Implementation of a richer library of movements for Babybot using an accurate method to generate trajectories

Project Technical Report: **part Three**

In the third part of the project we added a Cartesian trajectory generator to the robot movement vocabulary. At the state of the art the robot arm was moving guided by a generator of trajectories in the joint space; it is important to change the reaching task focus: from the robot point of view (e.g. using the robot coordinate system) to the humanoid point of view.

In order to implement arm movements "processed" in Cartesian space, we need to "translate" the problem from the well known joint-space movement task (i.e. the one that computes the trajectories in the robot joint space) to the more complex problem of computing the movement steps in Cartesian coordinates, for which we need some knowledge of the robot inverse kinematics. We break down the problem of such translation into few simpler steps: the input of our problem is two or three points in the Cartesian space (starting point, an optional via point and the ending point); the final output is a trajectory in the joint space (i.e. a sequence of angles for each joint).

The system steps we used are the following: (1) given two or three points in Cartesian space, p0, p1, p2, where p0 is the arm current position and p2 the final position, (2) generate the interpolated trajectory (via p1, when specified) minimizing the movement jerk, then (3) generate the joints configuration for each one of the trajectory points using the inverse kinematics and finally (4) generate a smooth trajectory in the joint space using the high PID "mode" that utilizes the arm control board trajectory interpolator.

Important consequence of this work is to improve the human-like mental process required to compute a simple reaching movement. Babybot reaches for an object mostly using observations of the environment and indirectly information on what it learned about its own body. Such a behavior has been previously achieved but we now simplify the process and make a direct use of biological results on how our body determines a trajectory to reach a point in the space (i.e. minimum jerk trajectories and use of Fitt's law to calculate the expected time to compute the reaching task).