Generation of Robot Motion Based on Measurement of Human Movement

Susumu Sakano[1], Satoru Shoji[1]

1College of Engineering, Nihon University
1 Nakagawara Tokusada Tamura-machi Koriyama 963-8642 Japan
Tel; +81 24 956 8774, Fax; +81 24 956 8860, e-mail; sakano@mech.ce.nihon-u.ac.jp

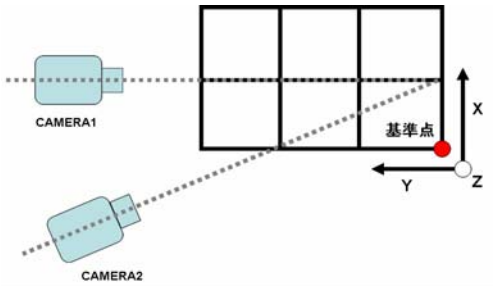
Abstract- The robot plays active part in the product field and the humanoid robot is intended to enter into our human life in near future. When the humanoid robot may enter into our daily life, the various problems are occurred and must be solved. One of the most important problems is how to moves like human and how to work like human. In this research, the human walking motions are measured using motion capture system and the simulation of the robot walking motion is carried out using the results of the motion capture measurements. It was confirmed that the humanoid biped robot can walk like the human walking from the experimental results.

1. Introduction

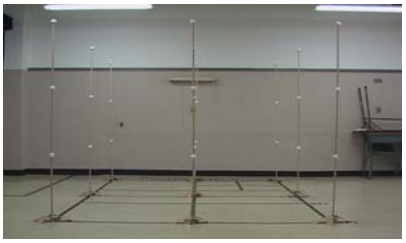
The industrial robots used in the manufacturing fields and the construction fields were the stream of the time, until now. However, the non-industrial robots called the personal robot at present have appeared in various fields. The human type robots and the animal type robots are developed as the non-industrial robots, and they are used in the fields such as the medical treatment and the welfare or in the fields such as the education and the entertainment. The operations of the robot have been practiced by the program of the numerical value input in the most of these robots. For example, the humanoid robot has multi-joints and in the operation, the controlled variables of each joint are unknown and the controls of each joint are also complicated. The robot motion is greatly different from the human motion in spite of making the motion of the robot by imitating as the human movement.
In this study, the walking of the biped robot is tried to carry out like the human walking. The human movements are measured using the motion capture system and the simulation of the walking motion is carried out using the measured results of the motion capture. The programs for the walking operation of the biped robot are created on the basis of the measured and simulated data. From the results of the experiments, it was confirmed that the robot can walk like human walking.

2. Motion capture system

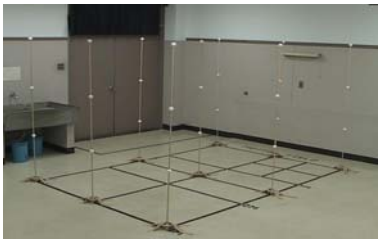
The motion capture is used in order to analyze the human walking motion. The data got by photographing the human motion using multi cameras and by measuring the motion using the sensors fixed to human body are incorporated and are analyzed in the computer. It is possible to calculate the angular variables, the moving distances and the moving speeds in the human moving by using the motion capture. The motion capture used in the study is a optical system. The makers are installed to the joint parts of the human body and the motions of the markers are photographed by the cameras.
The movements of the markers are calculated as the three-dimension data. The walking motions are photographed using DLT (Direct Linear Transformation) method in order to analyze the human motion in three dimensional spaces. The setting of the two cameras and the measuring space from the view of the cameras are shown in Fig. 1. The human moving image of each photograph by the two cameras is synchronized and the analytical moving image is created. The human walking motion is analyzed using the measured results of the motion capture. Then, the analyzed results are confirmed by the simulation of the human walking model.



(a) position of two cameras



(b) view from camera 1



(c) view from camera 2

Fig. 1 measuring space using two cameras

3. Experiments using motion capture

3.1 Results of motion capture and simulation

The three dimensional space for the measuring of the human walking is constructed as shown in Fig. 1. The human walking motions are photographed by the two video cameras in the above space. The photographed video is analyzed using Frame-DIAS. This Frame-DIAS is the analysis software of three dimensional video motions. The human walking motions are photographed as shown in Fig. 2.

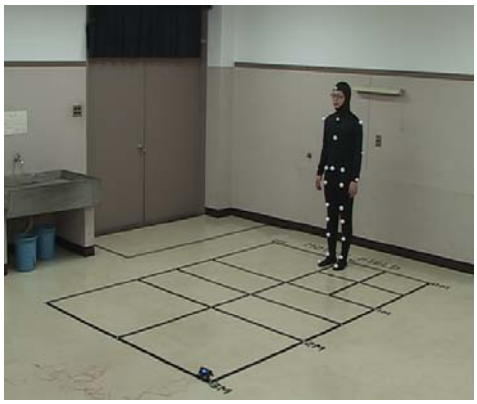


Fig. 2 measurement of human walking motion

The twenty six markers are installed on the body shown in Fig. 3 and using the photographs of these markers, the human walking motions are measured and analyzed. The motions are simulated using the robot model of 14 degree of freedom shown in Fig.4. The analytical program DADS is used in the simulation. The results of the simulation are checked with the results obtained in the motion capture. Then, the stick pictures of the human walking are made. One of the examples of the stick pictures is shown in Fig.

