

# 1 Introduction

This study is focus on the number of iterations needed to solve the MPC simplified problem for the quadruped. The goal is to find the minimum number of iterations of solver to have the shortest possible response time. The study proposed here is an empirical study in order to understand the behaviour of the solver in function of the number of iterations. Two parts will be studied. First let's analyse the behaviour of the solver with no initialisation. The second part will be focus on the minimum number of iteration with a warm start.

To analyses the behaviour in critical situation, the simulation analysed last 4s and the robot walks on the red blocks.

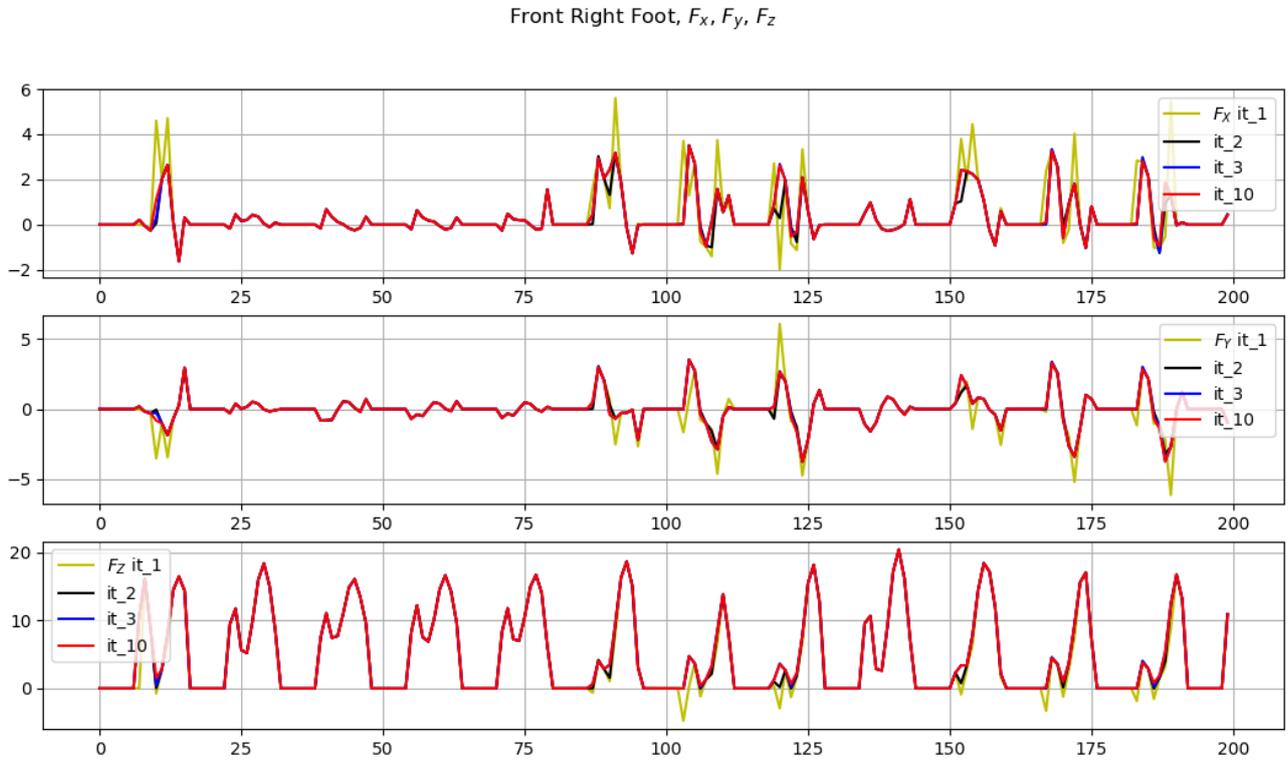
The friction coefficient is set to  $0.7 (\frac{1}{\sqrt{2}})$ . The cost weight on the friction coefficient is set to 10, the weight on the norm force is set to 0.2 for each force of the input command and the weight on the state is  $w_{state} = [1 \ 1 \ 150 \ 35 \ 30 \ 8 \ 20 \ 20 \ 15 \ 4 \ 4 \ 8]^T$ .

