IECAT 2024 Conference

The 2nd International Electronic Conference on Actuator Technology

04-06 November 2024 | Online

MDPI

Basic Driving Characteristics of 2-DOF Soft Mechanism

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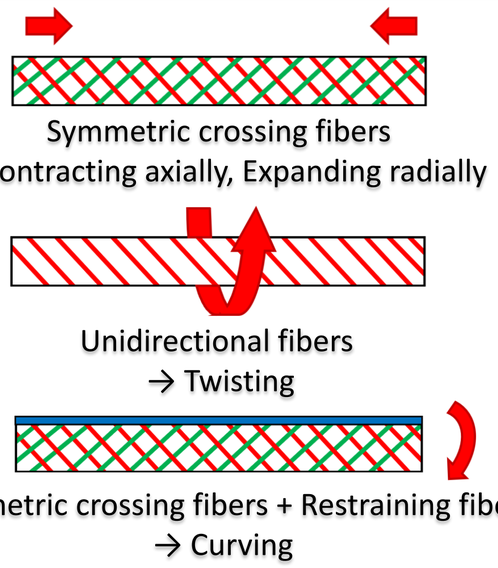
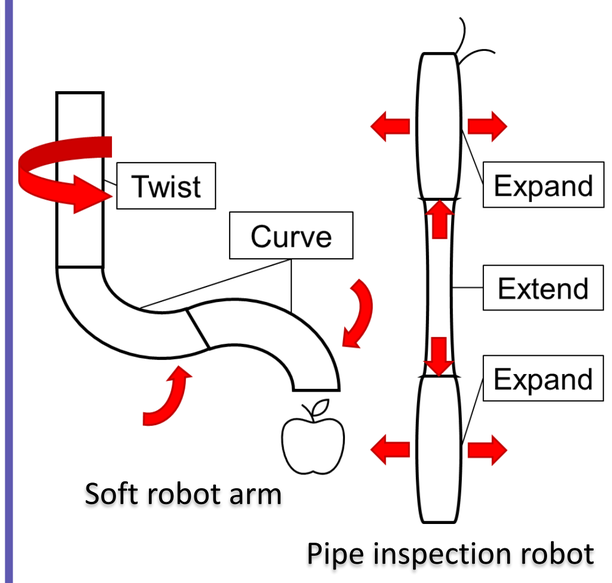
Introduction & Aim

Pneumatic artificial muscle[1][2]

Inner Rubber Tube + Reinforcement Fibers
How to reinforcement ⇒ Motion type



Cord-shaped soft mechanisms[2][3]



Achieving a variety of motions
by combining different artificial muscles

Problems

Complexity of manual fabrication

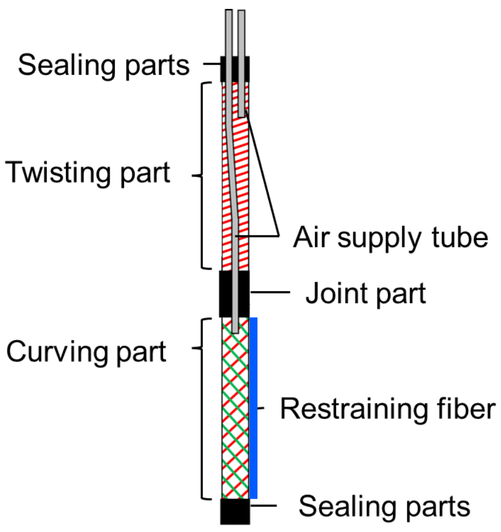
- **Fabrication of each artificial muscle one by one**
- **Bonding process of them**

