50	£12,500
	Goalkeeper behavior logic	Behavior Algorithm Developer	2	30	£7,500
Weeks 5-6: System Integration	Robot model & motion control integration	Simulation Lead	1	20	£5,000
	Behavior algorithm & motion control interface integration	All Developers	5	75	£18,750
	Competition field visualization development completion	Environment & Ball Developer	1	30	£7,500
Weeks 7-8: Testing & Optimization	Single robot functional testing & debugging	All Developers	5	100	£25,000
	Multi-agent team collaboration testing	All Developers	5	80	£20,000
	Strategy optimization & performance tuning	Behavior Algorithm Developer	2	40	£10,000
	Simulation verification & test report writing	Simulation Lead	1	20	£5,000
	Phase progress management & reporting	Project Manager	1	30	£7,500
Subtotal				**765**	**£191,250**
	Hardware test plan development & NAO6 access arrangement	Hardware Test Lead	1	20	£5,000

Fortnightly Time Allocation Record

Team Number: 8 | Reporting Period: Semester 1 | Week | 2&3

	Name	Student #	Role
Team Member 1	Yunhao Huang	3132056H	PM/Model-Developer
Team Member 2	Xuanwei Ge	3129788G	Model-Developer
Team Member 3	Ramis, Mena Youssef Gouda	3172685R	Algorithm-Developer
Team Member 4	Niu Kai	3132433N	Algorithm-Developer
Team Member 5	Zihao Jing	3122376J	Model-Developer
Team Member 6	Lingyu Guo	3119118G	Algorithm-Developer

#	Workpackage	Activity	Start Date	End Date	Hours: Team member 1	Hours: Team member 2	Hours: Team member 3	Hours: Team member 4	Hours: Team member 5	Hours: Team member 6	Total hours
1	Project Planning and Requirements Analysis	A1.1 Analyze RoboCup 4v4 competition rules and requirements	29/9	5/10	3	3	3	3	3	3	18
2	Project Planning and Requirements Analysis	A1.2 Define the system architecture	29/9	5/10	1	0	4	0	0	0	5
3	Weekly Meeting	Supervisor meeting	29/9	5/10	1	1	1	1	1	1	6
4	Weekly Meeting	Online meeting	29/9	5/10	1	1	1	1	1	1	6
5	Project Planning and Requirements Analysis	A1.3 Assign team roles and responsibilities	6/10	12/10	4	2	2	2	2	2	14
6	Project Planning and Requirements Analysis	A1.4 Develop project timeline and milestones	6/10	12/10	2	2	2	2	2	2	12
7	Simulation Environment Setup	A2.1 Configure and customize Webots world file	6/10	12/10	3	3	1	4	3	4	18
8	Simulation Environment Setup	A2.2 Import and place four robot models	6/10	12/10	2	3	2	0	0	0	7
9	Simulation Environment Setup	A2.3 Add ball, goals, and initial positioning	6/10	12/10	1	3	0	4	2	1	11
10	Simulation Environment Setup	A2.4 Test simulation stability and environment parameters	6/10	12/10	0	0	2	1	4	4	11
11	Weekly Meeting	Supervisor meeting	6/10	12/10	1	1	1	1	1	1	6
12	Weekly Meeting	Online meeting	6/10	12/10	1	1	1	1	1	1	6
13											0
14											0
15											0
		OVERALL TOTAL			20	20	20	20	20	20	120
		E-SIGNATURE									

Fortnightly Time Allocation Record

Team Number: 8 | Reporting Period: Semester 2 | Week | 1&2

	Name	Student #	Role
Team Member 1	Yunhao Huang	3132056H	PM/Model-Developer
Team Member 2	Xuanwei Ge	3129788G	Model-Developer
Team Member 3	Ramis, Mena Youssef Gouda	3172685R	Algorithm-Developer
Team Member 4	Niu Kai	3132433N	Algorithm-Developer
Team Member 5	Zihao Jing	3122376J	Model-Developer
Team Member 6	Lingyu Guo	3119118G	Algorithm-Developer