## 2 Number of iterations without warm start

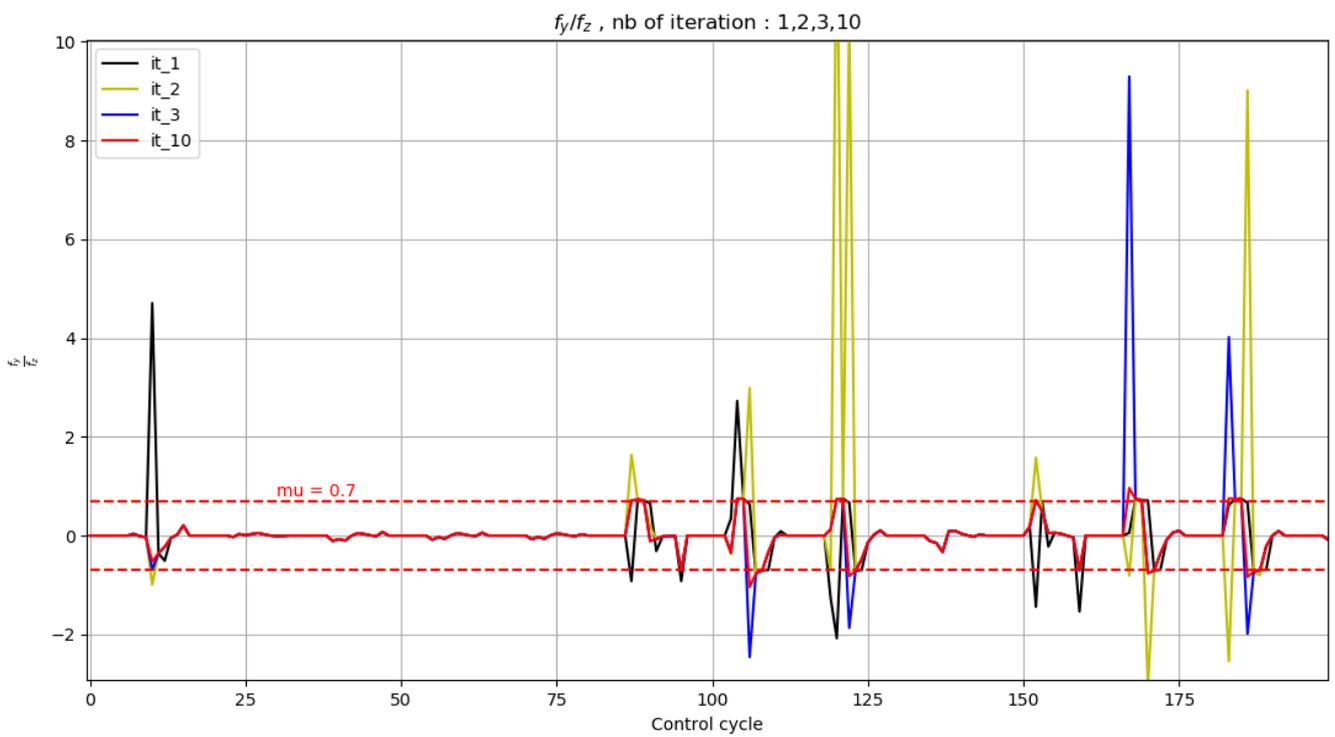
