Control of Snake Like Robot for Locomotion and Manipulation

M.Yamakita[1, 2], Takeshi Yamada[1] and Kenta Tanaka[1]

[1]Tokyo Institute of Technology, 2-12-1 Ohokayama, Meguro-ku, Tokyo, Japan, yamakita@ctrl.titech.ac.jp

[2]BMC, RIKEN, 2271-130, Anagahora, Shimoshidami, Moriyama-ku Nagoya, Japan

1. Introduction

Environment in which human being works has spread in the various directions by development of technology in recent years. In many cases, such field is accompanied with danger, then the necessity for work robots in such space is increased. Furthermore, the multi functional robot which can do many tasks is desirable in such environment. Therefore, development of the robot which has redundancy was investigated and developed, to name just a few. [1][2][3][4]

As a model of the snake type robot treated in this paper, it is assumed that the robot has passive wheels at each link and a friction coefficient to the tangent direction of the body link is 0 and normal one is infinity, i.e., the snake robots has constraints of not sliding to the normal direction of the wheels. (See Fig. 1)

In control of this type of the robot, singular avoidance of postures is one of the important problems where the singular posture means the state when it is impossible for a robot to move further. As typical examples, the shape of a straight line or arc are known.[6][5](Fig 2)

In the last paper, we proposed a winding control technique using a physical index of horizontal constraint force. [7] When it approaches a target point, it is necessary to raise a head and to work like a manipulator. However, depending on the number of links to raise, the degree of freedom may be insufficient or conversely redundant. Therefore, a technique of the head configuration control using a criterion function which is not influenced a number of links to raise was proposed.

Figure 1: A snake robot (SMA)

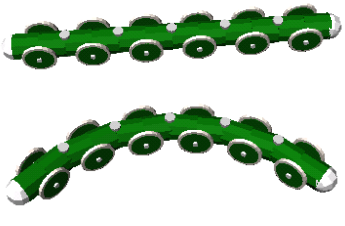

Figure 2: Singular posture

In order to show the validity of the proposed methods, we constructed a snake like robot called SMA (Super-Mechano Anaconda). Using the experimental system, we showed that the winding pattern with which the robot can avoid a singular posture is generated automatically, and head position and head configuration converge to a desired one. In this paper we summarized the last results and a control method of the winding just before raising the head for reaching to avoid falling down of the whole body. The validity of the proposed method is shown by numerical simulation.

References

[1] S.Hirose, Biomechanical Engineering, Kougyou Tyousa Kai, 1987

[2] S.Ma, W.J.Li, and Y.Wang: A Simulator to Analyze Creeping Locomotion of a Snake-like Robot, Proc. of IEEE ICRA01, pp. 3656/3663 (2001)

[3] I.A.Gravagne and I.D.Walker: On the Kinematics of Remotely-Actuated Continuum Robots, Proc. of ICRA'01, pp.2544/2550 (2001)

[4] Z.Y.Bayraktaroglu, F.Butel, P.Blazevic and V.Pasqui: A Geometrical Approach to the Trajectory Planning of a Snake-like Mechanism, Proc. IROS'99, pp.1322/1327 (1999)

[5] H.Date,Y.Hoshi and M.Sampei "Dynamic Manipulability of a Snake-Like Robot with Consideration of Side Force and its Application to Locomotion Control"Proc. AMAM'00,Montreal,Aug.8-12,2000

[6] P.Prautsch and T.Mita "Control and Analysis of the Gait of Snake Robots",IEEE,Int.Conf. on Control Applications,p.502-507,1999

[7] M. Yamakita et.al.: "Control of Locomotion and Head Configuration of 3D Snake Robot (SMA)", Proc. of ICRA'03