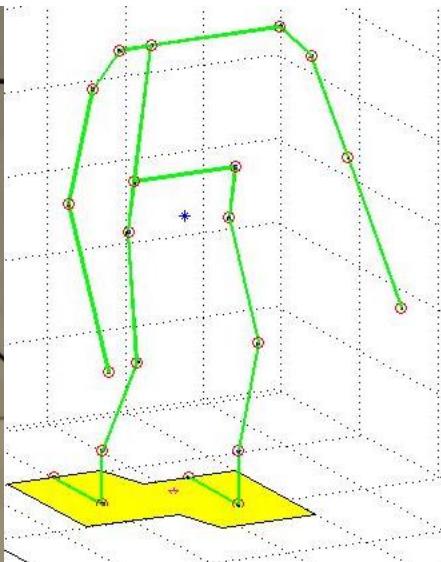
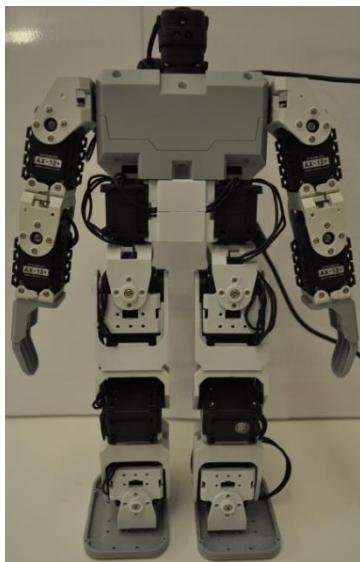




Introduction

The gait method installed to the humanoid built by the University of Bristol, PANTHER, is found to be slow and unstable. Therefore the aim of this project is to use a commercially developed robot, BIOLOID, and a kinematic model to identify parameters that has an effect on achieving a stable dynamic gait.



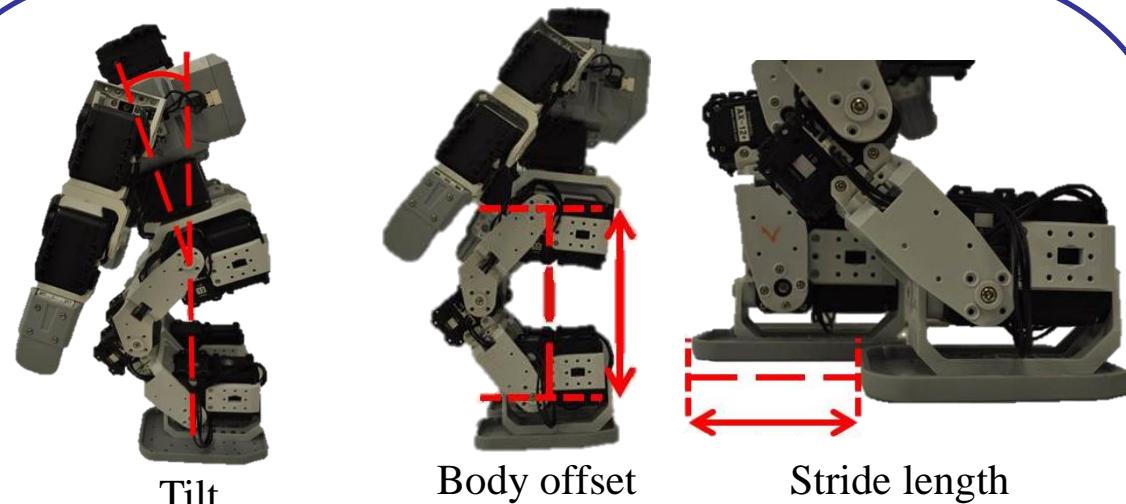
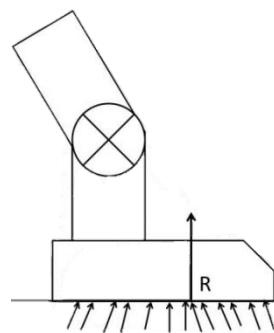
Two properties are used for analysis:

Center of mass (COM)

It is the center point of the body where the body mass is considered to be concentrated at, and where all external forces act on. Its projection should be in the support polygon most of the time.

