

2022 Fall semester

## Homework # 2

## Problem 2 ZMP Planning (For forward walking)

※ **Reference** : Y. Choi, D. Kim, Y. Oh, and B.-J. You, "Posture walking control for humanoid robot based on kinematic resolution of CoM jacobian with embedded motion," *IEEE Trans. on Robotics*, vol. 23, no. 6, pp. 1285–1293, 2007.

※ The first step's support foot is the left foot.

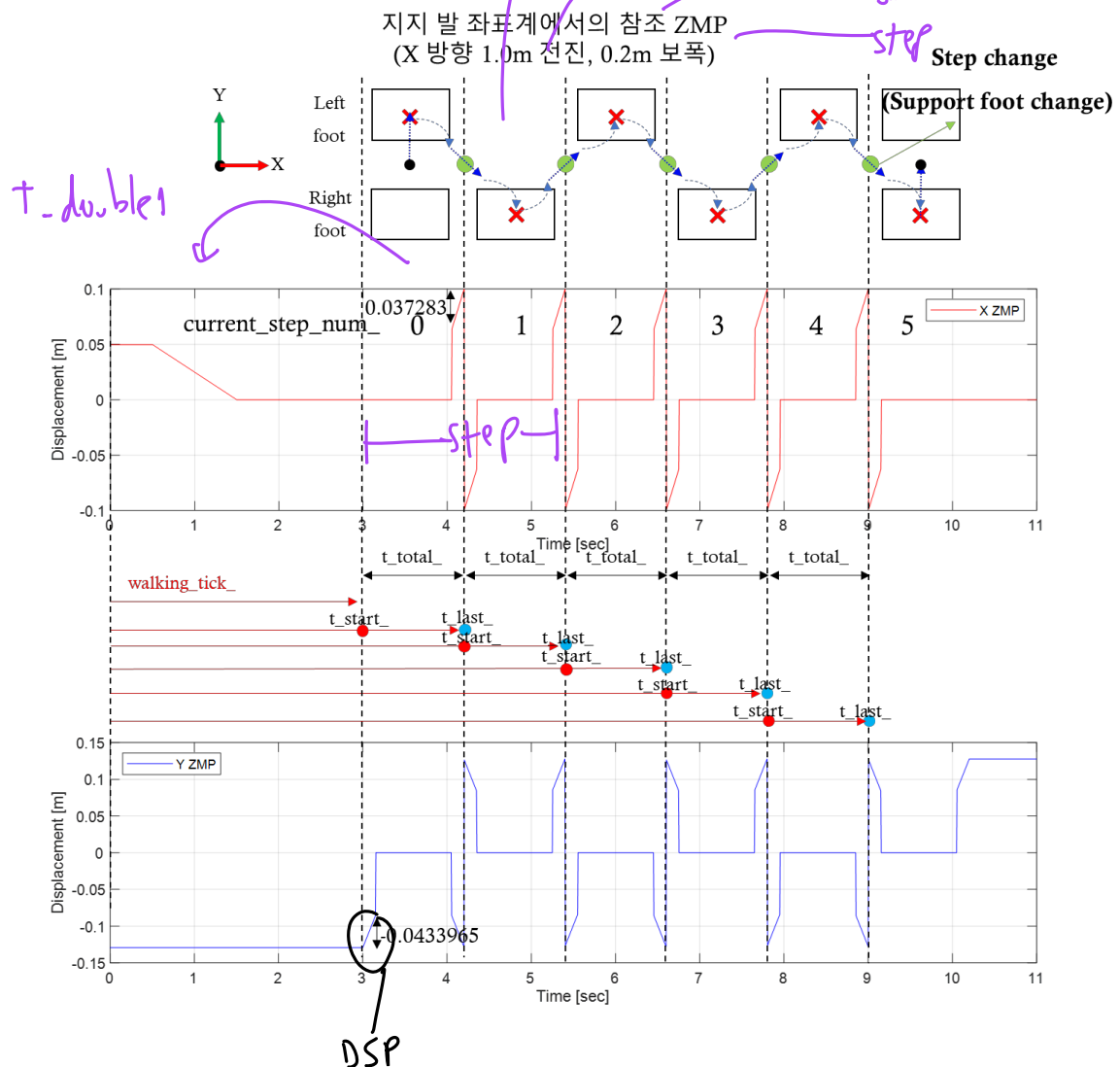


Figure. 1

- ✓ Design the reference ZMP trajectory w.r.t the support foot frame as shown in the figure. 1 (Note the figure. 1 and reference paper.)

- 1) Since the robot's initial X ZMP is not zero, design a reference ZMP trajectory that makes X ZMP zero before the walking. (Note the X ZMP in the figure. 1)

Robot initial  $\omega_m$  is in forward direction

- 2) Design the 3 step ZMP trajectory at every step including the current step. (If the current step is the first step, design the reference ZMP of steps 1,2,3, and if the current step is the second step, design the reference ZMP trajectory of steps 2,3,4.)
- 3) If the number of target steps is less than 3 steps including the current step, design the ZMP trajectory only for the remaining steps.

✓ Run it after programming

- 1) `roslaunch dyros_jet_gui dyros_jet_gui` → X: 1.0m, Step length : 0.2m → START walking button click!!
- 2) Plot the Reference X, Y ZMP trajectory

※ Hint

Available variables implemented in code framework. (Refer to the figure. 1)

Simulation time → `walking_tick_` (1tick : 0.005sec)

1 step time (1.2sec) → `t_total_` (1,2,3) ✓

Start time of each step → `t_start_`

End time of each step → `t_last_`

First DSP and last DSP time in one step → `t_double1_` (0.1 sec), `t_double2_` (0.1 sec)

The total number of steps to reach the target point. (It is automatically calculated when you click the start walking button.) → `total_step_num_`

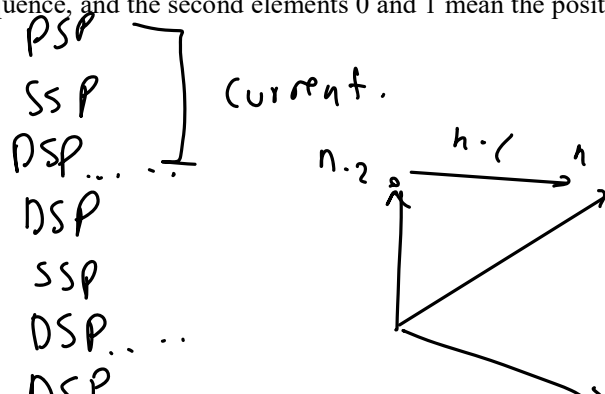
Current number of steps → `current_step_num_` updates itself

Initial X, Y, Z CoM position w.r.t the support foot → `com_support_init_(0)`, `com_support_init_(1)`, `com_support_init_(2)`

Foot step position w.r.t the current support foot frame

→ `foot_step_support_frame_(n,0)`, `foot_step_support_frame_(n,1)`

→ The first element n of the variable means sequence, and the second elements 0 and 1 mean the positions of X and Y, respectively.



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