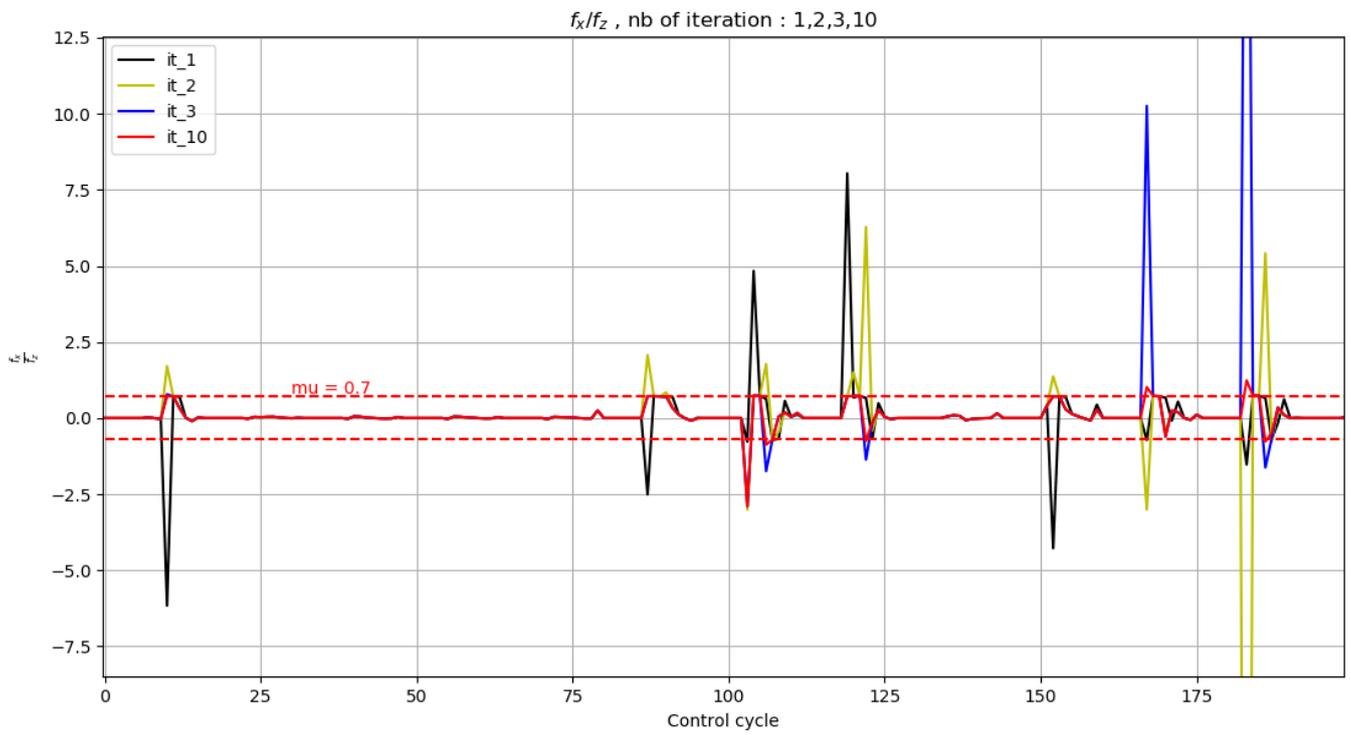
The initial state and input command is set to zeros.

