

# Monorail-Like Gripper System with Dynamic and Modular Reconfiguration for Diverse Finger Layouts

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**Abstract**—Robotic grasping requires flexible reconfiguration to handle diverse objects and tasks. This paper proposes a monorail-like reconfiguration framework for robotic grippers, inspired by train–rail relationships, that generates diverse finger layouts. The proposed framework unifies two complementary forms: dynamic reconfiguration, in which finger units move along an arbitrary non-circular track defined by the palm shape (palm track) to change the finger layout, and modular reconfiguration, in which the palm track shape and the number of fingers are modified to alter the achievable finger layout space. We developed a prototype gripper system that embodies the proposed framework and experimentally validated its unified reconfiguration capability. Dynamic reconfiguration with the S-shaped palm achieved seven distinct finger layouts with successful object grasping, while on-the-fly modular reconfiguration expanded the achievable finger layout space, enabling rapid adaptation to different grasping tasks. This work establishes a new design principle for reconfigurable grippers toward highly adaptive and versatile robotic grasping.

## I. INTRODUCTION

Robotic grippers can be classified into two types based on finger layout relative to the palm: fixed-type grippers, in which the finger layout is fixed [1]–[8], and reconfigurable-type grippers, in which actuators allow the finger layout to be changed. As shown in Fig. 1(a), fixed-type grippers have a simple mechanism but limited grasping capability. In contrast, reconfigurable-type grippers incorporate additional mechanisms for finger movement, enabling task-adaptive finger layouts. Fig. 1(b) shows representative reconfigurable-type grippers [9]–[18], in which actuators are mounted on the palm and each finger is connected to the actuator output shaft via a link, producing arc-shaped finger motion. For instance, a three-fingered gripper with independently rotating fingers [9] and a four-fingered gripper with two independently rotating finger pairs about the palm center [10] have been developed. In such link-constrained designs, the motion range is typically limited to less than a half turn due to link interference. Fig. 1(c) shows a reconfigurable-type gripper with actuator-integrated link-constrained finger units that can achieve rotations exceeding one full turn

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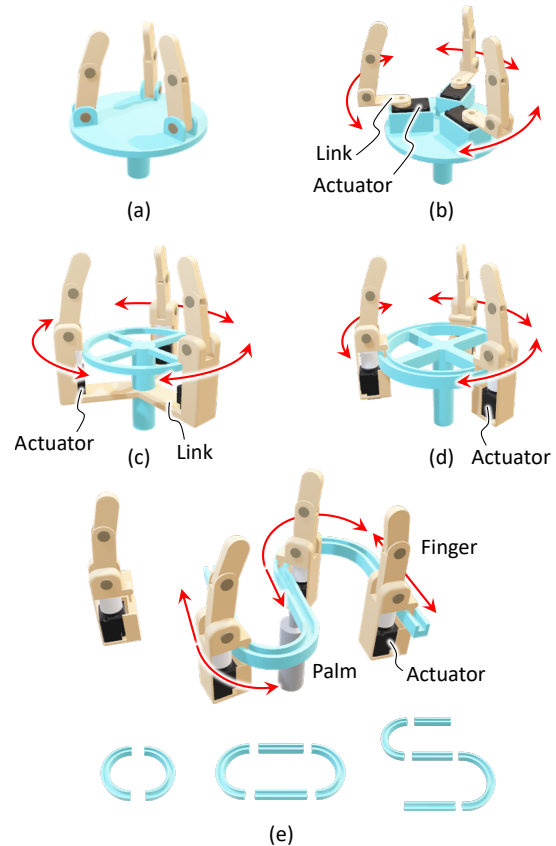


Fig. 1. Classification of grippers based on finger layout reconfigurability: (a) fixed type and (b)–(e) reconfigurable types. (b) Fingers are constrained by connecting links, with all actuators mounted on the palm. (c) Each finger has an actuator but remains link-constrained. (d) Each finger has an actuator and is link-free. In (b)–(d), finger units move only along circular tracks. (e) Proposed monorail-like reconfiguration framework: finger units move independently along a non-circular palm track (*dynamic reconfiguration*), while the palm track shape and the number of finger units can be modified (*modular reconfiguration*); together, enabling diverse finger layouts.

[19]. Fig. 1(d) presents a link-free design that enables easy attachment and detachment of finger units [20], in which finger unit movement is still confined to a circular track along the palm. Despite these variations, finger unit motion in most existing reconfigurable grippers remains confined to circular tracks. Enabling link-free finger units to travel along arbitrary non-circular tracks would diversify finger layouts and expand grasping strategies.