5. From the motions of the stick pictures, the robot motion program is constructed. The human walking and the stick picture motion are shown in Fig. 6 and Fig.7.

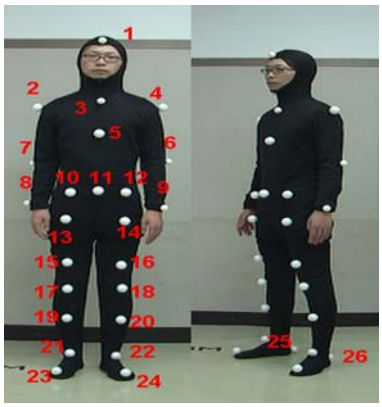


Fig. 3 markers non the human body

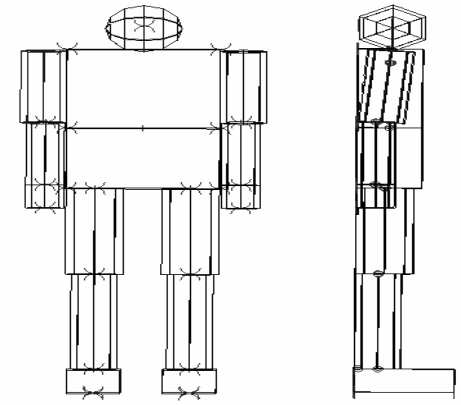


Fig. 4 simulation model of robot

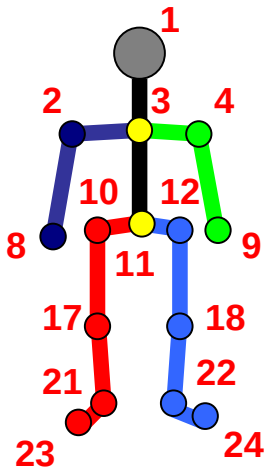


Fig. 5 stick picture

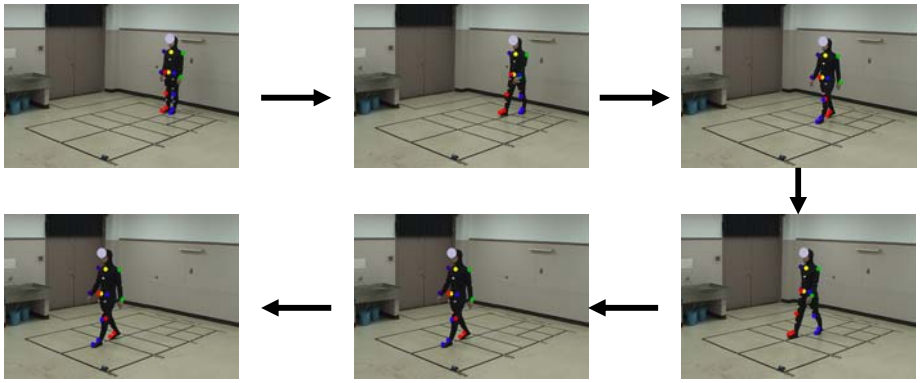


Fig. 5 human walking motions

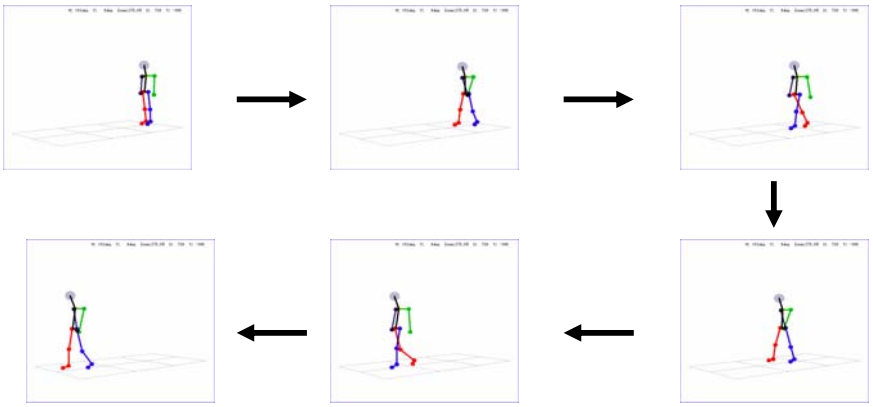


Fig. 6 stick pictures motions

3.2 results of experiments

The angular displacement of the swing of the both knees in the YZ plane is shown in Fig. 7 as one of the example of the experimental results. The angle of the knees is the angle between the arm and Y axis. The changes of the deflection angle of the knees are periodic. The knee angle shaken in the front is bigger than the angle shaken in the rear. Fig. 8 shows the walking pattern obtained from the analysis of the stick picture.