### 3 Number of iterations with warm start

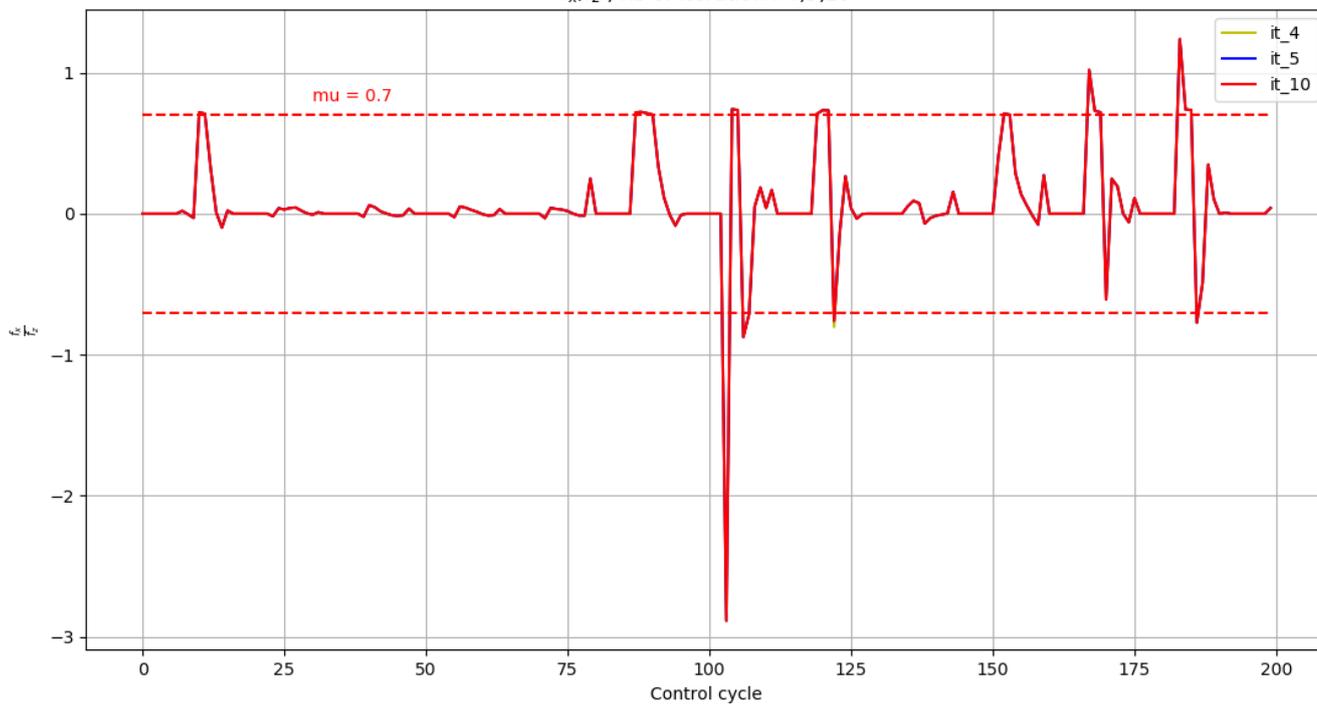
The initial state and input command are set with the previous values computed by the solver. The figure below represents the forces applied on the front right foot, depending on the number of iteration of the solver.