Based on this concept, we propose a novel reconfigurable gripper system for generating diverse finger layouts. We introduce a monorail-like reconfiguration framework for robotic grippers, inspired by train–rail relationships, as

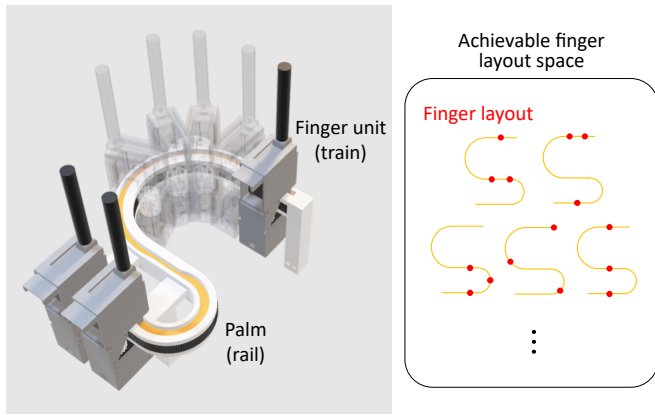


Fig. 2. Gripper with a monorail-like finger movement mechanism enabling *dynamic reconfiguration*. Multiple finger units move independently along a non-circular track defined by the palm shape (palm track) to change the finger layout. In modular reconfiguration, the palm track shape and the number of fingers are modified to alter the achievable finger layout space.

shown in Fig. 1(e). The framework unifies two complementary forms of reconfiguration. In dynamic reconfiguration, multiple finger units move independently along an arbitrary non-circular track defined by the palm shape (palm track) to change the finger layout. In modular reconfiguration, the palm track shape and the number of fingers are modified to alter the achievable finger layout space. We developed a prototype gripper system that embodies the proposed framework and experimentally validated its unified reconfiguration capability. Using non-circular palm tracks, we demonstrate diversification of finger layouts and corresponding object grasping. Notably, dynamic reconfiguration with the S-shaped palm achieves seven distinct finger layouts, while on-the-fly modular reconfiguration expands the achievable layout space and enables rapid adaptation to different grasping tasks. These results confirm the effectiveness and versatility of the proposed framework.

## II. MONORAIL-LIKE RECONFIGURABLE GRIPPER SYSTEM

We employ a reconfiguration framework inspired by the train–rail relationship in a monorail system. The gripper incorporates a finger movement mechanism that enables reconfigurable positioning of finger units, as shown in Fig. 2, where the finger units and palm correspond to the train and rail, respectively. Based on this gripper architecture, a monorail-like gripper system is constructed from reconfigurable modules, analogous to assembling tracks and trains, as shown in Fig. 3. These illustrations show the prototype system; details are provided in the next section. In the proposed framework, a finger layout represents the instantaneous state of the gripper. The achievable finger layout space is defined as the set of all possible finger layouts for a given palm track shape and number of finger units. The reconfiguration framework unifies two complementary forms, as follows:

*Dynamic Reconfiguration:* As shown in Fig. 2, each finger unit is equipped with an actuator and a power transmission mechanism that enables independent motion along the palm

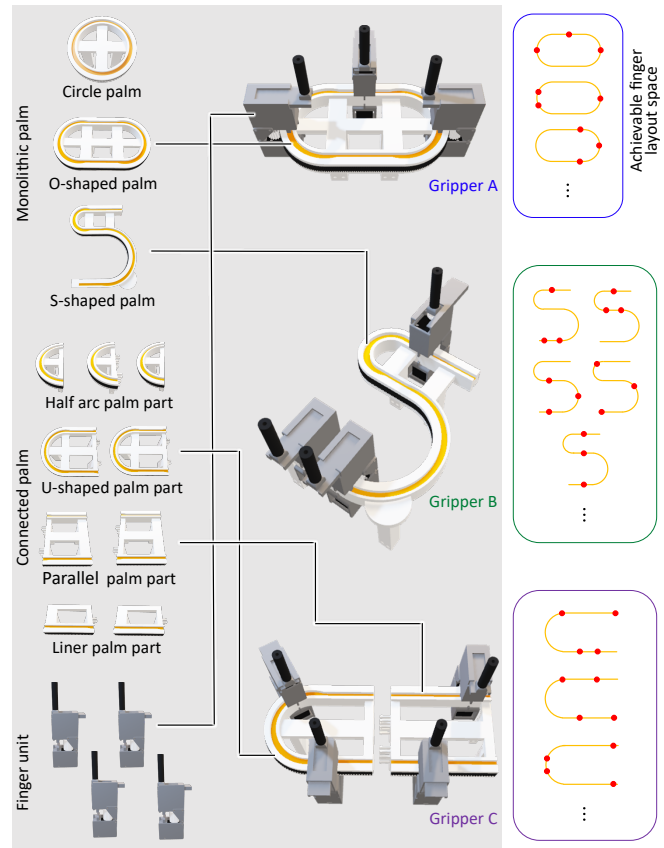


Fig. 3. Monorail-like gripper system enabling *modular reconfiguration*. By modifying the palm track shape and the number of finger units, the system alters the achievable finger layout space.

track, allowing dynamic reconfiguration of the finger layout on a given track. In conventional reconfigurable grippers, whether link-constrained or link-free, finger unit movement is generally limited to circular or arc-shaped tracks. In contrast, the proposed mechanism enables finger units to travel along an arbitrary non-circular track, thereby realizing dynamic reconfiguration beyond circular motion constraints.

