



香港中文大學
The Chinese University of Hong Kong

中大發明爬樹機械人
保養樹木 提高林業效率

爬樹機械人 Treebot

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Motivation

- Assist or replace human's forestry works



Autonomous Tree Climbing

- Method of environment exploration?
- How inchworms navigate?
 - Tentacles
 - Not rely much on vision
 - Simple in processing



Inchworm-like Robot: Treebot

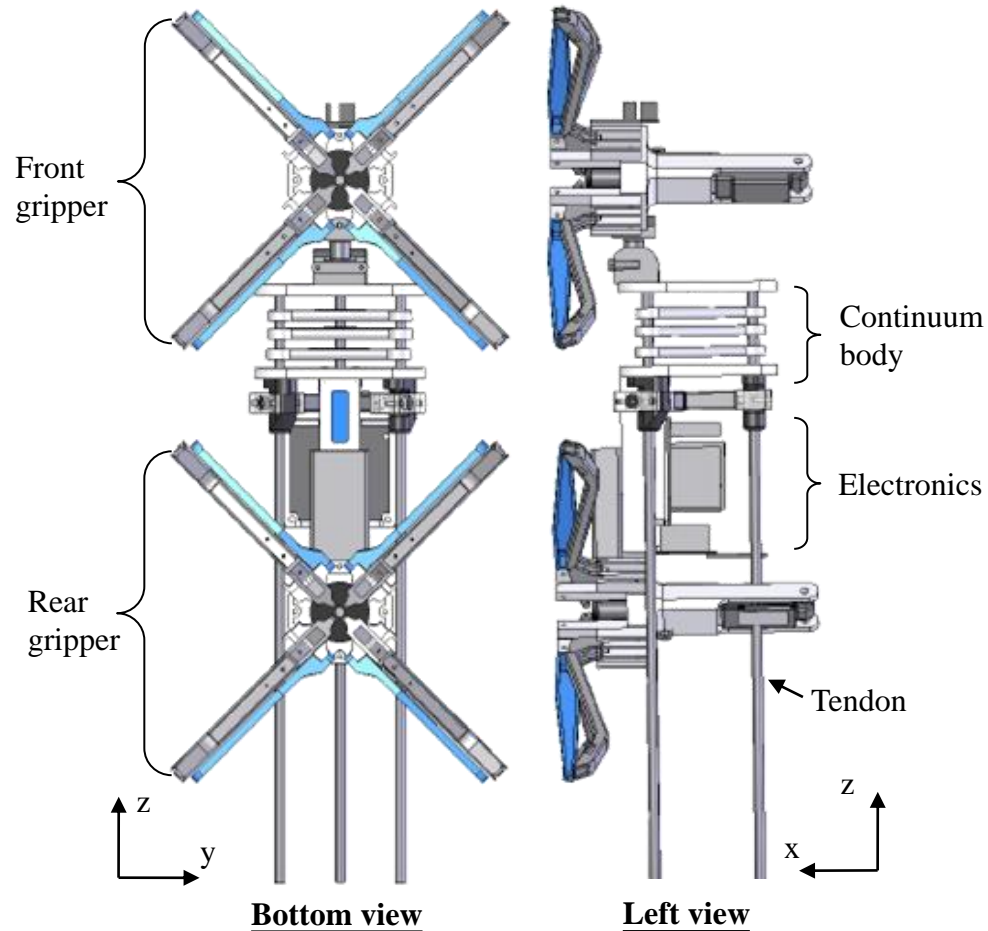
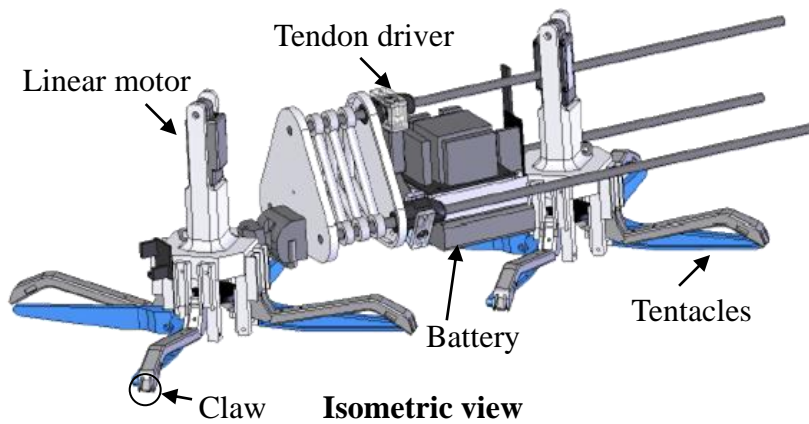