Aim of this study

A braider machine Technology + **Water soluble fibers**

Simple fabrication process

Structure and Method



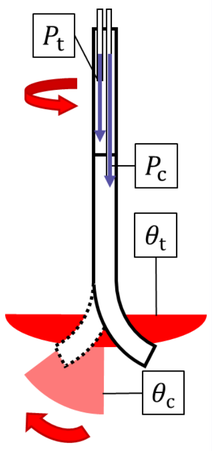
2-DOF soft mechanism

How to achieve twisting motion
→Unidirectional fiber removal

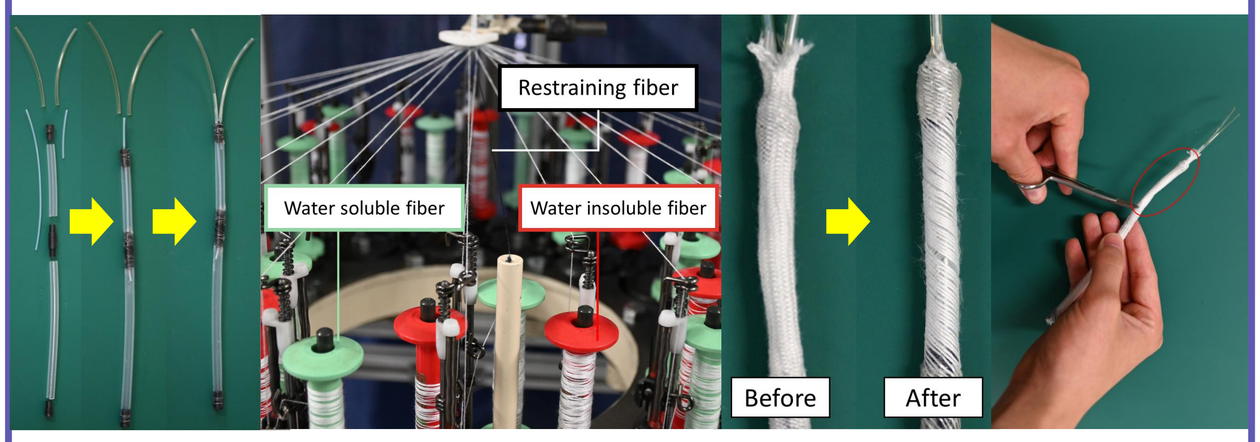
How to achieve curving motion
→Insertion of restraining fiber

