MODELING AND IMPLEMENTATION OF A FUNCTIONAL HUMANOID ROBOT IN A 3D SIMULATOR

Lucas Ricardo Moraes Lagoeiro[1], Reinaldo Augusto da Costa Bianchi[2]
[1] Department of Robotics Engineering, FEI
[2] Department of Electrical Engineering, FEI
uniellagoeiro@fei.edu.br, rbianchi@fei.edu.br

Resume: The RoboFEI Humanoid project aims to build a robot capable of playing soccer autonomously. To improve its decision-making and test its performance across various terrains and situations, as well as to develop its localization capabilities, the creation of a simulated environment became necessary. In this context, the current scientific initiation project was developed, with the goal of modeling and implementing the RoboFEI Humanoid robot in the Webots simulator.[1]

1. Introduction

Simulation has become essential in robotics due to its cost-effectiveness and versatility, with various software options offering realistic representations of the physical world. This study explores the importance of simulation, providing a step-by-step guide for including a robot in the simulation, using the RoboFEI humanoid robot "Prometheus" as an example. The process covers everything from modeling in Onshape to implementation in Webots, and also addresses the transition to the "SigmaBan" model and the integration of the "DarwinOP" walking algorithm.

2. Bibliographical References

2.1 URDF

The *UNIFIED ROBOT DESCRIPTION FORMAT* (URDF) is based on XML (Extensible Markup Language) and provides a standardized way to represent the geometry, kinematics, inertia, and other properties of robots. It allows developers to describe a robot's structure, its joints (articulations), sensors, and links (robot parts), as well as their physical properties. The following image is an illustrative example to explain how URDF works. [2]

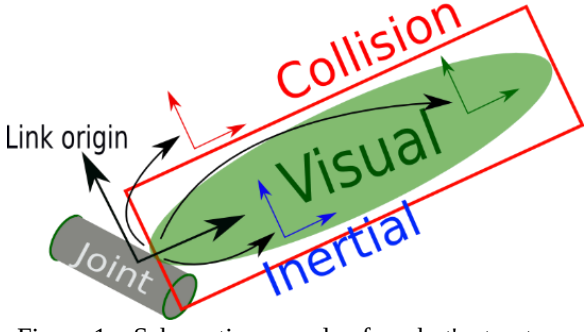

Figure 1 – Schematic example of a robot's structure.

3. Methodology

A software called Onshape (Figure 2) was used, which includes a tool for converting CAD files to URDF. Afterward, it is necessary to convert it to PROTO, the correct format for Webots.

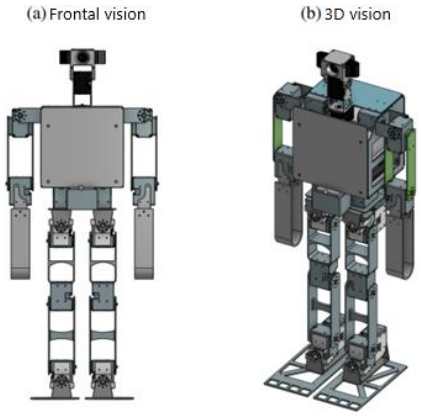

Figure 2 – The humanoid robot "Prometheus" in the Onshape software.

With the robot in Onshape, it was possible to convert it to URDF and visualize it in a simulation environment called PyBullet (Figure 3), where all its shapes and joints were accurately represented.[3]

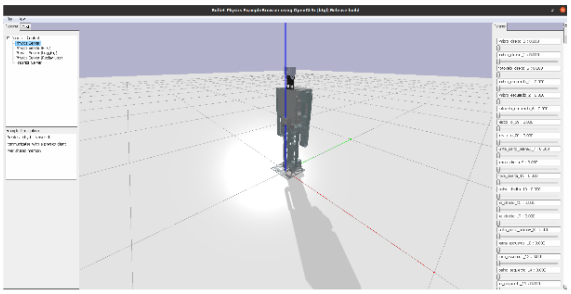

Figure 3 – “Prometheus” simulated in *PyBullet*

To test the robot in Webots' ODE, a final conversion from URDF to PROTO was necessary, using a tool called urdf2proto. This will initiate the final conversion process.

3.1 A new model

During the development of the model in the real world, mechanical failures were identified in "Prometheus" during testing, leading to the decision to replace it with the "SigmaBan" model from the Rhoban team (Figure 4). This model, already simplified in

Webots' ODE, will be used for the same purposes as "Prometheus" and to initiate the walking simulation.

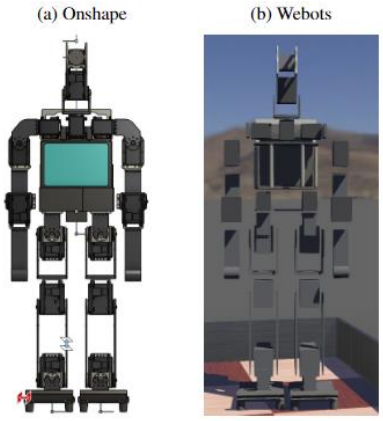

Figure 4 – The humanoid robot “SigmaBan”

The implementation of the "SigmaBan" model was facilitated by the availability of the .PROTO format on the Rhoban GitHub, requiring only its integration into the "DarwinOP" workspace on a soccer field to test its functionality for the RoboFEI team in Webots.

After inserting the robot into the simulation environment, it was necessary to configure the motors by adjusting their names and rotation directions to be compatible with "DarwinOP." These changes were essential to ensure the correct operation of "SigmaBan" with the walking algorithm.

4 Results

4.1 Prometheus

The result is a functional model of "Prometheus," the RoboFEI humanoid robot (Figure 5). This model was developed with the goal of faithfully reproducing the physical properties of the real robot. Additionally, the aim is to ensure that the model is capable of performing the same actions and movements as the original "Prometheus," thus allowing for an accurate and realistic simulation of its capabilities.

Figure 5 – “Prometheus” in position 0

By replicating the physical and behavioral characteristics of "Prometheus" in the virtual environment, it is expected to obtain a powerful tool for testing, development, and research in the field of humanoid robotics.

4.2 SigmaBan

The results with the new "SigmaBan" model were extremely positive, with the robot and the walking algorithm functioning effectively and demonstrating remarkable performance in the simulator (Figure 6).

Figure 6 – “SigmaBan” in position 0

The robot walks efficiently forward and backward, in addition to executing turns and gaits accurately in both clockwise and counterclockwise directions (Figure 7).

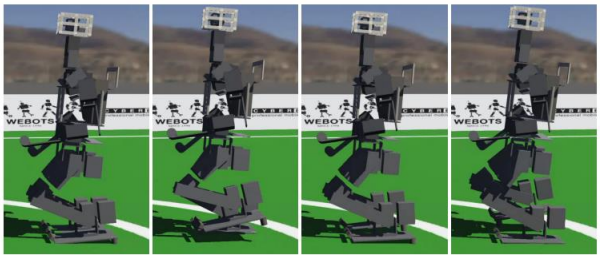

Figure 7 – *Gait*

4. Conclusions

The project was a success, achieving its main objectives. The implementation of the humanoid robot "Prometheus" in the Webots simulator was successfully carried out, involving complex steps such as converting the CAD model to URDF and PROTO formats, ensuring that the physical properties of the real robot were faithfully reproduced in the virtual environment. Despite the mechanical failures detected in the "Prometheus" model, the team decided to use the "SigmaBan" model from the Rhoban team. The implementation of this new model in Webots was successful. The walking algorithm of the "DarwinOP" was a success, as evidenced by the robot's ability to perform movements in a balanced and efficient manner.

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5. References

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