#	Workpackage	Activity	Start Date	End Date	Hours: Team member 1	Hours: Team member 2	Hours: Team member 3	Hours: Team member 4	Hours: Team member 5	Hours: Team member 6	Total hours
3	Pitch Presentation	A10.1 Define pitch storyline and key messages	15/1	25/1	5	4	6	5	6	4	30
4	Pitch Presentation	A10.2 Create pitch slide deck	15/1	25/1	4	6	5	5	6	2	28
3	Pitch Presentation	A10.3 Prepare key visuals/diagrams	15/1	25/1	5	4	3	3	7	6	28
4	Pitch Presentation	A10.4 Produce pitch demo video	15/1	25/1	2	5	2	6	4	6	25
5	Weekly Meeting	Supervisor meeting	15/1	25/1	2	2	2	2	2	2	12
6	Weekly Meeting	Online meeting	15/1	25/1	2	2	4	2	2	2	14
7	Pitch Presentation	A10.5 Integrate supporting materials (results/metrics + repo snapshot + run steps)	26/1	1/2	8	7	6	6	2	7	36
8	Pitch Presentation	A10.6 Rehearsal and Q&A preparation (timed run + backup plan)	26/1	1/2	8	6	8	7	7	7	43
9	Weekly Meeting	Supervisor meeting	26/1	1/2	2	2	2	2	2	2	12
10	Weekly Meeting	Online meeting	26/1	1/2	2	2	2	2	2	2	12
11											
12											
13											
14											
15											
16											
17											
18											
		OVERALL TOTAL			40	40	40	40	40	40	240
		E-SIGNATURE									

University of Glasgow

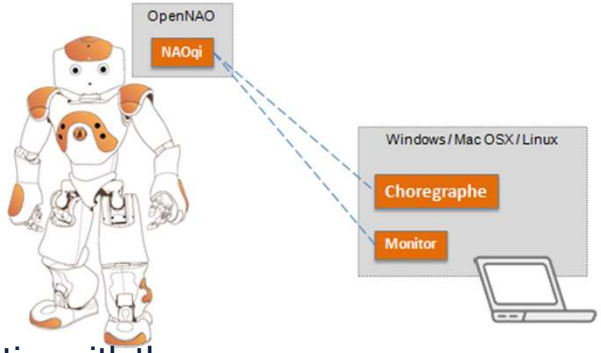
TAR Recorder

University of Glasgow

Technical Aspect and Methodology …

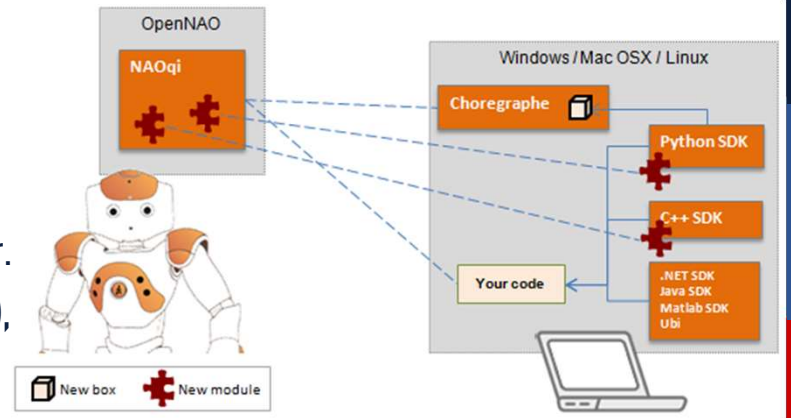
University of Glasgow

How does NAO Robot actually Work ?? !!



NAOqi is the main software and operating system framework of NAO Robots.
It acts as the "BRAIN" of the robot, managing motion, sensor data, and interaction with the environment, while also providing a programming framework for developers.

<u>Development & Programming</u>:
Languages: It supports C++ and Python.
Tools: The **<u>Choregraphe suite</u>** is used for graphical programming, and the software allows for simulation of the robot on a computer.
Create code with Python, remotely controlling the robot (all SDKs),
Or creating modules and upload them on the robot (C++, Python)



University of Glasgow

Great, Here is the Story !

We Start to Code ...

