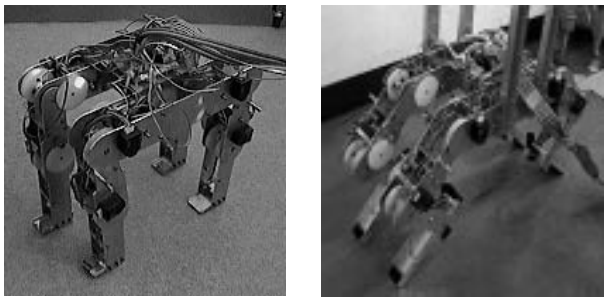

Fig.1 The quadruped "Patrush" for walking and running.

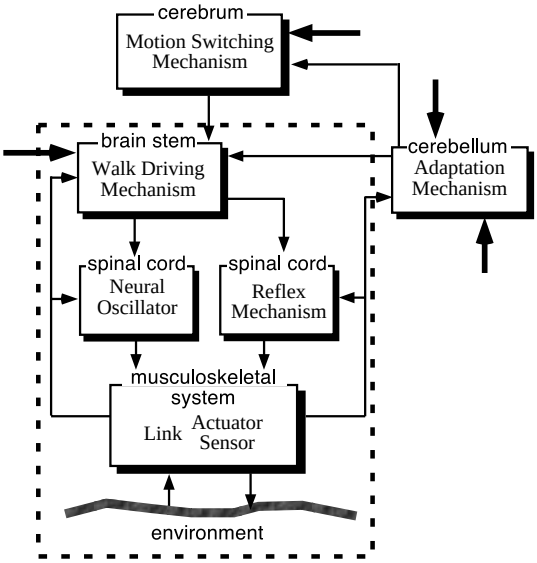

Fig.2 Primitive control mechanism of legged locomotion in animals.

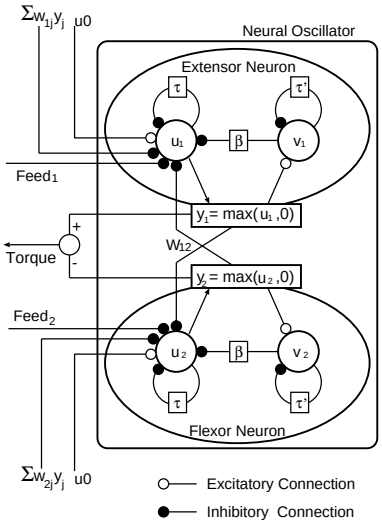

Fig.3 Neural oscillator.

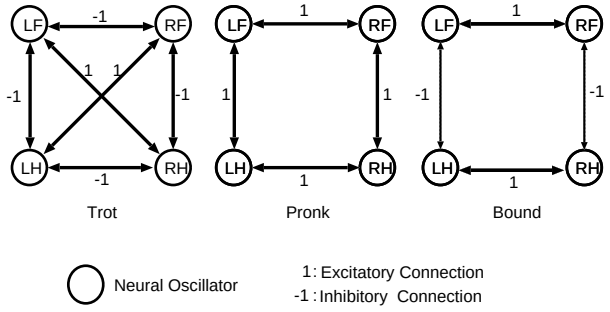

Fig. 4 Neural oscillator networks for walking (a trot gait) and running (pronk and bound gaits). An excitatory connection makes the phase difference between legs zero. An inhibitory connection makes the phase difference 180 degrees. LF, LH, RF and RH stand for left foreleg, left hindleg, right foreleg and right hindleg, respectively.

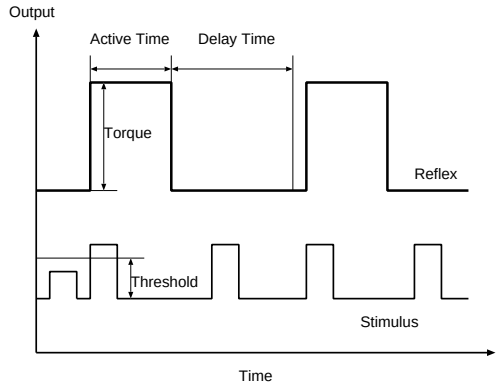

Fig.5 Reflex mechanism.

