WARTHOG PROJECT

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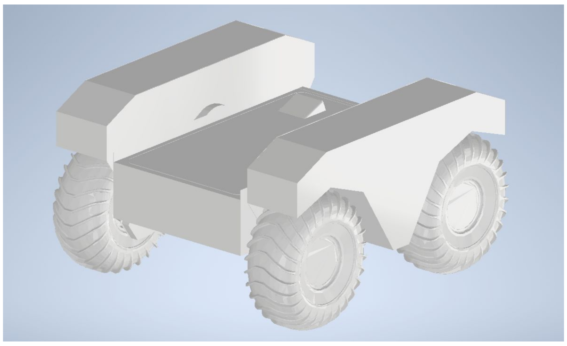
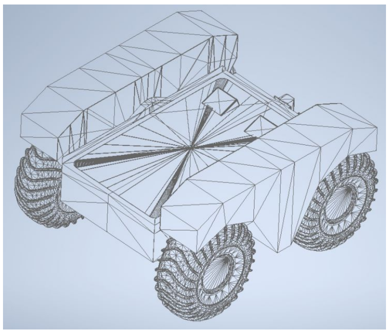
Introduction

The project aims to provide a simulation of the WARTHOG **A**UGV (designed by the Canadian firm CLEARPATH ROBOTICS. Warthog is a large all-terrain unmanned ground vehicle capable of traveling on land and in water. It can handle tough environments with its rugged build, low ground pressure, and traction tires, which allow effortless mobility through soft soils, vegetation, thick muds, and steep grades.

CAO

We initially dispose of most of the parts of the Warthog robot (chassis, cover, wheels, joints, etc.) in 3D digital format ".stl". Initially, we used existing parts in order to dimension the primary shapes (paving stones, cylinders, etc.) on V-REP.

We then carried out the digital assembly using Autodesk Inventor software, which allowed us to better visualize the overall shape of the robot and the possible articulations.

Once the assembly was completed, we were then able to group parts belonging to the same equivalence class to obtain a simplified mechanical system.

Finally, all we had to do was to export each equivalence class in the 3D format ".stl", a format that could be used by Coppelia software.

Weight constraint

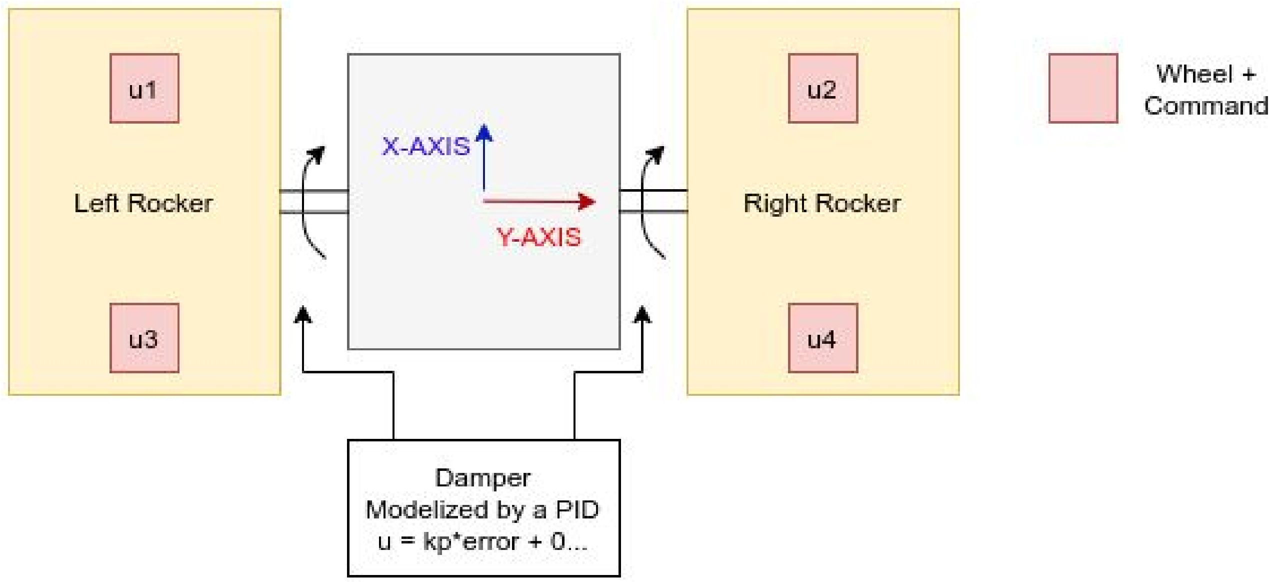
To meet the weight constraint, we have chosen weight of 25 kilograms for each wheel, 50 kilograms for the central tray and 50 kilograms for each rocker. The total weight of our robot is therefore 250 kilograms.

Rocker

The WARTHOG is built with two rockers, in rotation along the y-axis allowing the WARTHOG to cross any obstacles. We added some damper on the joint in order to stabilize the WARTHOG central platform, in the case where the platform begins to rotate along the y-axis.The damper is simulated by a proportional controller on the joint, with just have a KP, therefore if theta increases, it goes back to the zero degrees, like a spring: F = kp*error. The WARTHOG cross rocks and water in simulation. The behavior seems realistic. In the following figure, you can visualize the system. You can also watch the WARTHOG in simulation on the following videos :

- https://www.youtube.com/watch?v=WxgSTA-ixdk (WARTHOG in the sea)
- https://www.youtube.com/watch?v=YT_t-u7yGwk (WARTHOG in the sand)

You can also play with the simulation with a keyboard, following the instructions in the GitHub. https://github.com/gwendalp/WARTHOG



ROS INTERFACE

The major advantage of V-REP is that it can be interfaced with VSWR. This allows us to test the system's main algorithms. So we can test different functionalities of the system. The big disadvantage is that to make this interface you have to code in Lua.