*Modular Reconfiguration:* Building on this non-circular track capability, the system supports modular reconfiguration through exchanging or recombining palm parts and by adding or removing finger units, as shown in Fig. 3. This form of reconfiguration is founded on an innovative reconfigurable track concept, in which the palm track itself is modularized and can be reshaped by assembling palm components of different geometries. Two palm types are used: monolithic palms, which are single pieces with high stiffness but fixed tracks, and connected palms, which are assembled from multiple parts to allow rapid modification of the palm track, although the stiffness at the couplings is reduced. The palm track must be continuous and smooth and form a simple curve without self-intersections; it need not be closed. By selecting palm parts and finger units, the achievable finger layout space is altered, enabling layouts not attainable through dynamic reconfiguration alone.

The proposed gripper system integrates dynamic reconfig-

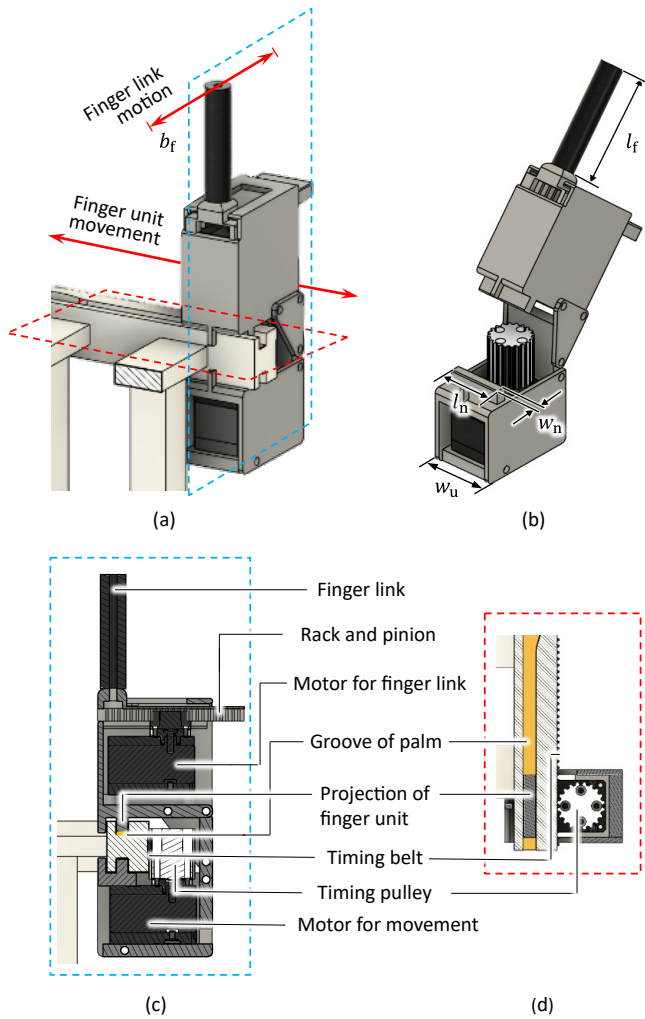


Fig. 4. Design of the finger unit. (a) Closed state attached to the palm. (b) Open state. (c) Vertical cross-section. (d) Horizontal cross-section.

uration, which changes the finger layout by moving finger units along a given palm track, with modular reconfiguration, which alters the achievable finger layout space by reshaping the palm track and adjusting the number of finger units. These complementary forms together support diverse finger layouts across a wide range of tasks.

### III. PROTOTYPE

We developed a prototype of the proposed gripper system. This section describes the mechanical design, modular components, and motion characteristics of the finger unit.

#### A. Finger Unit

Fig. 4 shows the detailed design of the finger unit. The parameters are listed in TABLE I. Figs. 4(a) and (b) illustrate the closed state attached to the palm and the open state. The unit opens and closes about a central hinge, enabling quick attachment and detachment. Figs. 4(c) and (d) show vertical and horizontal cross sections. A projection–groove engagement constrains the finger unit to one degree of freedom along the palm track. A timing pulley mechanism drives

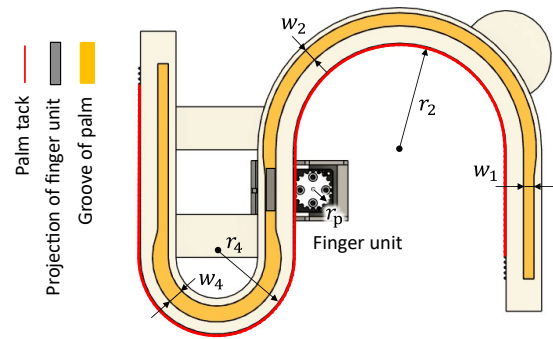


Fig. 5. Design of the palm (e.g., S-shaped monolithic palm).

