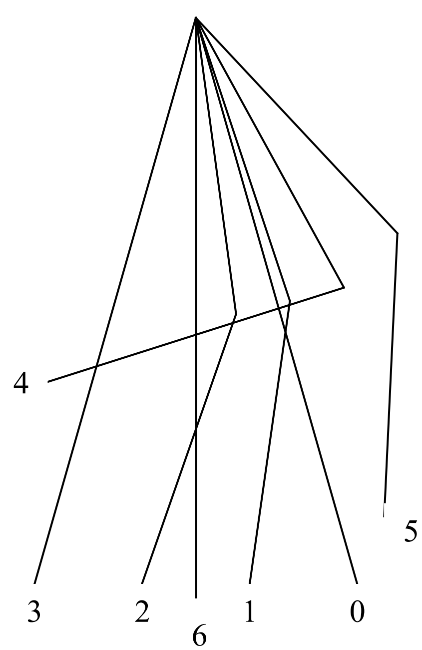
Four legged walk design.

Bright ideas:

1. Use paperclips to build cheap legs.
2. Insert a small (1 ohm) resistor in the servo ground leg to sense power. Found servos pulse motor power so added RC integration.
3. Zero integrator (by dumping charge through sensing port) before each servo current pulse – Output then corresponds to size (length) of each pulse.



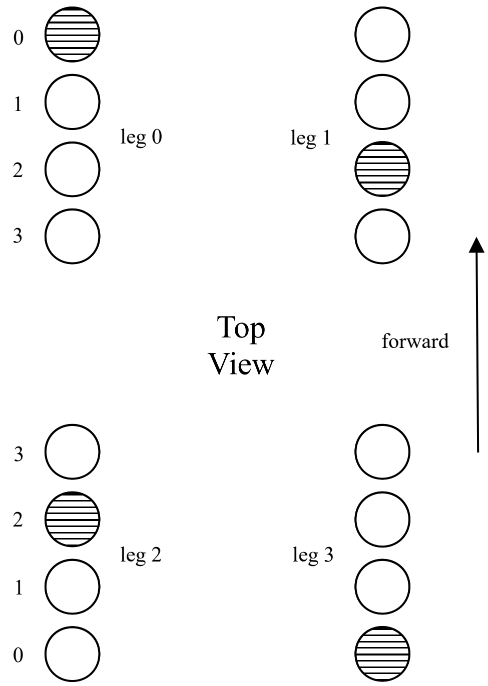
Leg:

Thigh length: 1.5"
Shin length: 1.5"
Stride (0-3): 2.0"

Positions per test 2009/01/19:

#	Hip	Knee	
0	-40	80	
1	-32	40	
2	-47	40	
3	-78	80	
4	0	-60	*
5	10	-60	*
tall	60	-80	
low	17	76	

*Don't match figure



Track width: 3.0”
Track length: 6.0” (4.75” as of 2/5)

Rear legs reverse forward sequence

Three legs on the ground at all times (four instantaneously).

Shaded positions show phase relationship between legs – Leg 0 has just been placed down and leg 3 has just been lifted. Note: center of gravity should enter triangle formed by legs 0-2 as leg 3 is raised.

Transitions 0-1, 1-2, 2-3 and 3-4-5-0 all are of equal time.

Weights:

Robot with solderless breadboard controller	360g
Plastic plate wheels	70g
Solderless breadboard controller (ATmega164)	100g
NiMH batteries in holder	130g
4xNiMH AA 2500mAH	115g
4xLithium AA	60g
Point to point wired controller (ATmega644)	45g
Leg (3 servos & all hardware)	25g
Robot with m644 and NiMH batteries (2/9)	295g

offsets per test 02/09/09:

0	-60	4	-20	8	-200
1	0	5	0	9	50
2	160	6	0	10 (:)	100
3	0	7	200	11 (;)	180

I knew before the 2/11 walk attempt that leg 3's knee servo (#7) was very stiff – Visibly lagging the others and showing sense readings in the high 30's under no load (as opposed to 10-13 for the other knees). After the walk attempt I disassembled leg 3 and swapped the knee servo with the rotate servo (#11). It made no difference in the walk at that point, nor did changing to the lighter and higher voltage lithium batteries.

Knew I had to adjust the center of gravity for a successful walk. Considered adding a servo or two to swing a weight (or better yet – the batteries) around in sync with the pace but then realized I should just use the legs to sway the whole thing. Added another function into the 2/13 software which swayed the robot from side to side (varying left and right legs between positions 8 and 9) to get some idea how much leg extension was required.

Side to side resonant frequency of robot with NiMH cells: 2.5 Hz, with lithium: 3.0Hz. Front to back resonance is about double – Legs are weaker side to side due to servo horns.

offsets per test 02/13/09:

0	-60	4	-20	8	-200
1	0	5	0	9	80
2	160	6	0	10 (:)	100
3	0	7	-80	11 (;)	-280

Positions per test 2009/02/13 (first successful walk):

#	Hip	Knee	
0	44	50-	(medium)
1	42	40-	(shortest)
2	52	50-	(medium)
3	66	70-	(tallest)
4	30	10	
5	18	0	
6	60	-70	(straight up)
7	17	76	(crouch)
8	44	40-	(sway low)
9	50	50-	(sway medium)

Tuned offsets in position 6 – allows walk on paper with NiMH at t16

0	-40	4	-120	8	-200
1	-60	5	100	9	80
2	160	6	0	10 (:)	100
3	-60	7	-80	11 (;)	-280

Current drains (using NiMH showing 5.0V at no load)
125mA idle
440mA crouch (p7)
350mA air walk (cannot walk with 5v supply)
920mA max observed (crouch->tall)
~10mA per sensor count.

Positions recovered from robot on 11/11/09. I THINK these are the correct first walk data – most agree but some are suspiciously different from those above.

#	Hip	Knee	
0	44	50-	(medium)
1	42	40-	(shortest)
2	52	50-	(medium)
3	66	70-	(tallest)
4	30	10	
5	18	20-	
6	60	70-	(straight up)
7	17-	76	(crouch)
8	54	58-	(sway low)
9	44	40-	(sway medium)

Recovered offsets – these aren't changed.

0	-40	4	-120	8	-200
1	-60	5	100	9	80
2	160	6	0	10 (:)	100
3	-60	7	-80	11 (;)	-280