Humoto software for walking motion generation

Jan Michalczyk
jan.michalczyk@inria.fr

Bipop Team

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1. Humoto
   - Humoto library

2. Humoto with LIRMM control framework
   - Integration of Humoto with LIRMM control framework

3. Perspectives
Humoto library

Humoto

- Open-source [https://github.com/bip-team/humoto](https://github.com/bip-team/humoto)
- Software framework for manipulation of linear least-squares problems with constraints
- Special interest in MPC problems for robotics applications in real-time
- Specific functionalities related to robotics (FSM for walking, trajectories, logging etc.)
- Interfaces to external tools (solvers, yaml-cpp, rbdl etc.)
- Modular architecture (enable/disable parts)
- Regression tests and Continuous Integration
- Support for foreign toolchains (Aldebaran’s qibuild)
Humoto library

Humoto core classes

Humoto bridges
(interfaces to external tools)

main classes
MPCforWPG
WalkParameters
Task*
Model
PreviewHorizon

module

config.yaml
CMakeLists.txt
demonstration tests
regression tests
**Control objectives as tasks**

- Optimization problems are posed as hierarchical least squares problems.
- They consist of tasks in the following form:
  \[ \underline{b} \leq A x \leq \bar{b} \]
- Equalities are represented by setting equal lower and upper bounds \( b = \bar{b} \).
- During a single control iteration we form all necessary objectives and organize them into a hierarchy. Individual class is created for each objective with the corresponding \( b, A, \bar{b} \) matrices.
- Two levels of hierarchy possible when using qpOASES.
- Arbitrary number of hierarchy levels possible when using LexLsi.
Humoto control loop

prepare control problem for the next iteration
↓
form optimization problem
↓
solve the problem
↓
shift FSM forwards to obtain the next stance (only for walking)
↓
get next state of the model
↓
update the model
Integration of Humoto with LIRMM control framework

Humoto

WBC

mc_control

v-rep

cmp_vrep

mc_RTC

HumotoController class

Humoto software for walking motion generation
Integration with LIRMM control framework

Humoto software for walking motion generation
Perspectives
Implement humoto module containing all relevant functionalities
- Obstacle avoidance
- Feet rotations
- Time-variation of footsteps
- Vertical CoM motion

Obstacle avoidance already partly implemented
Adding state feedback in simulations with LIRMM framework
Implementations of MPC schemes on hrp4
Thanks