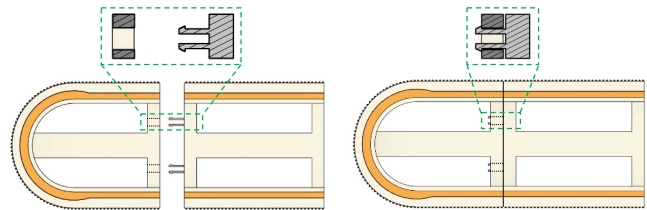


Fig. 6. Connected palm formed by snap-fit coupling of palm parts.

the unit along the track. A timing belt (Mitsubishi Belting Ltd., Standard Belt 100S3M900G) runs along the palm and is connected to a servo motor (ROBOTIS, DYNAMIXEL XC330-T288-T) mounted at the lower part of the finger unit, moving the unit via pulley rotation. The upper part contains a finger link actuated by a rack-and-pinion mechanism and a servo motor of the same type, providing one translational degree of freedom perpendicular to the finger unit movement along the palm track. The silicone finger link offers elasticity and friction for grasping. Power and control cables are routed with sufficient length to avoid interference during motion.

#### B. Palm

Fig. 5 shows the palm design, with an S-shaped monolithic palm as an example. TABLE I lists the parameters, and the red solid line indicates the track for finger unit movement. One side wall of the palm aligns with the palm track, along which the timing belt is attached. A central groove engages with the projection of the finger unit. The groove width and minimum curvature radius are determined by the projection geometry; a rectangular projection requires a wider groove for tighter curvature. The palm is fabricated from polylactic acid (Pxmalion PLA) using 3D printing. Fig. 6 shows a connected palm in which two parts are joined by quick snap-fit couplings. Improving the robustness of these couplings is important for practical use.

#### C. Developed Modular Components

The prototype system included modular components shown in Fig. 3. Four finger units with identical specifications were developed. For monolithic palms, circular, O-shaped, and S-shaped palms were fabricated. For connected

TABLE I  
DESIGN PARAMETERS OF THE FINGER UNIT AND PALM.

$w_u$	Width of finger unit body	26.0 mm
$w_n$	Width of engagement projection	24.0 mm
$l_n$	Length of engagement projection	4.8 mm
$l_f$	Length of finger link	50.0 mm
$b_f$	Stroke of finger link	43.0 mm
$w_1$	Groove width at linear section	5.0 mm
$w_2$	Groove width at smaller-curvature arc section	6.1 mm
$w_4$	Groove width at larger-curvature arc section	7.5 mm
$r_2$	Radius of smaller-curvature arc section	50.0 mm
$r_4$	Radius of larger-curvature arc section	35.0 mm
$r_{min}$	Minimum radius of curvature of palm track	20.0 mm
$r_p$	Radius of timing pulley	9.4 mm
$v_{max}$	Maximum velocity of finger unit	57.4 mm/s

palms, three half arc, two U-shaped, two linear, and two parallel palm parts were fabricated.

#### D. Motion Characteristics of Finger Unit

In dynamic reconfiguration, each finger unit moves along the palm track defined by the palm shape. To describe this motion quantitatively, we introduce a coordinate  $s$  along the palm track, where one end is  $s = 0$  and the other is  $s = s_e$  (Fig. 5). Fig. 7(a) shows the curvature  $\kappa$  as a function of  $s$  for the S-shaped palm. The relationship between the finger unit position  $s$  and the pulley angle  $\phi$  is given by

$$\phi(s) = \begin{cases} \frac{s}{r_p} & (0 \leq s \leq s_1) \\ (s - s_1)\left(\frac{1}{r_p} - \kappa(s)\right) + \phi(s_1) & (s_1 < s \leq s_2) \\ \frac{s - s_2}{r_p} + \phi(s_2) & (s_2 < s \leq s_3) \\ (s - s_3)\left(\frac{1}{r_p} + \kappa(s)\right) + \phi(s_3) & (s_3 < s \leq s_4) \\ \frac{s - s_4}{r_p} + \phi(s_4) & (s_4 < s \leq s_e) \end{cases} \quad (1)$$

where  $r_p$  is the pulley radius and  $\phi = 0$  at  $s = 0$ . Substituting a desired position  $s_d$  into (1) yields the corresponding pulley angle  $\phi_d$ . Figs. 7(b) and (c) show preliminary experiments in which the unit moved from  $s = 0$  to  $s_d = s_e$  at constant velocities  $v_d = \{24.6, 36.8, 49.2\}$  mm/s. Fig. 7(b) plots the measured position over time, and Fig. 7(c) shows the trajectory on the palm track for  $v_d = 49.2$  mm/s. The position was measured using an overhead camera. As shown in Fig. 7(b), the position error increased with velocity and was approximately independent of palm track curvature. This suggests that slippage between the pulley and belt was the primary error source. The mechanism is therefore sensitive to external disturbances. Future work will improve mechanical robustness and incorporate sensing to measure the finger unit position relative to the palm.

## IV. EXPERIMENTS

The proposed system was experimentally validated, as demonstrated in the supplementary video. Dynamic reconfiguration with non-circular palms generated diverse finger layouts and enabled various object grasps<sup>1</sup>. Modular recon-

<sup>1</sup>This paper does not discuss the exact correspondence of each grasp configuration to grasp theories such as form closure, force closure [21], and caging [22].

