Automatic generation of humanoid's geometric model parameters

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Abstract. This paper describes a procedure that automatically generates parameters for the geometric modeling of kinematic chains. The convention of modeling used is the Denavit Hartenberg convention modified by Khalil Kleinfinger, noted DHKK. The procedure proposed here has two advantages. First the user does not need to calculate the geometric parameters by himself. He simply has to give the directions of the successive joint axes, and for each joint axis, a point that belongs to the axis. The second advantage deals with the use of model-generic matrices for the beginning and the end of the kinematic chains, and not only for the joint axes. This prevents the user from doing specific calculation to connect the joint matrices derived from the model with the initial and the final coordinate frames of the chain. Due to its unified formalism, the procedure allows to save time when the kinematics of the robot has to be changed. This paper includes the application of this procedure to the geometric modeling of legs and arms of two versions of the NAO humanoid robot, the one used in the RoboCup 3D Simulation League, and the other one used in the RoboCup Standard Platform League.

1 Introduction

Usually the calculation of the geometric model of a kinematic chain starts with the selection of a convention of parameterization to define the successive coordinate frames to go from one extremity to the other extremity of the chain. The user has to master the convention rules and has to manually calculate distances and angles necessary for the parameterization [1]. This is often a tedious task that requires a certain amount of time for the calculation itself, the checking and the validation with simulations. The task is even harder when there are multiple kinematic chains. If we take the example of a humanoid robot, there are five kinematic chains, the head, the arms and the legs. The number of parameters to determine is at least equal to the total number of degrees of freedom of the robot.

This paper proposes an automatization procedure for determining the parameters related to the modeling convention. This procedure simplifies the job of the robotics engineer since he does not have to do any calculation any more. It is straightforward and can be applied to any robot model or kinematic chain. It can be useful at the design stage and at the simulation stage to modify the dimensions of the bodies of the kinematic chain, the layout and the directions