2D VHIP

Dynamics:

CoM state:

Considering We can find a point holding :

For any state we have:

such that

We also have a restriction of : It is over the initial ballistic trajectory.

In a particular case of flat terrain, we have:

**3D VHIP CONVEXITY REQUIREMENT**

**MAIN RESULT: THE 3D VHIP w. VARIABLE COP IS INSTANTANEOUSLY 0-STEP CAPTURABLE IF AND ONLY IF THE REGION BELOW THE BALLISTIC TRAJECTORY INTERSECTS THE CONVEX HULL OF THE COP LOCUS.**

We can define a plane below and over the ballistic trajectory. We have:

We have:

The ballistic trajectory is defined for a single instant:

For any time, we have:

If

If :

We have:

Because is positive, the *closest* (in the sense of vertical distance) point is defined after some time ahead. We have:

We have supposed that the whole ballistic trajectory is below the plane, *including* its closest point to the plane:

So if then .

Let’s consider now the function:

The ballistic trajectory is defined for a single instant:

For any time, we have:

The initial ballistic trajectory (when ) holds:

The vertical distance from the ballistic trajectory at any time to the plane B is:

We have a maximum over the variable given by:

Taking into account that ballistic trajectory counts only for future times () we can consider the following cases:

If :

If :

We have: