COMPARING THE GAIT OF BIPEDAL ROBOTS WITH THAT OF INFANTS

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INTRODUCTION

There has been renewed interest in the capabilities of bipedal robots in the past decade. They may be classified as *active*, (having their own power supply and actuators) or *passive* (driven by the effects of gravity), and *static* (the centre of gravity is always within the base of support) or *dynamic*, where the CG sometimes falls outside the support base [1].

Just as a bipedal robot needs to trade off balance and propulsion, so too does the human infant need to master these two factors when learning to walk [1]. In this paper we compare our recent data for an active and a passive robot with our prior data for young children [2].

METHODS

We based our active robot on the "drunken sailor" design [3], in which two actuators were incorporated, one to drive the legs and the other to tip the robot from side-to-side in order to clear the swinging leg (Figure 1). The robot had adjustable leg lengths (of 122, 137 and 152 mm), a mass of 0.72 kg and a programmable controller, allowing different cadences and step lengths to be implemented. A six camera Vicon system was employed to capture images at 120 Hz from four retro-reflective markers attached to the hip joints and feet of the robot. The 3D data files enabled us to calculate cadence, stride length and velocity, from which dimensionless velocity – the square root of the Froude Number – was derived [4].

Figure 1: Powered bipedal robot driven by two motors.

Our passive robot was based on the design of Garcia *et al.* [5] and implemented in both a physical and computer simulated form. We present here our simulated data. The robot had adjustable leg lengths (520, 770 and 1160 mm), a mass of 3.46 kg and we varied the angle of the inclined slope from 1.0 to 4.5 degrees. The temporal-distance parameters, which enabled us to calculate the dimensionless velocity, were a direct output of the simulation.

RESULTS AND DISCUSSION

Our active robot used a static pattern of movement to maximize stability (Figure 1) and hence sacrificed velocity, having dimensionless velocity values between 0.031 and 0.043 (Figure 2). In contrast, our passive robot used a dynamic gait pattern, achieving dimensionless values up to 0.3 for shorter leg lengths and a slope of 4.5 degrees (Figure 2). With increasing leg lengths, however, stability was critical and the dimensionless velocities dropped off to 0.1. These data are in good agreement with the literature: Collins *et al.* [6] built and tested a 3D passive dynamic walker, while Honda's ASIMOV robot [7] has an active dynamic pattern (Figure 2). The dimensionless velocities for children [2, 4] increase from 0.25 for an 18 month-old up to a value of 0.45 for teenagers and adults.

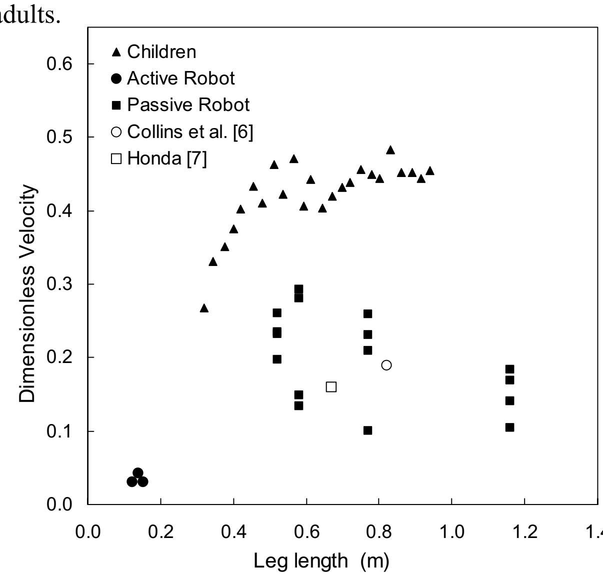

Figure 2: Dimensionless velocity as a function of leg length.

CONCLUSIONS

From a developmental point of view, the gait of sophisticated bipedal robots is just beginning to approach that of infants.

REFERENCES

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