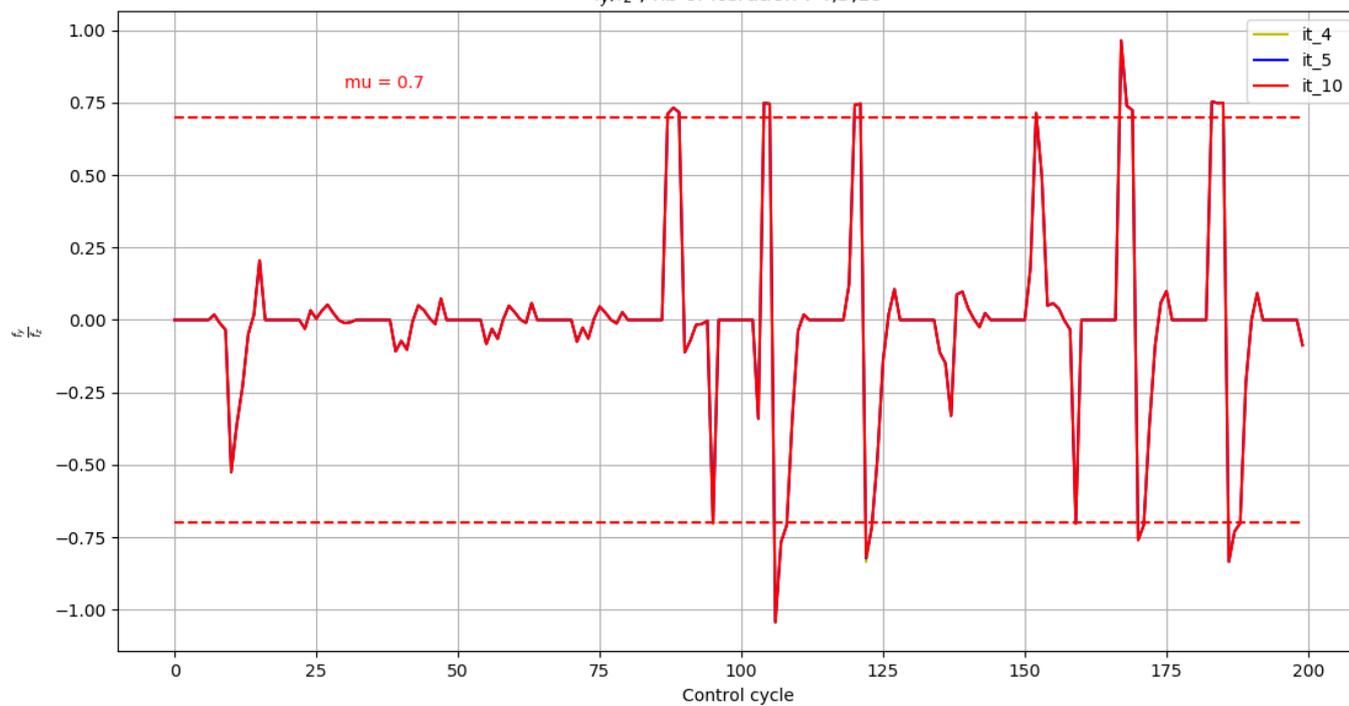
Let's analyse the overshoot of the friction cone.