University of Glasgow

Here it comes the Fun Part…

SimSpark:

A multi-robot simulator based on the generic components of the **Spark** physical multi-agent simulation system, it has been used in the RoboCup Soccer Simulations and development. As the result, RoboCup soccer simulations have changed significantly over years.
It provides a rich set of features to create, debug and modify multi-robot simulations.
It has three main components, including the simulation engine, the object and memory management system, and the physics engine
REF: https://ssim.robocup.org/3d-simulation/3d-tools/

University of Glasgow

What to do with SimSpark?

1. **RoboCup 3D Simulation:** Develop soccer-playing agents that, since 2008, control a simulation of the NAO robot model.
2. **Physics Simulation:** Use the integrated Open Dynamics Engine (ODE) to simulate rigid body dynamics, including inertia, friction, and collision detection.
3. **Sensor/Actuator Development:** Program agents to interpret data from simulated sensors (cameras, accelerometers, gyros, touch, audio) and **control the 22 joints** within the humanoid robots.
4. **Multi-Agent Coordination:** Research team behaviors and cooperation, as multiple agents participate in a single simulation.
5. **Heterogeneous Systems:** Create and test teams with robots of different physical properties (e.g., varying limb lengths) at runtime.

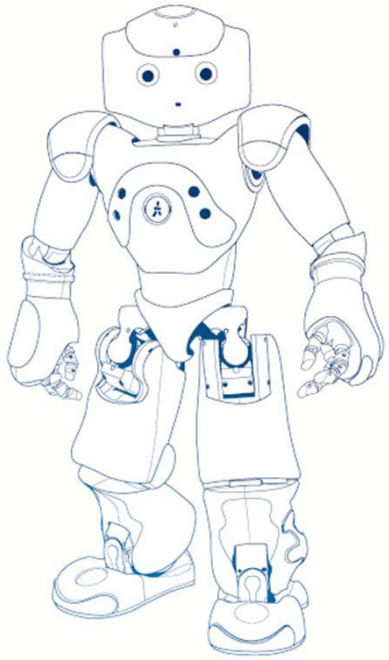
University of Glasgow

Then…

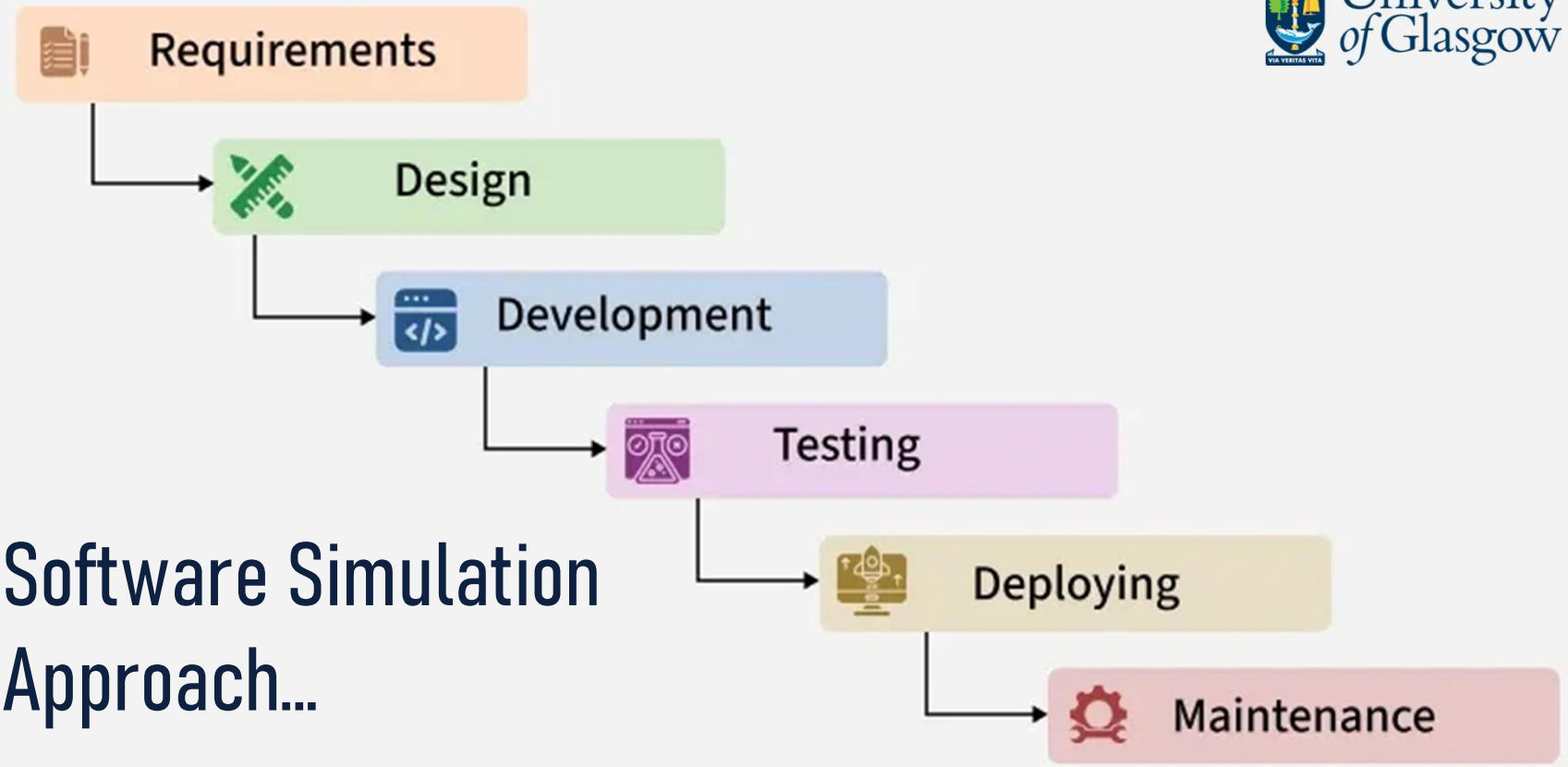
Welcome to Python Coded Simulation…

University of Glasgow

Full 4Vs.4 Robots Soccer Game Implementation …

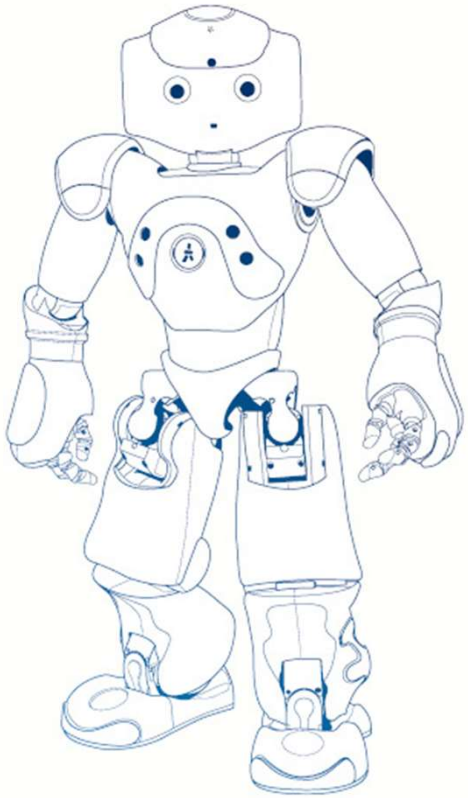


Software Simulation Approach...



University of Glasgow

10-Sec 4Vs.4 Robots Soccer Gam



University of Glasgow

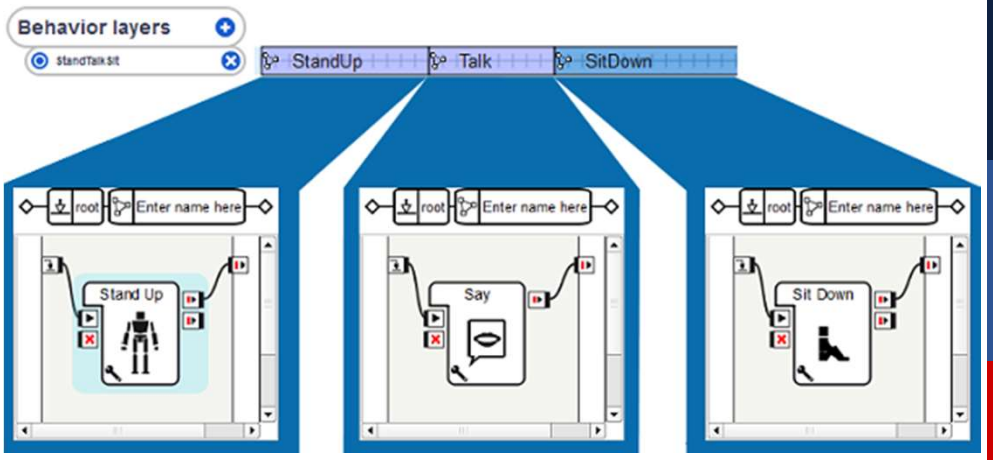
Transfer Behavioral Simulation to Choregraphe (Python).

