Master 2 project 2016-2017

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**Laboratory :** LAAS-CNRS (Gepetto), Toulouse, France
**Thematic :** Robotics
**Keywords :** State estimation, robot dynamics, humanoid robotics
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**Title :**          **Joints flexibilities state estimation for a humanoid robot**

To control a humanoid robot, we generally consider it as a multi-body with stiff limbs and joints. However, some robots have flexibilities, for example in ankles as in the HRP-2 humanoid robot,  or in joints as in the Pyrene humanoid robot.

In previous works we developed a state estimator for the flexibility in HRP-2 ankles from propioceptives data and either an Inertial Measurement Unit (IMU) sensors only, or a fusion of IMU and contact forces sensors.

We are now interested in generalizing the approach to a state estimator of flexibilities in all the joints of the Pyrene humanoid robot. The goal of the intership is to understand the dynamical model developed for this purpose and to implement the state estimator based on this model. The state estimator will be tested in simulation and on the real robot.

**References :**
[1] Mehdi Benallegue, Florent Lamiraux. **Humanoid Flexibility Deformation Can Be Efficiently Estimated Using Only Inertial Measurement Units and Contact Information**
*2014 IEEE-RAS International Conference on Humanoid Robots*, Nov 2014, Madrid, Spain
[2] Alexis Mifsud, Mehdi Benallegue, Florent Lamiraux. **Estimation of Contact Forces and Floating Base Kinematics of a Humanoid Robot Using Only Inertial Measurement Units**
*IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2015)*, Sep 2015, Hamburg, Germany. 6p., 2015
[3] Mehdi Benallegue, Alexis Mifsud, Florent Lamiraux. **Fusion of Force-Torque Sensors, Inertial Measurements Units nd Proprioception for a Humanoid Kinematics-Dynamics Observation**
*2015 IEEE-RAS International Conference on Humanoid Robots*, Nov 2015, Seoul, South Korea

**Requirements :**
  – Good programming skills in C/C++ using GIT and Cmake
  – A background in state estimation and/or dynamical modeling (Newton-Euler, inverse kinematics, ...)
  – Any knowledge or practical interest in robotics would be relevant

**Environment :**  Located in the University town of Toulouse, in the south-west of France, the Gepetto group belongs to the LAAS-CNRS, laboratory for the analysis and architecture of systems, a 640 man-strong research center with about 90 people working in robotics. Among our robot fleet, we have access to HRP-2 and Romeo, while a new humanoid robot is expected within the year. The laboratory benefits from strong connections to the adjoining universities and the space and aeronautics industry.