Simple, yet effective relaxation mechanism to prevent overheating

We will address the problem of overheating joints during the game. We developed an algorithm relaxing the joints in a minimal way during the phases where the robot is in stand. As the result we observe significantly reduced power consumption by the joints and even "cooling" of the joints despite low stance and bent knees. Our approach addresses a very real issue existing in the league. At the same time our method is very simple, easily applicable yet very effective. For this reason, we believe our findings might be of interesting to a wade range of teams of different levels.

what is the problem

It is a well known and common problem that NAO's joins consume too much energy while standing. In fact data we collected over the course of several past competitions had shown that our robots heat up the most during the standing phase, if no countermeasures are applied. This happens because the target stand pose is usually fixed. When robot stops after walk, this pose usually cannot be assumed precisely because of natural errors caused uneven ground, play in the joints, errors in the execution of the steps etc. As a result, the robot ends up in a stance where its legs might be slightly twisted. These errors are usually very small (well below one degree), but, since the ideal target pose is fixed, the motors are under constant pressure trying to equalize these small errors. Because, those deviations are distributed unevenly due to morphology of the robot. Usually the joints get hot in pairs: RKneePitch and LAnklePich, or LKneePitch and RAnklePich.

what can be done

There are different approaches to solve this problem. Some teams assume higher stance or relax the stand pose in some way. Both approaches have their challenges. In case of higher stance the height of the robot needs to be adjusted before and after walking phase introducing delays and possible instabilities. Relaxation might lead to reduced stability of the robot while standing and might require corrections when the robot relaxed too much.

what did we do

We developed an algorithm relaxing the joints in a minimal way. The adjustments made by the algorithms are minimal and require a correction of the pose only after a prolonged period of time. At the same time the energy reduction is so profound that the "temperature sensors" report cooling down of the joints even in the low stance.

how does the method work

Each join can be controlled in a discrete number of steps. Our algorithm relaxes the join with the highest energy consumption if it reaches a certain threshold by just one motor step. This correction is infinitesimal and induces no visible motion of the joint. This almost has no effect on the stance of the robot, but reduces energy consumption of this joint significantly. This way the load distribution between the joints is kept evenly distributed.

what we will show

In our demonstration we will explain and demonstrate this mechanism. For the demonstration we will use one robot and a screen showing the levels of the current used by each joint illustrating the mechanism in action. We will observe the energy levels in different situations, e.g., after walk, after standup, different heights of the stand pose, with and without the relaxation procedure. In case no screen is available, a second NAO will be used to illustrate the energy levels by rising and lowering it's arms.

why did we choose this topic

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