- **High maneuverability**
 - Large workspace
 - Capable of climbing from a tree trunk to a branch
- **High adaptability**
 - A wide range of gripping curvatures
 - Capable of climbing many types of trees
- **Lightweight and compact**
 - 600g; 370(L) X 175(W) X 135(H) mm³
- **High payload capacity**
 - 1.75kg



Structure of Treebot

- **Continuum body**
 - Extendable & Bendable
- **Tree gripper**
 - Adaptive to a wide range of gripping curvature



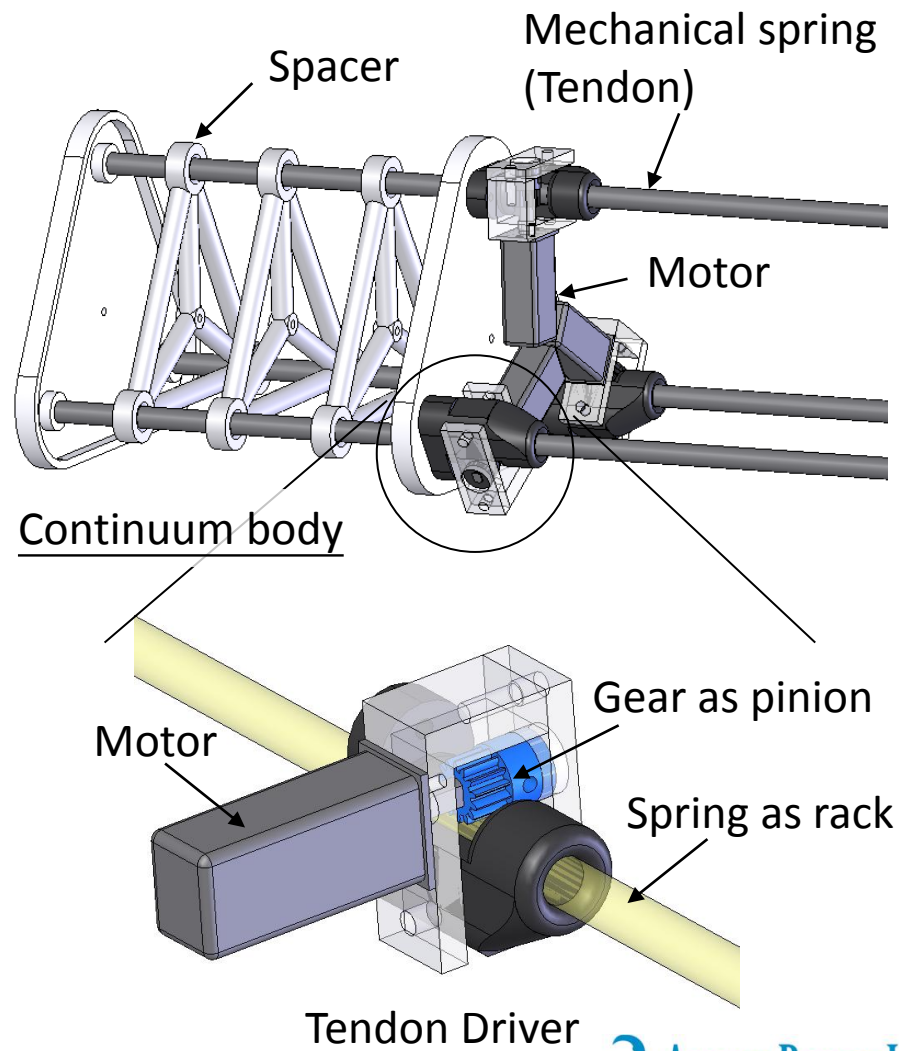
A Novel Continuum Body

- **Design**

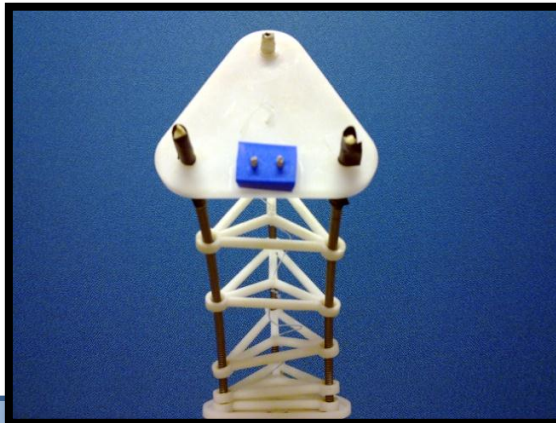
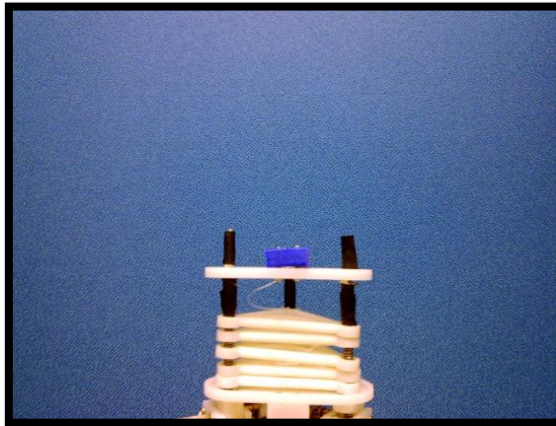
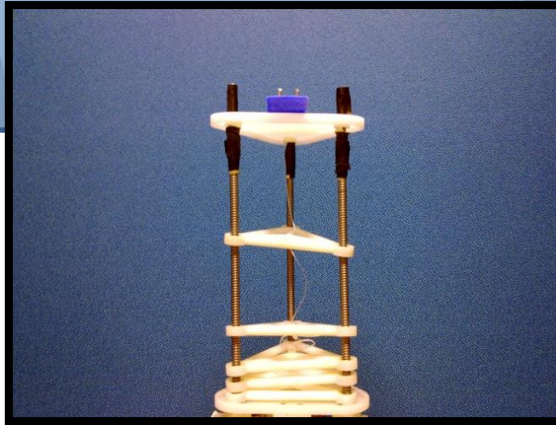
- 3 bendable tendons
- 3 actuators to control the length of tendons
- Rack and pinion driving mechanism

- **Features**

- Extendable and bendable
- DOF = no. of actuators (compact)