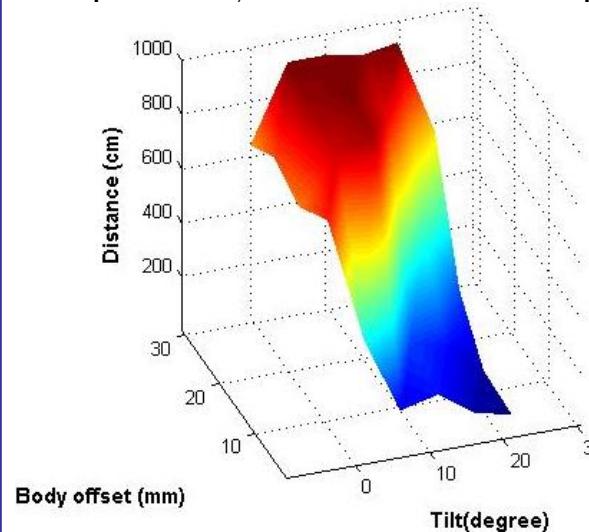
Zero Moment Point (ZMP)

It is the point at which the net moment by all torque and forces on the ground at horizontal direction is zero. The point should be within the support polygon at all times.

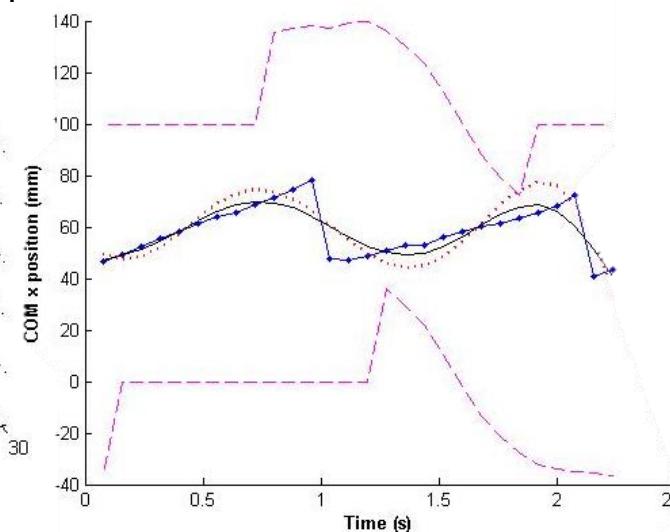


Experiments

The parameters shown above are postural properties that are identified that may have an effect on quality of gait and therefore are explored. Each parameter is varied and is matched to a combination of different settings of the other two parameters to create different gaits. 48 sets of gait methods are created. Two stages of walking tests will be performed. The first stage is the stability test. This is measured by the distance that can be travelled by the BIOLOID without falling. Gaits that walked more than 5m are proceeded to the speed test, in which the time required to travel 5m is recorded.



Stability test results. Red region indicates the most stable combinations while blue is the most unstable one



COM and ZMP trajectories in forward direction indicated in blue and red dotted line respectively, with support polygon marked in purple dashed line

Conclusion

- **Tilt:** It is found that the most stable and optimized tilt angle is greater than 0 but less than 13 degrees, contradicts the initial hypothesis which moving the COM forward improves stability and speed
- **Body offset:** Adding more body offset helps stabilizing the robot speeding up the walking speed slightly. It however has a minimal effect to the trajectories of COM and ZMP in the horizontal directions.
- **Stride length:** Initial hypothesis for adding stride length improves stability has been partly disproven. Improvement in balance is shown in relatively stable gaits, but has also worsen unstable gaits due to the increase of inertial forces from increase of walking speed