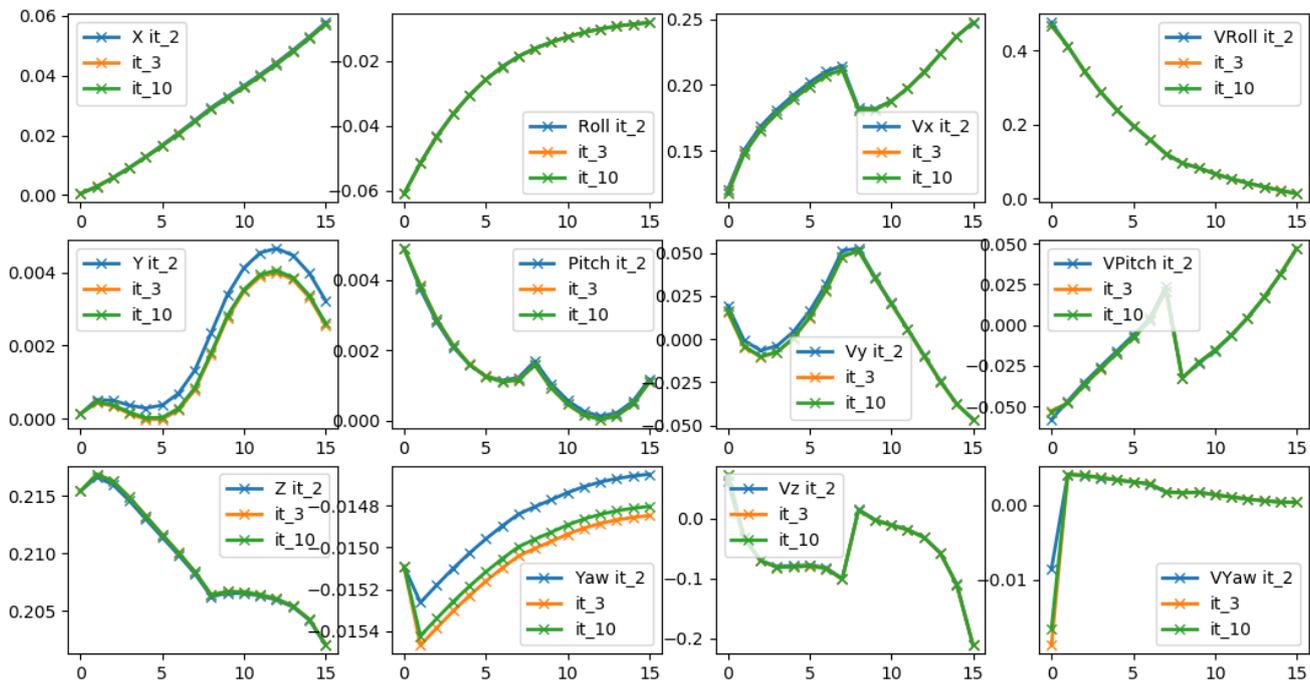


$f_x/f_z$ , nb of iteration : 4,5,10

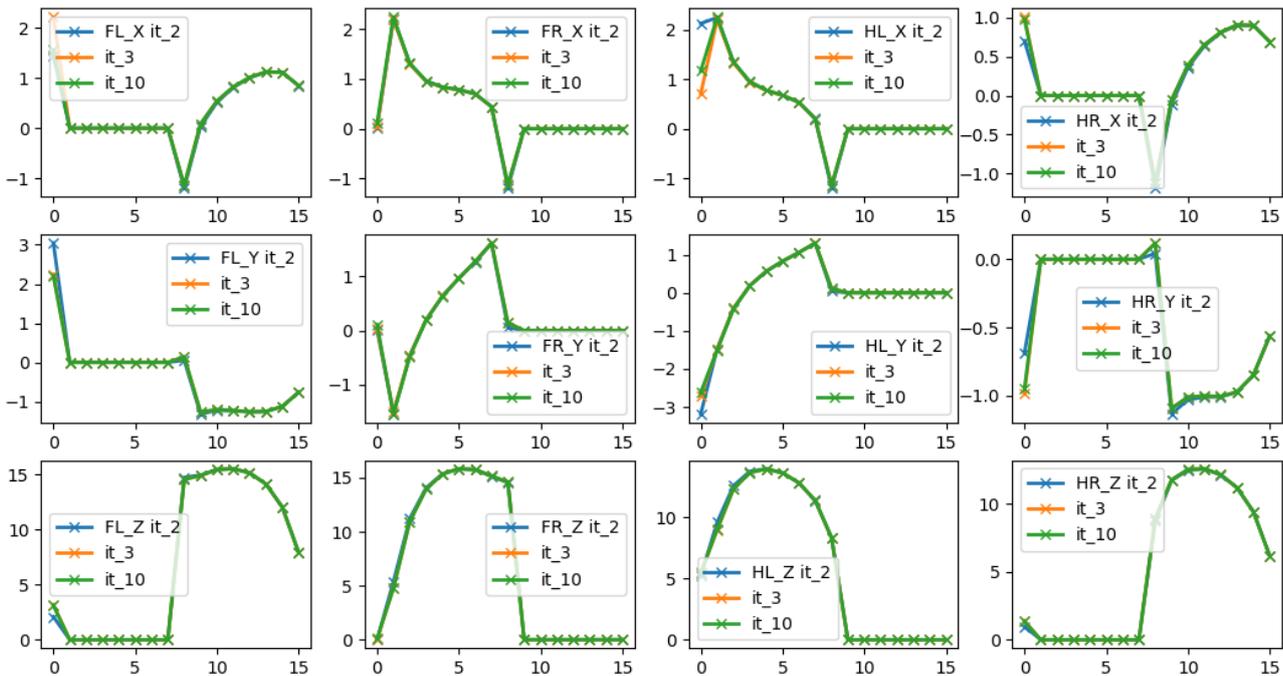


$f_y/f_z$ , nb of iteration : 4,5,10





Iteration : 167 ; MPCs prediction



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