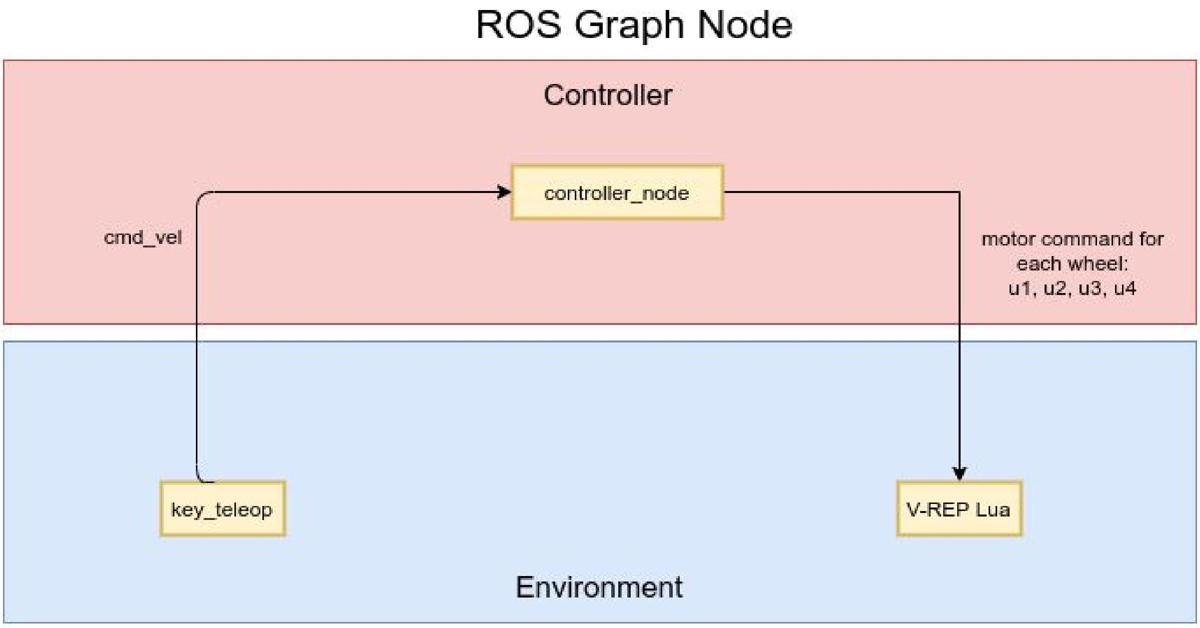
The principle is quite simple and is realized in a single script. Indeed, at the end of the realization of the physical model. We can control the different joints of the robot. Speed, control position ...

To order joints with ROS, simply instantiate the joints you want to order.

And connect a subscriber to the joint you want to order.

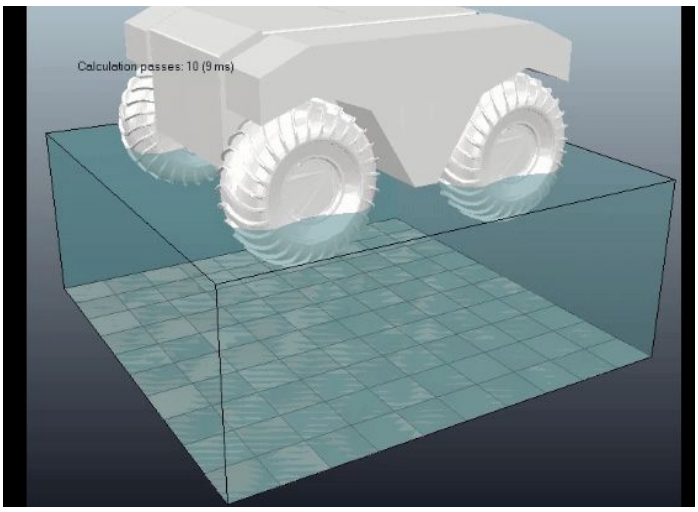
Then you need to run VSWR before running V-REP. And you just have to write on the topic corresponding to the articulation you want to control to set the corresponding speed.

We added a ROS controller node, which is subscribed to the twist message coming from the key_teleop. For instance, if vel.angular.z > 0 , WARTHOG turns on its left and U1=U3 < 0 (left rocker), U2=U4 > 0 (right rocker). The commands of each wheel are noticed on the rocker figure. Now you can play with your keyboard on the simulation. The instructions are on GitHub.



Buoyancy

For the Warthog's buoyancy, we first modeled a ball. It must float on the surface of the water. We then added an LUA script that allowed us to calculate and add the forces on the solid. The weight is already implemented on the V-REP simulator. We had to add Archimedes' thrust and fluid friction. For the Archimedes' thrust, we defined the height of the water, and it appears only when the ball is below the water surface. The friction of the water is proportional to the speed of the solid. Finally, we managed to make a satisfactory model of the ball.



To add buoyancy to the Warthog, we had to put a sphere for each wheel. This is the simplest and gives satisfactory results fairly quickly. This way we have the same behavior as with the ball made previously. We had to connect the balls of the wheels by bars mounted on ball-and-socket joints, in order to let the balls rotate freely but to keep them at a constant distance. So we have the Warthog floating properly on the surface of the water.