Generating Human-like Behaviors for Humanoid Robots Using Neural Oscillators

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In recent years, public concern about the serious aging society , welfare and nursing care in Japan. For such background, robot technology especially humanoid robots are standing in the center of attention. Humanoid robots have advantage that they can be directly used the tool and environment for human being. Moreover, we can feel kinship with them since humanoid robots have similar shape to human beings. There is the hope that humanoid robots active wide range sectors from daily life to welfare as care receiver is removed anxiety in the future.

Thus, humanoid robots have various possibilities. However, adaptive action generation is necessary under an unknown environment when actually thinking about use in daily life. Existing controller have to do modeling the controlled object and the environment, so generating of adaptive walking is very difficult. So robotics researchers pay attention Neural Oscillators now.

Humans or animals show marvelous ability of autonomous dynamic adaptation to the environment. This can be realized through the properly timed and coordinated action of their neuron-musculo-skeletal system. Thus, the so-called biologically inspired locomotion control base on central pattern generators (CPGs) which exist in spinal cord of humans or animal currently

gains increasing attention to realize human-like rhythmic locomotion in humanoid robots. The CPGs generate and sustain rhythmic movements activating the flexor and extensor neurons periodically, which are composed of networks of neural oscillators.

The Neural Oscillators is modeling of this CPG. Neural Oscillators changes own natural frequency accordingly a periodic continuation input, and tuned at the cycle of the input. This characteristic is called global entrainment. It has potential robustness, so can be generating biped locomotion. So, researchers pay attention this controller.

Thus, a lot of research is done for the stabilization of the biped locomotion of humanoid robots. On the other hand, a lot of present humanoid awkward walk such as have all appearances robots. In general, A lot of robots become awkward and a weak walking to turbulence because controlled that specifies the angle of the joint of each step is done by the high gain feedback of delay 0. Moreover, many researchers think the most important thing is not human-like walking which is entertainment but stability for use real environment. However, when we observe human's walking, we notice that using unstable power like gravity and inertia force, etc. When the body is advanced to forward, human doesn't carry forward it by only muscular power. Human is skillfully using gravity when he generates support leg motion. As we analyze the biped locomotion in detail, it is composed of the gyration. Since human can keep center of gravity high, we keep falling COG when walking. In this time, trunk moment by gravity is generating the falling motion of COG. This trunk moment make it possible to walk without generating needless energy. In addition, swing leg motion generation is using inertia force. f inferior limb is the same as the pendulum. The motion o First, rising the femoral is generating the acceleration. Secondly, as against it, the inferior limb is received the inertia force. In addition, downing the legs is the same it. By these forces, knee joint flexing or extending, so this joint is generating efficient motion.

It pays attention to this walking, and the passive walking is researched in recent years. Passive walking is applied a dynamic mechanism like chugging toy can be down slope without any power by using gravity . And this walking algorithm is said that energy efficiency is good.

Then in this research, I focused attention on this human walking com-

bining stability and instability and proposed walking generation method with using power like gravity and inertia force, etc. As control method, rolling motion generation is using Neural Oscillator in frontal plane, the support leg motion generation is using PD control and spring dump model connected virtually with environment and swing leg motion generation is using PD control and inertia force in sagjittal plane. However, the rolling motion doesn't undertake ensuring stability single-handed in this proposal technique.

I know that I separate frontal plane from sagjittal plane when generating motion for the simplification of the control, but actually the rolling motion is influenced by the pitching motion. For this approach, I control rolling motion using neural oscillator's good periodic follow-up and poor amplitude following capability. In addition, to obtain stability as the entire walking, I use swing leg's own weight, raising or downing leg and inertia force. Moreover, to achieve securing stability and generating thrust, the torque to stabilize the center of gravity position was allocated in each joint according to the virtual spring dump model. In addition, to use inertia force for the generation of swing leg motion, the torque was allocated by the PD control. By this technique, generated humanoid walking can use maximum knee extension, while old humanoid robots bent knee articulation to evade the significant point in the control of the angle of the joint. As a result, generated a smooth walking closed to human beings. In addition, I compare this walking result to human walk, and verify. As a result, generated walking form has characteristic of the level intermediate between infantile patterns and adult type. Moreover, according to the torque and the torque power compared, generated wave were obtained some common features in human walking. In addition, running a biped locomotion simulation on the floor including about 2 cm steps as disturbance.

As a result, robots recovered own posture and return regular walking.

From these results, the important thing to stabilize isn't just specializing only stabilization control but using unstable item for example gravity, inertia force, and etc.

If these results of study apply to humanoid robots, robot's walk is more and more humanly. Then humanoid will be going to find general acceptance with affinity in the future.