1. Base Agent Structure
2. Behavior, Motion and Kinematics
3. Team Communication
4. Path Finding
5. AI Reinforcement Learning (If Required)

University of Glasgow

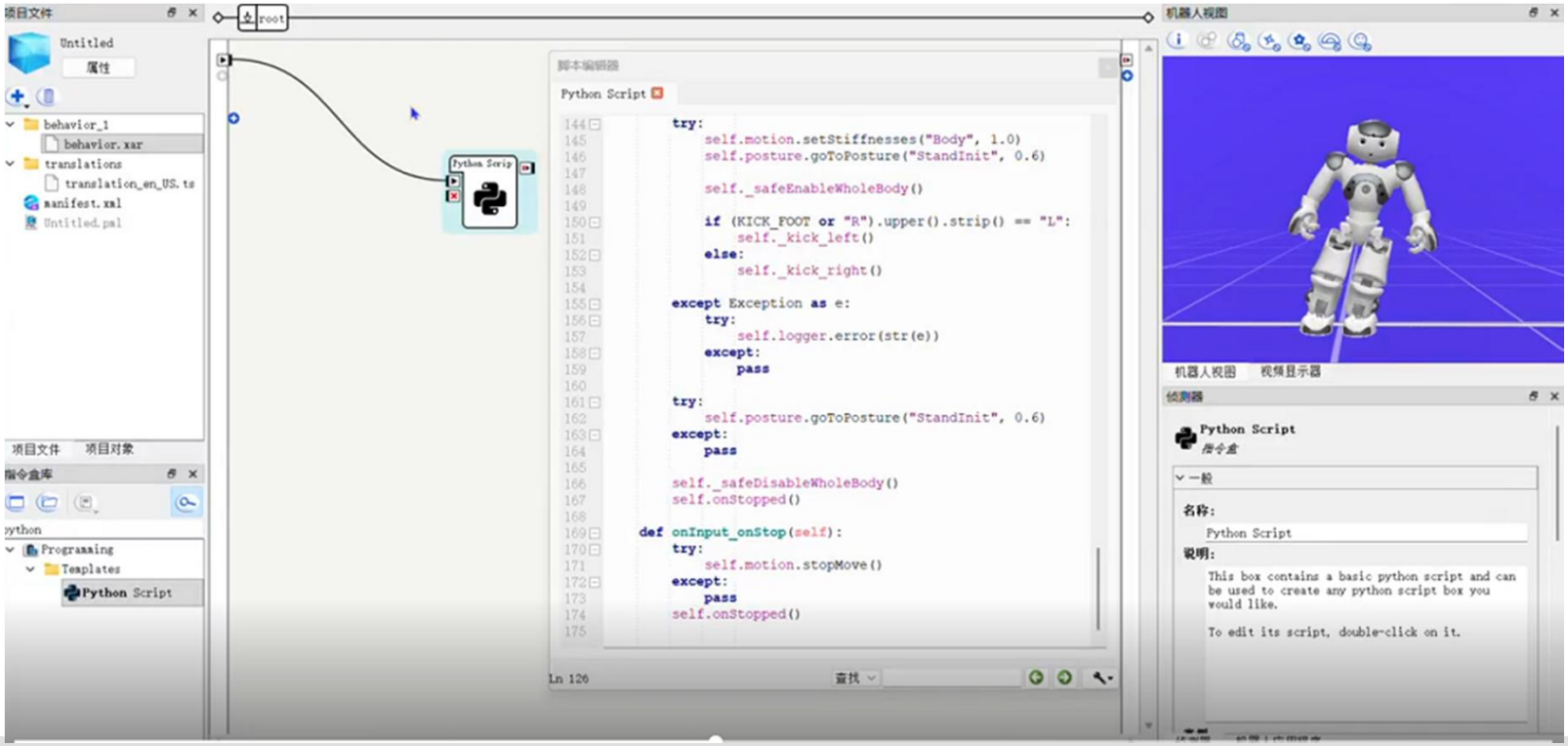
Preparing Physical Team -

1. Using successful simulation code from SimSpark to Choregraphe.
2. Testing basic Simulated Actions into physical plant (Real-Dimensional Playground).
3. Applying the same methodology for Team Communication.
4. Full Game Strategy Implementation



