Soft Legs Small Handbook

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1 Files and Commands

The .cpp files are stored in the following path

```
home\catkin_ws\src\Qb_Legs_Synergies
```

and in the dropbox folder

```
Backup_Matlab_PC_Wa...oftLegs\CPP_material\catkin_ws\src\Qb_Legs_Synergies
```

You can find there three particular subfolders which contain the three main projects that you could need to move the *Softlegs*, i.e :

```
zmp_walk_gui
optimal_walk_gui
qb_legs_gui
```

To launch them you have to open a shell (I would suggest to use Terminator), launch roscore and then copy and paste the following commands to activate the guis

```
roslaunch qb_legs_gui qb_legs_gui.launch

roslaunch zmp_walk_gui zmp_gui.launch
roslaunch optimal_walk_gui optimal_gui.launch
```

Remember to launch one per time and per experiment and at the end to check if the nodes have been correctly killed. Otherwise kill them by yourself using

```
rosnode kill ......
```

Remember to use just one gui per time since they publish on the same topics.

Files are commented and a fast reading should be enough to understand the main functions. In the following a brief explanation of the gui functions is presented.

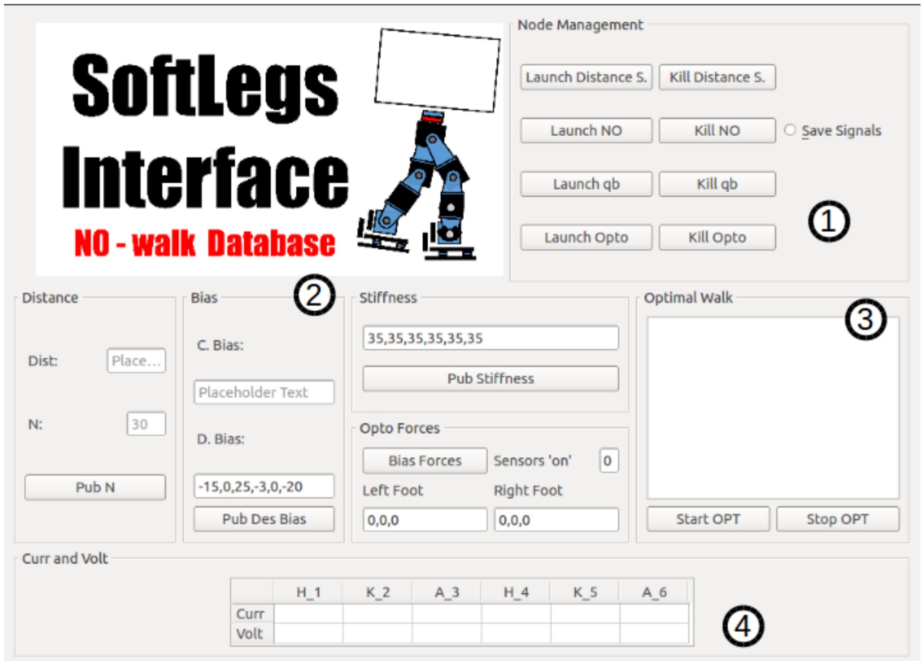

Figure 1: Optimal Walk Gui

Optimal Walk Database

The features presented in the following are exactly the same for the **Zmp Walk Database** and hence are not reported for the zmp case study.

Command to launch

```
roslaunch optimal_walk_gui optimal_gui.launch
```

1 - Node Management

This panel contains the buttons which allow to launch and kill the needed programs. In particular it is necessary to launch:

- the distance sensor
- the optimal database (NO)
- the Optoforce sensors
- the qbmove advanced

Activating and deactivating *Save Signals* it sets the beginning and the ending of the saving process of the robot signals. Signals are saved in the folder

`Documents/Treadmill_Exp_Results`. More details are reported in the file *Save qb legs.cpp*

2 - Data Panels

For each node you can pub and request the current data.

In particular with setting N and clicking *pub N* you choose the length of the temporal filter window and you can look at the distance in the blank space above.

C.Bias is the current bias and D. Bias is the desired bias which can be modified. Pub Des Bias change the bias in the robot.

Pub Stiffness publishes the robot stiffness

It is possible to set the Bias of the force sensors by clicking *Bias Forces*. You can chekc the measures in the blank spaces below and the number of the activated sensors in *Sensors on*

3 - Optimal Walk

It shows the optimal dataset. The simulation can be activated or stopped by clicking the start and stop button respectively. Double clicking the simulation in the database the selected trajectory is automatically selected to the robot. The trajectories are not connected, i.e. the robot ends up the walk and starts again with the new one.