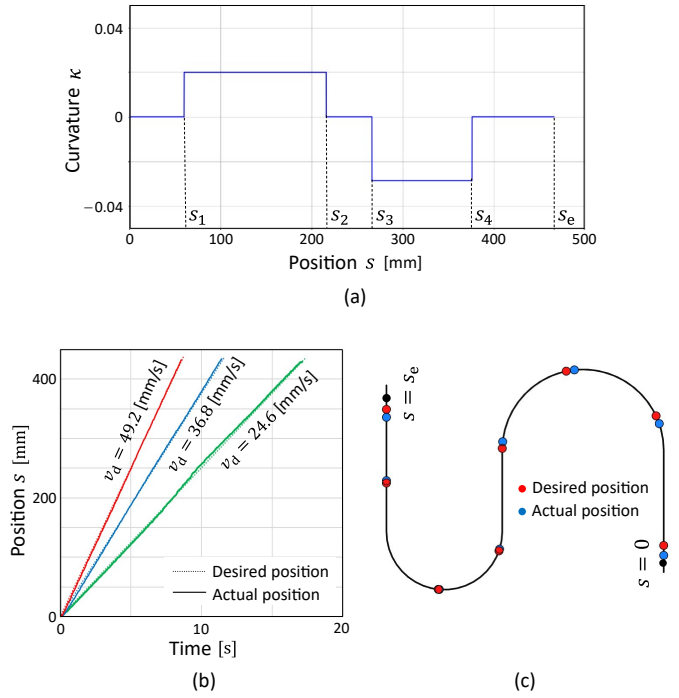


Fig. 7. Preliminary experiment on the finger unit movement. (a) Curvature  $\kappa$  with respect to position  $s$  along the palm track of the S-shaped palm. (b) Finger unit position with respect to time. (c) Finger unit position along the palm track.

figuration expanded the achievable finger layout space for task adaptation.

#### A. Dynamic Reconfiguration

1) *O-Shaped Palm*: Fig. 8(a) shows a gripper with an O-shaped monolithic palm and three finger units. The gripper was mounted as the end-effector of a robot arm (UNIVERSAL ROBOTS, UR5e). Experiments were conducted to evaluate dynamic reconfiguration in generating diverse finger layouts and performing object grasps. Fig. 8(b)–(f) show five finger layouts and corresponding grasps. Finger layouts are regarded as distinct when they differ in geometric configuration (opposing, enveloping, or linear) or in scale. Note that, from a given finger layout, the fingertip can achieve instantaneous two-DOF motion through the combined finger unit and finger link motions for object grasping. In each subfigure of Fig. 8, the top row shows the finger layout (red points) on the palm track (yellow line) and the assumed target object (green dotted line), while the middle and bottom rows show the realized finger layout and the corresponding grasp in the experiment, respectively. Fig. 8(b) shows a narrow opposing finger layout with grasping of a slender cylinder (pen). Fig. 8(c) shows a wide opposing layout with grasping of a wide rectangular object (tissue box). Fig. 8(d) shows a small enveloping layout with grasping of a small cylinder (spray can). Fig. 8(e) shows a large enveloping layout with grasping of a large cylinder (biscuit tin). Fig. 8(f) shows a linear layout with grasping of two objects simultaneously, achieved solely by finger unit movement along the track.

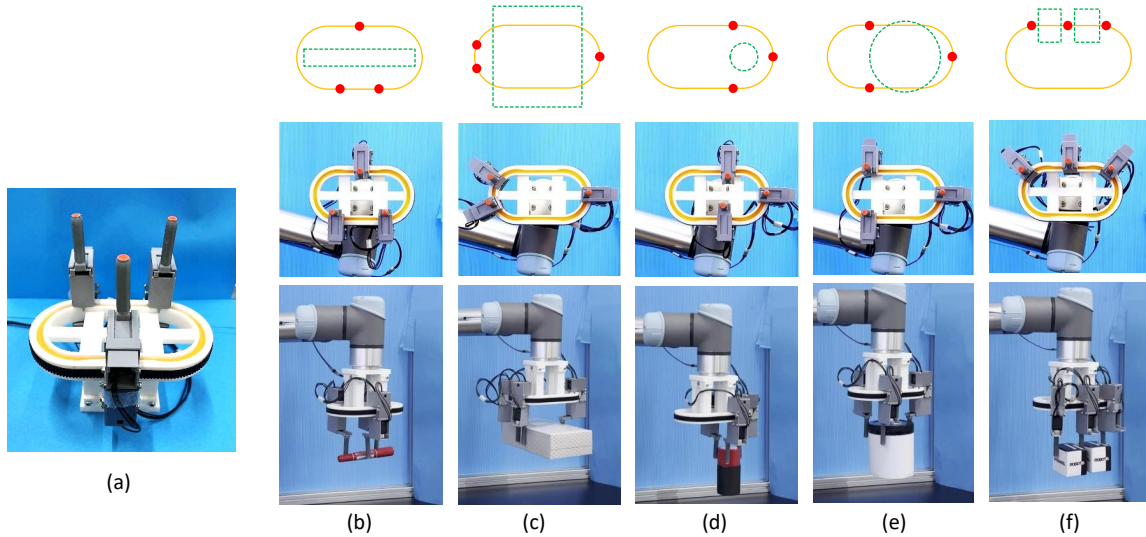


Fig. 8. Dynamic reconfiguration with the O-shaped palm, showing five finger layouts and corresponding grasps. (a) Gripper with an O-shaped monolithic palm and three finger units. (b) Narrow opposing finger layout. (c) Wide opposing finger layout. (d) Small enveloping finger layout. (e) Large enveloping finger layout. (f) Linear finger layout.