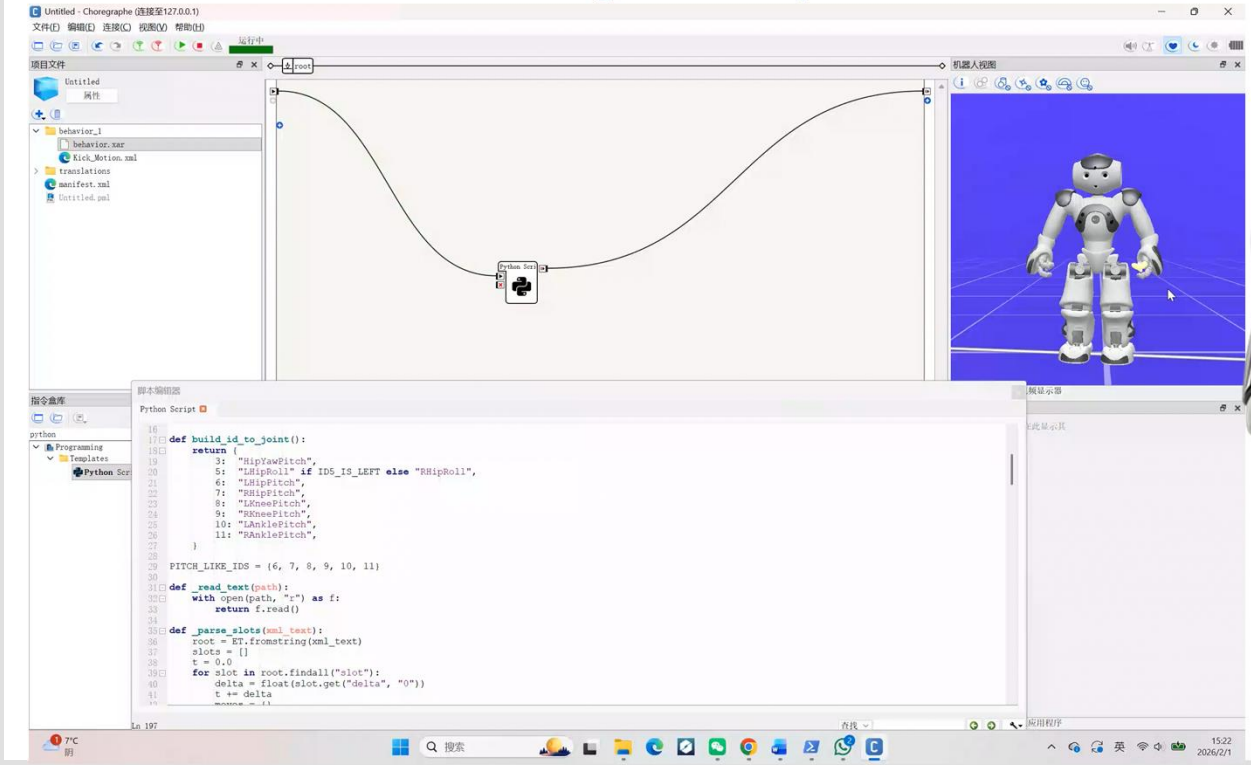
University of Glasgow

Behavior Programming in Action (PoC) …



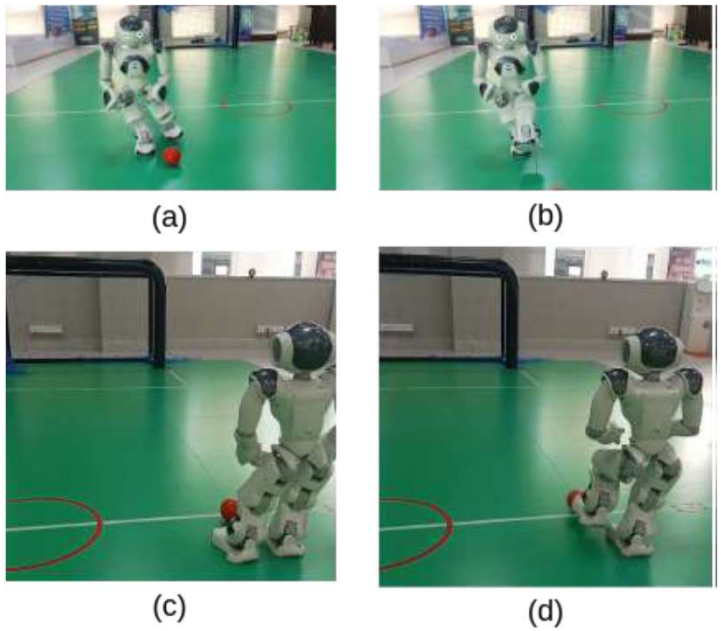
University of Glasgow

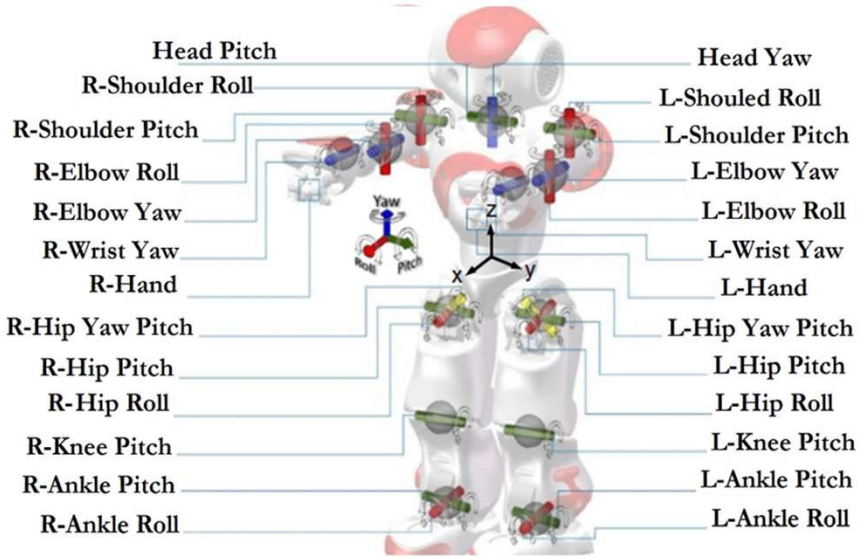
Working Example in Action (PoC) …



University of Glasgow

Simulation-to-Implementation for Real-World Environment (Workspace).





University of Glasgow

References

1. http://doc.aldebaran.com
2. https://wiki.ros.org/
3. https://www.cs.cmu.edu/~cga/nao/doc/reference-documentation/index.html
4. NAO Robot's Vision Control and Kick Motion Generation : https://vfast.org/journals/index.php/VTSE@
5. https://humanoid.robocup.org/materials/downloads/
6. https://www.robotlab.com/
7. https://scispace.com/pdf/simspark-an-open-source-robot-simulator-developed-by-the-1e1h0cbtes.pdf
8. http://www.er.ams.eng.osaka-u.ac.jp/Paper/2008/Joschka08a.pdf

University of Glasgow

References

11. https://www2.informatik.hu-berlin.de/~naoth/RoboNewbie/SimSpark-long.pdf
12. Main Robocup.org: https://ssim.robocup.org/3d-simulation/3d-tools/
13. https://gitlab.com/robocup-sim/SimSpark
14. https://github.com/magmaOffenburg/RoboViz
15. (UoG- Robotics TDP – 2022)https://github.com/UofG-RoboticsTeam9/RoboCupSoccer/tree/main
16. https://github.com/magmaOffenburg/magmaProxy

RoboCup
Team 8

RoboticsTDP-Team8

University of Glasgow

Q & A ...

RoboCup
Team 8

RoboticsTDP-Team8

University of Glasgow

Thanks!

RoboCup
Team 8

RoboticsTDP-Team8