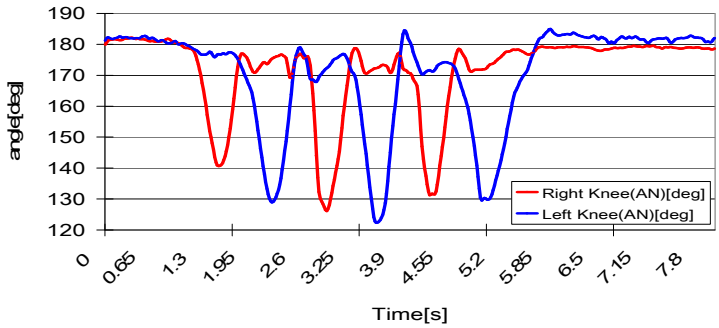


Fig. 7 angular displacement of knees

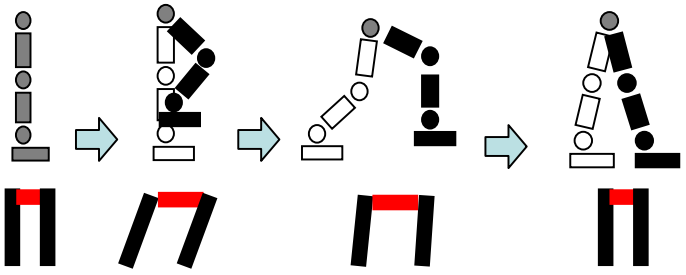


Fig.8 walking pattern of human walking

The walking experiments using the biped walking robot are shown in Fig.9. The program of the robot walking motions is generated from the analytical results above mentioned. The robot can walk similar to the human walking motion without overturning.

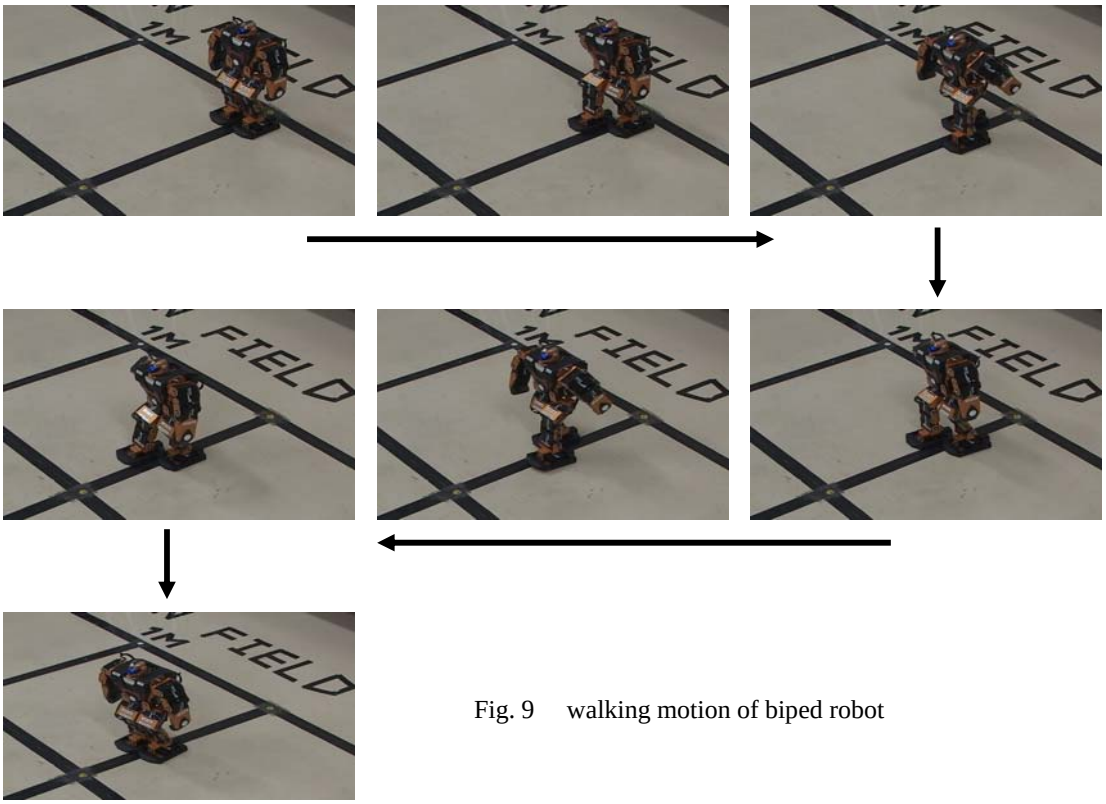


Fig. 9 walking motion of biped robot

4. Conclusions

The research for the robot motion closer to the human motion was studied. The human walking motion was measured and analyzed using the motion capture and the robot simulation. The generation of the robot walking motion was created base on these results. The validity of the analytical results was confirmed by the simulation. The results of the experiments were applied to the motion of the biped walking robot, and the robot motion which is almost similar to the human motion. The robot was able to walk like the human walking without overturning. However, the times of the robot motion were longer than the human motion.

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