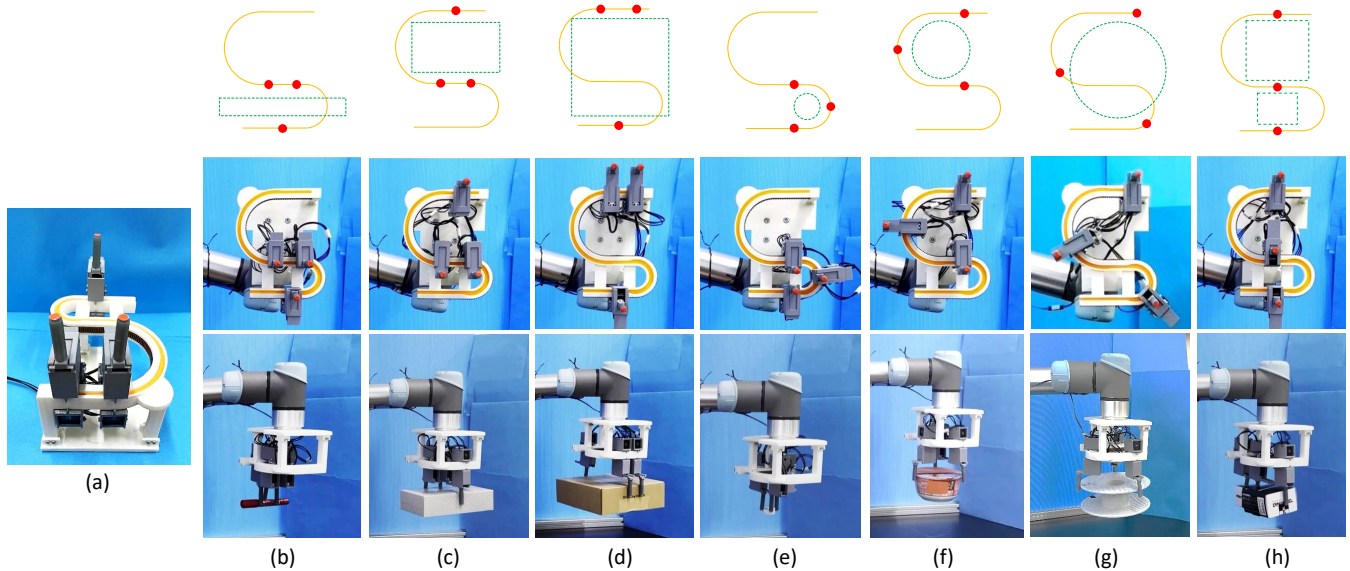


Fig. 9. Dynamic reconfiguration with the S-shaped palm, showing seven finger layouts and corresponding grasps. (a) Gripper with an S-shaped monolithic palm and three finger units. (b) Narrow opposing finger layout. (c) Medium opposing finger layout. (d) Wide opposing finger layout. (e) Small enveloping finger layout. (f) Medium enveloping finger layout. (g) Large enveloping finger layout. (h) Linear finger layout.

Unlike a circular palm, the O-shaped palm has two parallel linear sections that enable scaled opposing layouts as well as linear layouts. The track remains a closed curve, as in a circular palm, allowing synchronized rotation of all fingertips to produce a wrist-like twisting motion for in-hand manipulation such as object rotation and reorientation.

2) *S-Shaped Palm*: Fig. 9(a) shows a gripper with an S-shaped monolithic palm and three finger units. The S-shaped palm enables the generation of diverse finger layouts by combining three parallel linear sections with two curved sections of different curvatures. Experiments were conducted to evaluate dynamic reconfiguration in generating diverse finger layouts and performing object grasps. Fig. 9(b)–

(h) show seven finger layouts and corresponding grasps. Fig. 9(b) shows a narrow opposing layout with grasping of a narrow cylinder (pen). Fig. 9(c) shows a medium opposing layout with grasping of a medium rectangular object (tissue box). Fig. 9(d) shows a wide opposing layout with grasping of a wide rectangular object (cardboard box). Fig. 9(e) shows a small enveloping layout with grasping of a small cylinder (PET bottle cap). Fig. 9(f) shows a medium enveloping layout with grasping of a medium cylinder (instant noodle container). Fig. 9(g) shows a large enveloping layout with grasping of a large cylinder (filament holder). Fig. 9(h) shows a linear layout with grasping of two boxes simultaneously.