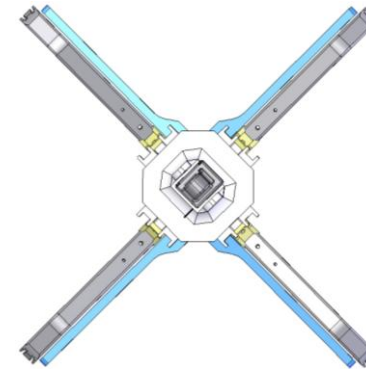


Continuum Body

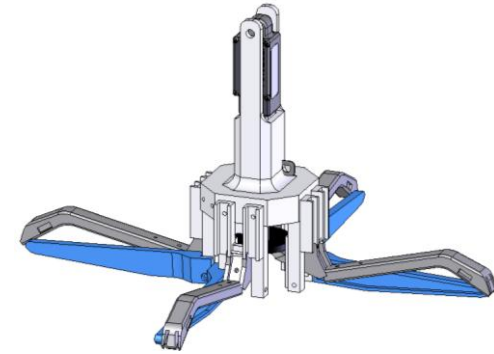


Features of the Tree Gripper

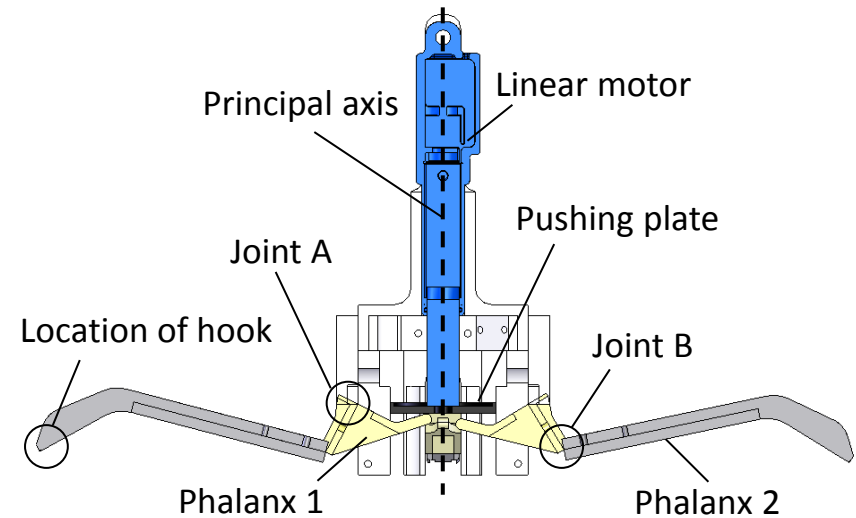
- **Compact & lightweight**
 - Actuated by single actuator
- **Adaptive to irregular shape**
 - Each claw is mechanically decoupled
- **A wide range of gripping curvatures**
 - The generated directional force is optimized
- **Zero energy consumption in static gripping**
 - Gripping force is provided by preloaded mechanical spring



Top view



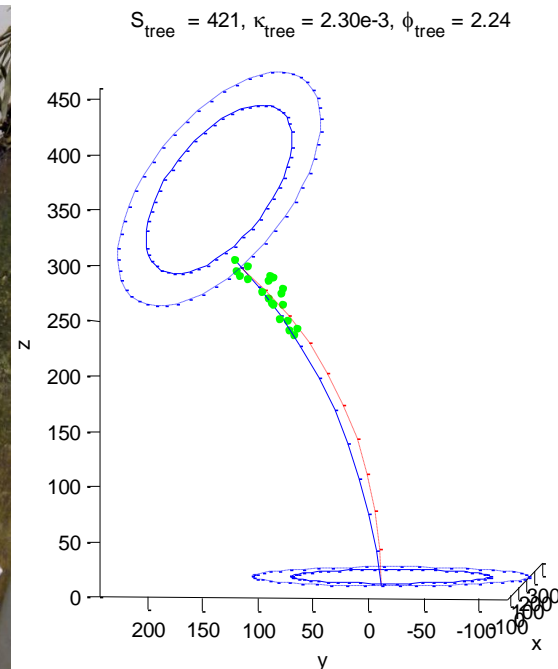
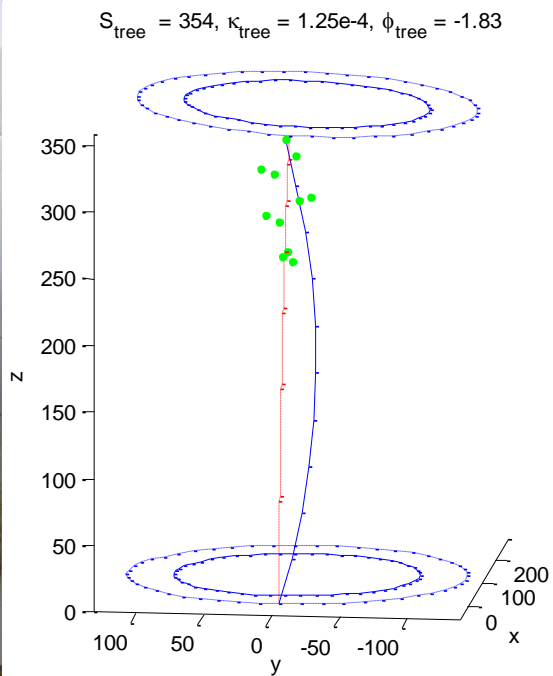
Isometric view