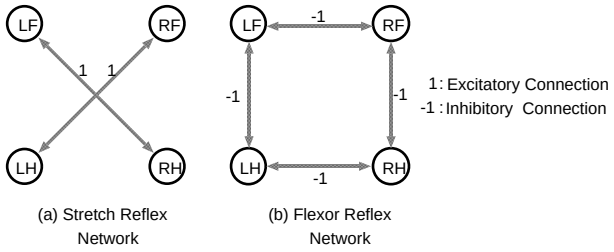

Fig. 6 Reflex networks. Raw torque is transmitted through an excitatory connection. Negated torque is transmitted through an inhibitory connection.

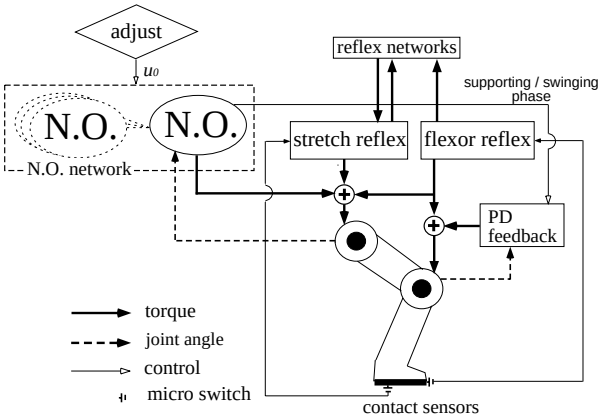

Fig.7 Actual control diagram for dynamic walking and running. N.O. network configuration for each gait is shown in Figure 4. Reflex network configurations are shown in Figure 6. The adjustment of the external input to a N.O. network is described in section **3.4.**.

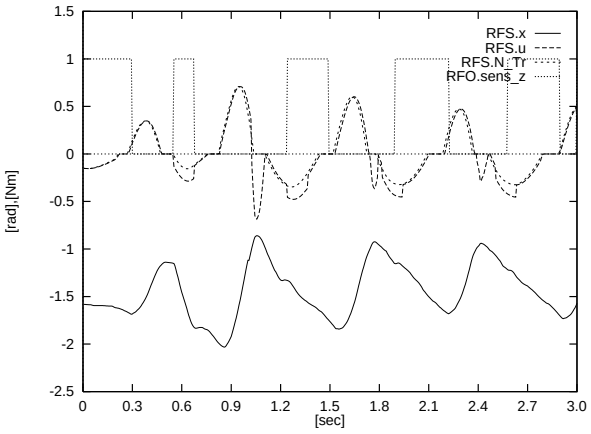

Fig. 8 Results of the experiment involving walking on flat terrain using the stretch reflex: *RFS.x* and *RFS.N_Tr* are, respectively, the angle and output torque of the N.O. of the hip joint of the right foreleg. *RFO.sens_z* is the vertical contact sensor output of the right foreleg. *RFS.u* is joint torque, which is the sum of *RFS.N_Tr* and output torque of reflex mechanisms.

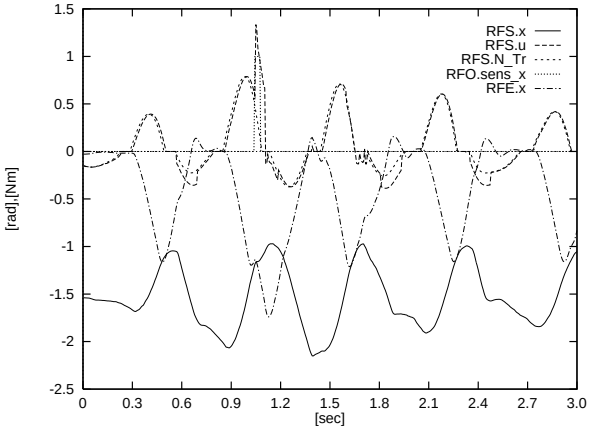

Fig. 9 Results of the experiment involving walking with a swinging leg obstructed using the flexor reflex: *RFO.sens_x* is the horizontal contact sensor output of the right foreleg. *RFE.x* is the angle of the knee joint.