These results demonstrate that the S-shaped palm real-

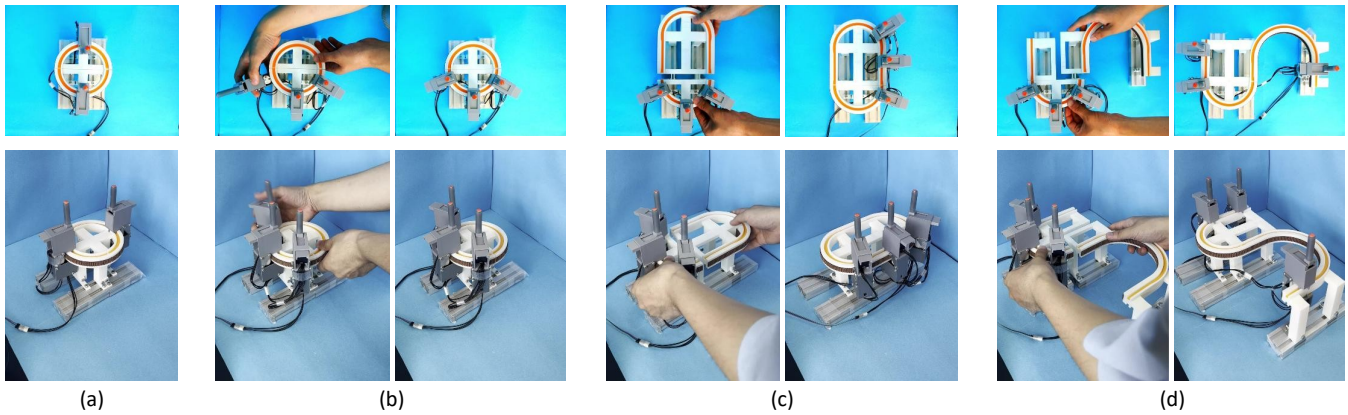


Fig. 10. Modular reconfiguration. (a) Initial gripper with a circular palm and two finger units. (b) Addition of one finger unit (left), resulting in three finger units (right). (c) Replacement of a semi-circular part with a U-shaped part (left), forming an O-shaped palm with three finger units (right). (d) Replacement with a linear part and another U-shaped part (left), forming an S-shaped palm with three finger units (right).

izes at least seven distinct finger layouts through dynamic reconfiguration, substantially increasing grasping versatility compared with typical circular palms, which realize only two layouts, such as opposing and enveloping ones. This highlights the capability of dynamic reconfiguration on non-circular palms to generate diverse finger layouts.

## B. Modular Reconfiguration

1) *Modular Reconfiguration Demonstration:* Fig. 10 shows an example of rapid modular reconfiguration on the physical system<sup>2</sup>, including modification of the palm shape and addition of finger units. The palm shape was modified sequentially from circular to O-shaped, and then to S-shaped. The upper and lower images in Fig. 10 show top and perspective views of the gripper, respectively. Fig. 10(a) shows the initial state of the gripper, composed of a circular palm made from two semi-circular parts and two finger units. In Fig. 10(b), a finger unit is added (left), resulting in a gripper with three finger units (right). Fig. 10(c) shows a U-shaped part being combined after removing one of the semi-circular parts (left). The resulting gripper has an O-shaped palm with three finger units (right). Finally, Fig. 10(d) shows the combination of a linear part and a U-shaped part with a different curvature after removing the previous U-shaped part (left). The resulting gripper has an S-shaped palm (right).

Through the above modular reconfiguration, a qualitative expansion of the achievable finger layout space is demonstrated. Systematic representation and quantitative characterization of this layout space based on the proposed framework are important directions for future research.

2) *On-the-Fly Task-Driven Modular Reconfiguration:* On-the-fly modular reconfiguration was demonstrated, in which the palm shape was modified and a finger unit was added according to the grasping task while keeping the gripper attached to the robot arm. Fig. 11(a) shows the task of grasping a large triangular plate. Initially, the gripper consisted of a small U-shaped palm with three finger units (left).

<sup>2</sup>The finger units and palm parts were designed for quick attachment and detachment to enable rapid modular reconfiguration.

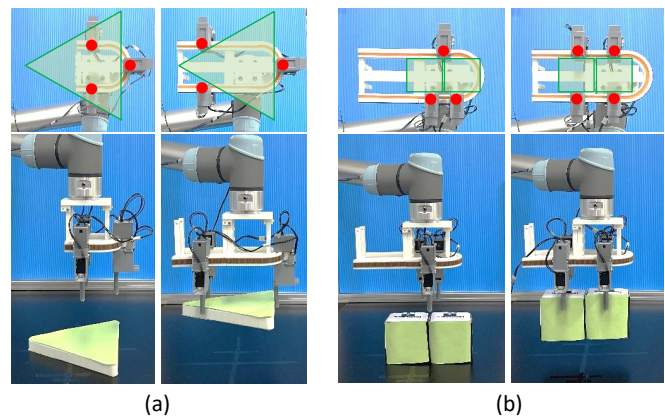


Fig. 11. On-the-fly task-driven modular reconfiguration. (a) A large triangular plate cannot be grasped (left); enlarging the finger unit movement range by adding a parallel linear palm part enables successful grasping (right). (b) Two boxes cannot be grasped with three fingers (left); adding a fourth finger unit enables simultaneous grasping of both boxes (right).