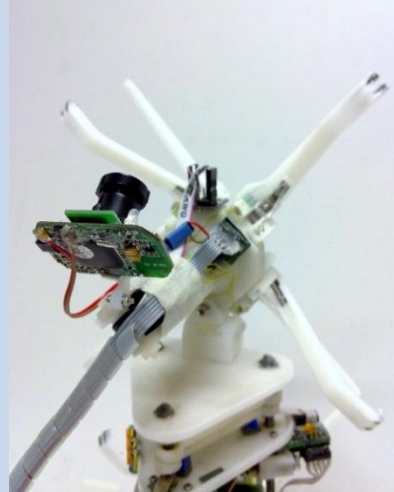
Cross-sectional view



Tentacles Exploring & Tree Shape Reconstruction

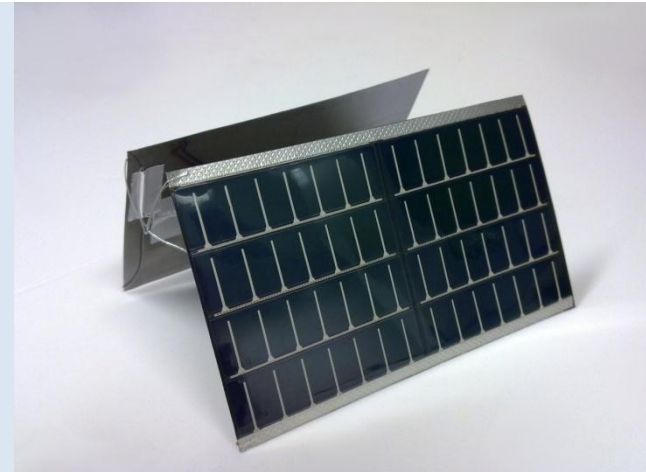
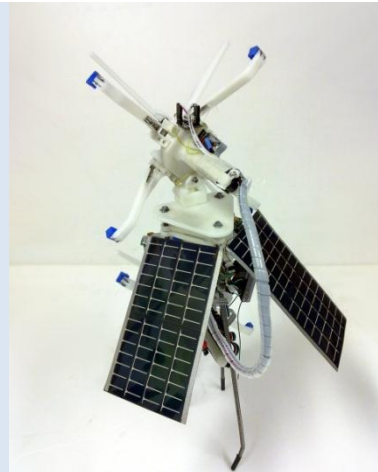


Equipment



- Wireless camera
- 12 grams

- Photovoltaic modules
- 10.9 grams (1Watt)



Climbing on Different Types of Trees



Tree	Perimeter (cm)	No. of steps (Success / Total)
Bauhinia variegata	81cm	20/20
Delonix regia	97cm	20/20
Bombax malabaricum	142cm	20/20
Callistemon viminalis	99cm	20/20
Roystonea regia	102cm	20/20
Bauhinia blakeana	25cm, 65cm	20/20
Araucaria heterophylla	87cm	20/20
Acacia confuse	72cm	20/20
Grevillea robusta	50cm	20/20
Bambusa ventricosa	20cm, 30cm	20/20
Cinnamomum camphora	66cm, 92cm	13/20
Bambusa vulgaris var. Striata	31cm	1/5
Melaleuca quinquenervia	140cm	0/5



Payload Test

- Climb with 1.75kg payload (*Treebot weighs 600g*)



Climbing Performance (Video)



(x6 speed)



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Other Tree Climbing Robots



WOODY 2006



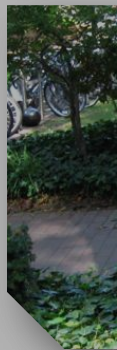
Treebot



Other Robots



R 2006

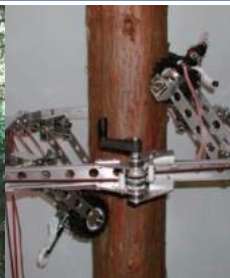


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Comparison

(/ = Unknown)



	Treebot	Woody	Pruning Robot	RiSE V2	RiSE V3	CPR
Weight (kg)	0.8	1.2	1.5	2.0	5.4	/
Payload capacity (kg)	1	1	1	1	/	/
Height (mm)	150	150	150	150	/	/
Width (mm)	150	150	150	150	275	/
Length (mm)	370	750	400	500	980	/
Runtime (minutes)	10	10	10	10	30	/
Climb-up speed (mm/min)	1000	1000	1000	1000	2600	333
Adaptable tree diameter (mm)	63-150	100-150	100-150	100-150	250 < /	/
Number of actuators	8	8	8	8	8	14
Workspace	Curved trunk and branches	Straight trunk	Straight trunk	Straight trunk	Straight trunk	Slightly curved trunk

Lightest

Smallest

Highest adaptability

Highest maneuverability

Highest weight to payload ratio





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THANK YOU