4 - Currents and Voltages

The current and voltage amounts are reported in the table. The values are reported in the table boxes and their colour changes as a function of the value.

Synergies

Command to launch

```
roslaunch qb_legs_gui qb_legs_gui.launch
```

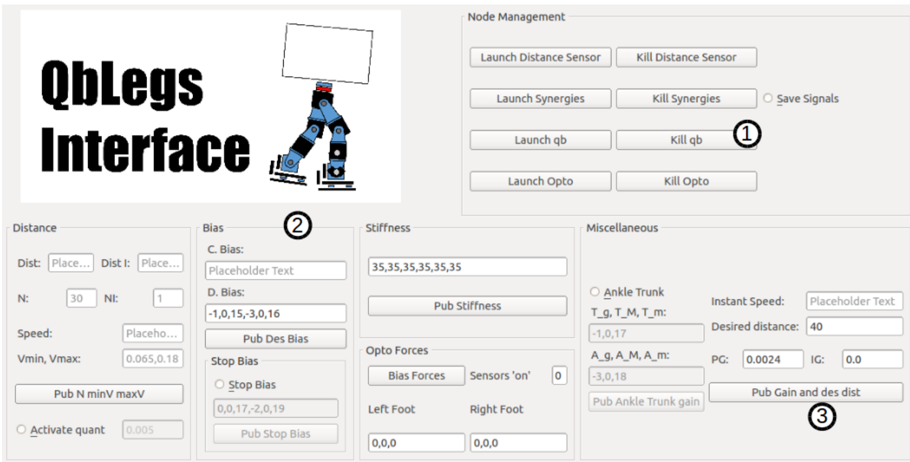

Figure 2: Synergy Gui

panels 1 and 2 are equal to the previous gui.

3 - Miscellaneous

This is the first gui realized and it still has some old commands. The only part really useful is the one related to the PI control:

- Desired Distance
- Proportional Gain PG
- Integrative Gain PI
- Pub Gain and des dist button

their functional is quite intuitive.

2 Matlab files

Matlab files can be found in the dropbox folder

```
Backup_Matlab_PC_Wa...oftLegs\MATLAB_material
```

ZMP NO Comparison

The function compares the Cost of Transport (COT) obtained applying two methods: numerical optimization and MPC on inverted pendulum (more details in [2]). For each case the file solve [2] and apply inverse dynamics to calculate the respective COT. It is necessary to run "Main Compare ZMP NO". The resulting figures are stored in folder named "Res". The results are just a small test set of the one provided in [1] (see Fig.4). It takes almost 500 seconds to terminate the task. A more detailed explanation is provided inside the files and in the paper. In the readme file you can find the list of the figures generated by the process.

From dataset to PCs and MCs

Taking as input the optimal dataset of walk provided via NO, the program returns the Principal Components (PCs) of the dataset , the identification of the Component Mapping functions (CMs) which relate the PC weights to the stride parameters and the validation of the CMs on a new dataset. It also generate a matlab function which implement the CMs. The figure generated are those used in [1]. It requires almost 40 seconds. A more detailed explanation is provided inside the files and in [1].

NO and Zmp Dataset

To create the hedaer files of the gui datasets, access to the folder

```
Backup_Matlab_PC_Wa...oftLegs\NO_ZMP_dataset_from_m..._to_cpp
```

and launch the file

```
Generate_NO_Optimal_Dataset_SoftLegs_GUI
Generate_ZMP_Dataset_SoftLegs_GUI
```

It automatically create the required files in a specific path. The files are commented.

References

[1] Gian Maria Gasparri, Silvia Manara, Danilo Caporale, Giuseppe Averta, Manuel Bonilla, Hamal Marino, Manuel Catalano, Giorgio Grioli, Matteo Bianchi, Antonio Bicchi, and Manolo. Garabini. Efficient walking gait generation via principal component representation of optimal trajectories: Application to a planar biped robot with elastic joints. *International Conference on Robotics and Automation ICRA18, IN REVISION*, 24(3):352–363, 2017.

[2] Shuuji Kajita, Fumio Kanehiro, Kenji Kaneko, Kiyoshi Fujiwara, Kensuke Harada, Kazuhito Yokoi, and Hirohisa Hirukawa. Biped walking pattern generation by using preview control of zero-moment point. In *Robotics and*

Automation, 2003. Proceedings. ICRA'03. IEEE International Conference on, volume 2, pages 1620–1626. IEEE, 2003.