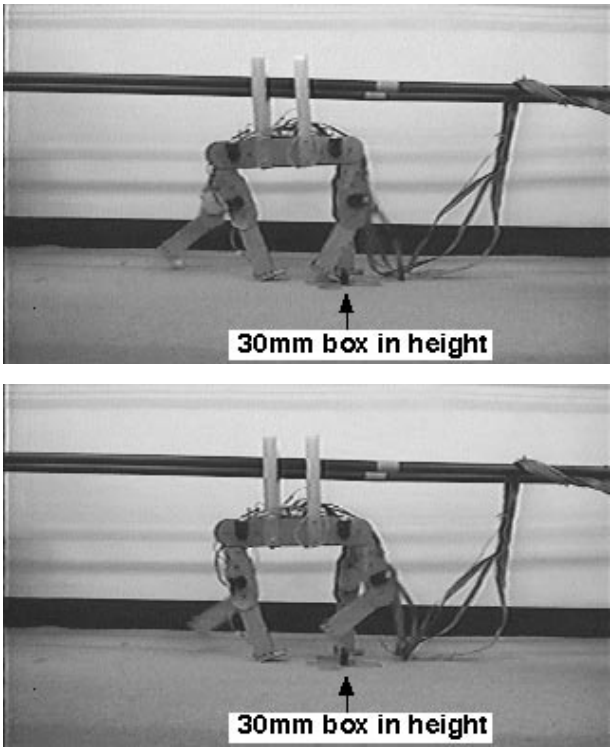

Fig.10 Photos of the quadruped walking with a swinging leg obstructed using the flexor reflex. The contact of the right foreleg with a box is sensed in the upper photo. The flexor reflex torque lifts the right foreleg over a box in the lower photo.

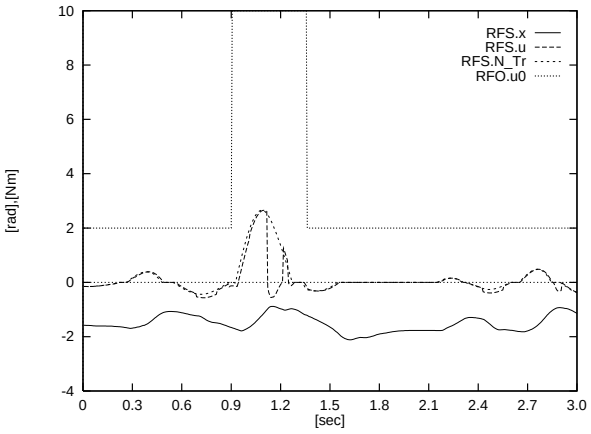

Fig.11 Results of the experiment involving walking up a step: *RFO.u0* is a driving input to a N.O. network. *RFO.u0* was increased from 2 to 10 for 0.9∼1.4(sec).

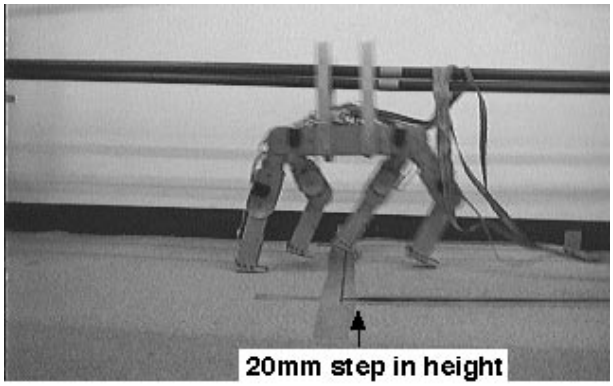

Fig.12 Photo of the quadruped walking up a step.

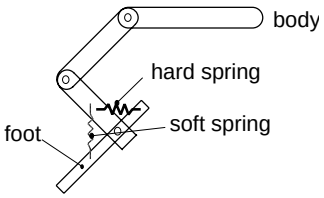

Fig.13 Spring mechanism at an ankle joint.