Air pressure (Twisting, Curving)
→ P_t , P_c

Angle (Twisting, Curving)
→ θ_t , θ_c



Target motion	
P_t = 300 kPa	P_c = 300 kPa
θ_t = 360°	θ_c = 90°



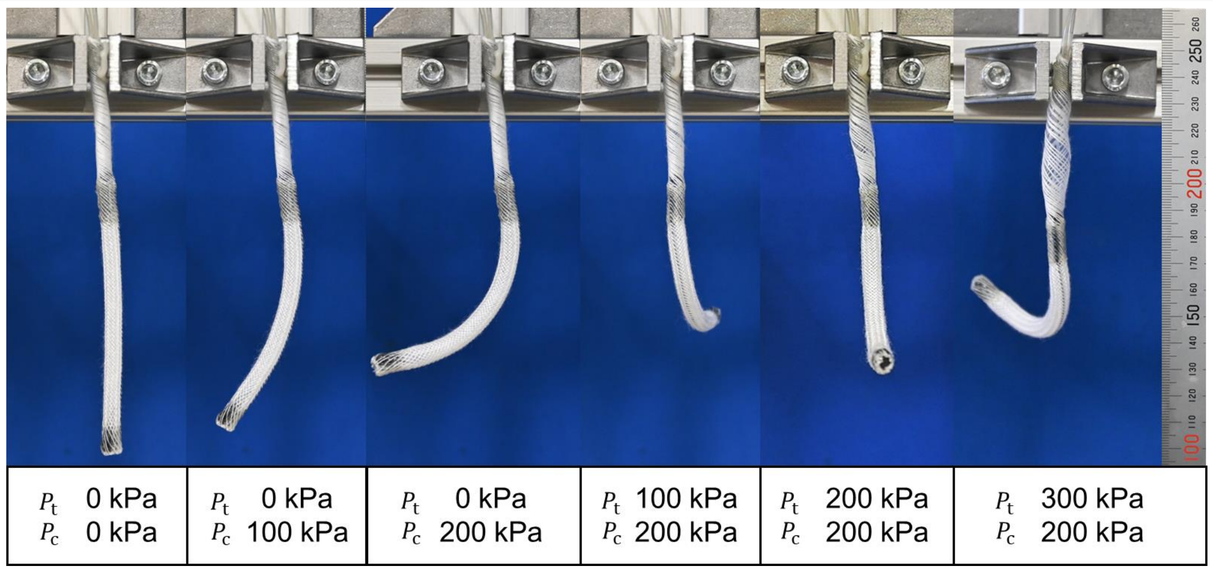
Making inner structure

Braiding of all fibers using a braider machine

Removal of water-soluble fibers from a twisting part

Removal of restraining fibers from a twisting part

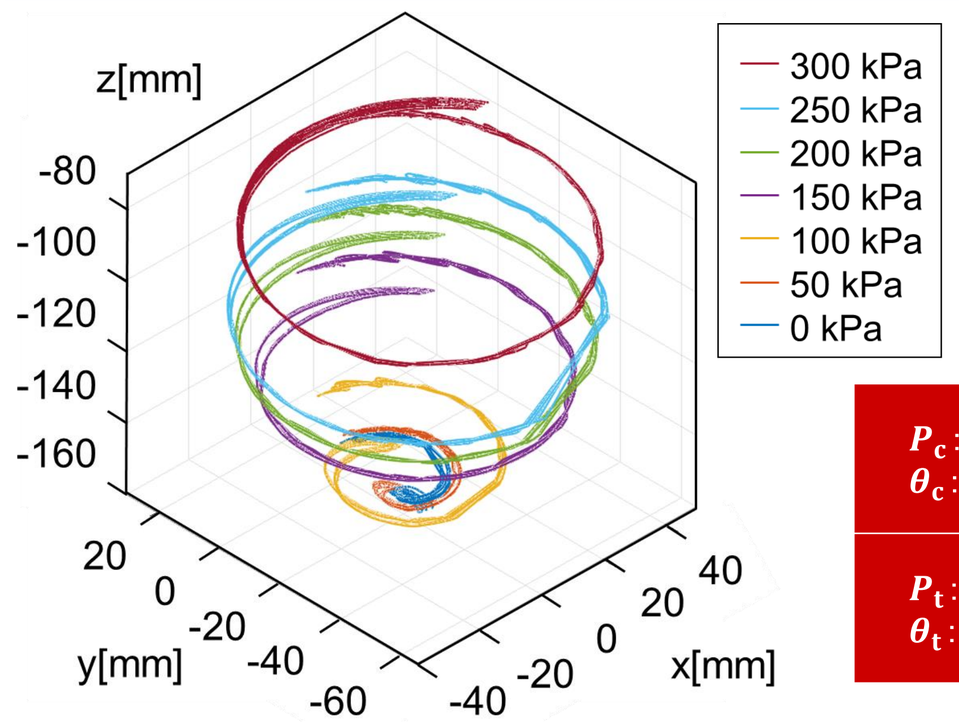
Motion and Characteristics



P_t 0 kPa P_c 0 kPa	P_t 0 kPa P_c 100 kPa	P_t 0 kPa P_c 200 kPa	P_t 100 kPa P_c 200 kPa	P_t 200 kPa P_c 200 kPa	P_t 300 kPa P_c 200 kPa

Air pressure condition

Twisting part P_t	Curving part P_c
Varying between 0 and 300 kPa	0 to 300 kPa in 50 kPa increments



P_c : 300 kPa
θ_c : 100°

P_t : 300 kPa
θ_t : 400°

Conclusion

- Easy Fabrication of a soft mechanism using this braider machine and water- soluble fibers
- Independent actuation of twisting and curving artificial muscles

Acknowledgements

- This study was partly supported by JKA through its promotion funds from KEIRIN RACE.

REFERENCES

[1] Tian, Weihang, Wakimoto, Shuichi, Yamaguchi, Daisuke, and Kanda, Takefumi, “Fabrication Process for Twisting Artificial Muscles by Utilizing Braiding Technology and Water-Soluble Fibers”, IEEE Robotics and Automation Letters, Vol.9-4, pp.3147-3154, (2024).

[2] Qinghua Guan, Jian Sun, Norman M. Wereley, and Jinsong Leng, “Novel Bending and Helical Extensile/Contractile Pneumatic Artificial Muscles Inspired by Elephant Trunk”, Soft Robotics, Vol.7, No.5, pp.597-614, (2020).

[3]Fionnuala Connolly, Panagiotis Polygerinos, Conor J. Walsh, and Katia Bertoldi, “Mechanical Programming of Soft Actuators by Varying Fiber Angle”, Soft Robotics, Vol.2, No.1, pp.26-32, (2015).