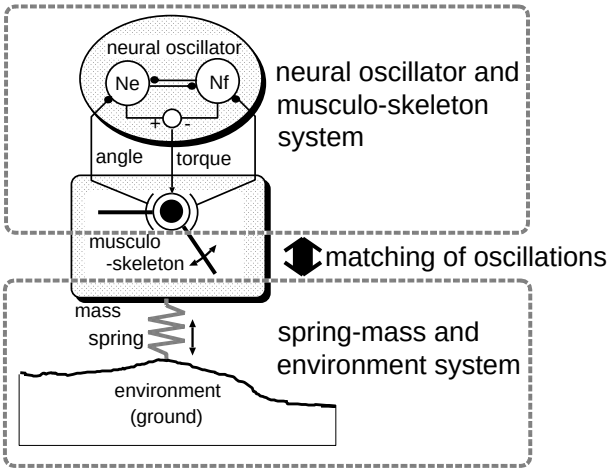

Fig.14 Matching of oscillations of two systems. One pair of oscillations includes the oscillation of the neural oscillator and that of the musculoskeletal system. Another pair includes the oscillation of the spring-mass system.

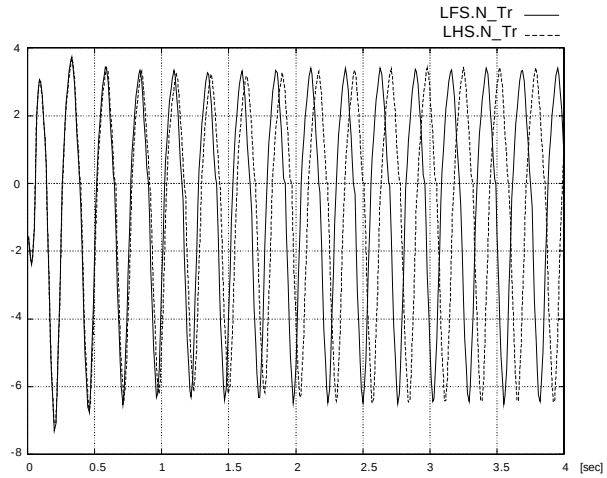

Fig.15 Results of the experiment involving the state transition from stationary standing to running in a pronk gait and the running gait transition from pronk to bound: *LFS.N_Tr* and *LHS.N_Tr* are joint torque of the hip joints of the left foreleg and left hindleg, respectively.

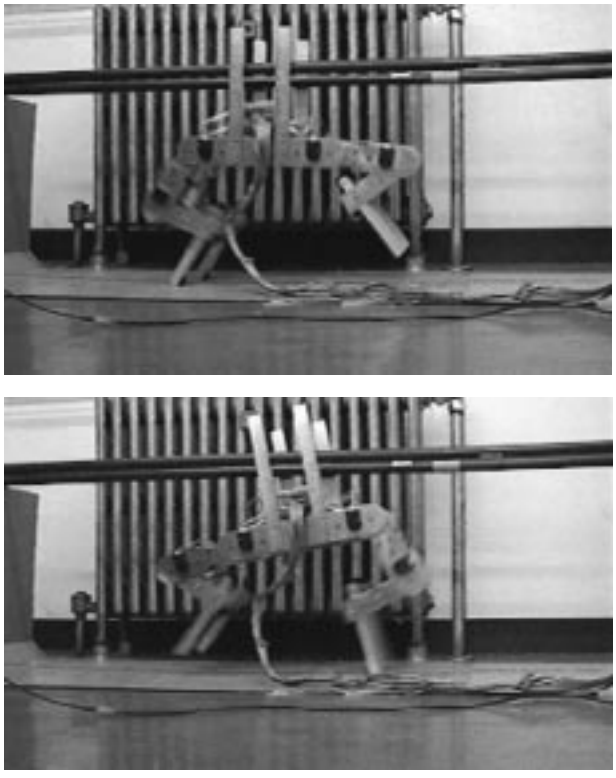

Fig.16 Photos of the quadruped running in a bound gait.