In this configuration, the finger spacing was insufficient to grasp the plate. By adding a parallel linear part to create a larger U-shaped palm, the range of finger unit movement was expanded, enabling successful grasping of the plate (right). Fig. 11(b) shows the subsequent task of grasping two boxes. Grasping both boxes simultaneously with only three fingers was difficult (left). By adding a fourth finger unit, a four-finger layout composed of two opposing two-finger layouts, one for each box, was generated, allowing both boxes to be grasped simultaneously (right). This four-finger layout also enables in-hand manipulation through coordinated motion of the finger units, such as moving the objects closer together or farther apart.

These results demonstrate the effectiveness of on-the-fly modular reconfiguration in enabling layout changes that cannot be realized through dynamic reconfiguration alone. From an implementation perspective, semi-automatic reconfiguration using tool changers and magnetic or motorized couplings is a key direction for task-driven adaptive gripper hardware. In addition, perception and planning for object recognition

and configuration selection are essential for realizing fully autonomous on-the-fly task-driven reconfiguration.

## V. CONCLUSION

This paper proposed a novel monorail-like reconfigurable gripper system capable of generating diverse finger layouts. The proposed framework unifies two complementary forms of reconfiguration: dynamic reconfiguration, in which finger units move independently along a given palm track to change the finger layout, and modular reconfiguration, in which the palm track shape and the number of finger units are modified to alter the achievable finger layout space. A prototype gripper system was developed to implement the proposed framework. Experiments demonstrated the unified reconfiguration capability in terms of finger layout diversification. Dynamic reconfiguration with the S-shaped palm achieved seven distinct finger layouts, while on-the-fly modular reconfiguration expanded the achievable finger layout space and enabled rapid adaptation to different grasping tasks.

Future work will address the quantitative representation and evaluation of finger layouts and the corresponding layout space within the proposed dynamic–modular reconfiguration framework. This includes the development of metrics such as coverage, reachability, and grasp stability, as well as benchmarking against conventional grippers. A systematic design and planning methodology will be investigated to determine palm track geometries, numbers of finger units, and motion strategies based on object properties such as shape, size, compliance, and multiplicity, together with task requirements including in-hand manipulation.

This work introduces an innovative reconfigurable non-circular track concept for multiple finger units that unifies dynamic and modular reconfiguration within a single gripper architecture. The proposed framework further suggests an analogy between coordinated motion planning for multiple finger units and coordinated multi-agent planning in swarm robotics, opening new directions toward the design and control of reconfigurable manipulation.

## REFERENCES

- [1] K. Telegenov, Y. Tlegenov, and A. Shintemirov, "A Low-Cost Open-Source 3-D-Printed Three-Finger Gripper Platform for Research and Educational Purposes," *IEEE Access*, vol. 3, pp. 638–647, 2015.
- [2] C. Liu, F. Chung, Y. Chen, C. Chiu, and T. Chen, "Optimal Design of a Motor-Driven Three-Finger Soft Robotic Gripper," *IEEE/ASME Transactions on Mechatronics*, vol. 25, no. 4, pp. 1830–1840, 2020.
- [3] Q. Lu, J. Wang, Z. Zhang, G. Chen, H. Wang, and N. Rojas, "An Underactuated Gripper Based on Car Differentials for Self-Adaptive Grasping with Passive Disturbance Rejection," *IEEE International Conference on Robotics and Automation*, pp. 2605–2611, 2021.
- [4] J. Li, J. Li, Z. Wu, and Y. Huang, "A Soft Variable Stiffness Hand With an Integrated Actuating–Cooling System," *IEEE Transactions on Industrial Electronics*, vol. 70, no. 11, pp. 11464–11473, 2023.
- [5] J. Yi, B. Kim, K. Cho, and Y. Park, "Underactuated Robotic Gripper With Fiber-Optic Force Sensing Tendons," *IEEE Robotics and Automation Letters*, vol. 8, no. 11, pp. 7607–7614, 2023.
- [6] R. Flores, and S. Nisar, "Design and Performance Analysis of a Single-Port Bidirectional Soft Actuator and Its Integration Into a Versatile 3-Finger Robot Gripper," *IEEE Access*, vol. 13, pp. 30127–30136, 2025.

- [7] J. Yoon, H. Jeong, J. Park, Y. Gong, D. Shin, H. Seo, S. Moon, and H. Choi, "A Three-Finger Adaptive Gripper With Finger-Embedded Suction Cups for Enhanced Object Grasping Mechanism," *IEEE Robotics and Automation Letters*, vol. 10, no. 2, pp. 915–922, 2025.
- [8] T. Nishimura, K. Akasaka, K. Ueno, Y. Suzuki, T. Tsuji, and T. Watanabe, "Lightweight and High-Payload Robotic Gripper Using Shape-Memory-Alloy Actuator and Self-Locking Mechanism," *IEEE Access*, vol. 13, pp. 120056–120068, 2025.
- [9] Barrett Technology, Inc.: BH8-282 BarrettHand Datasheet, <https://www.barrett.com>, 2013.
- [10] R. Ma, and A. Dollar, "An Underactuated Hand for Efficient Finger-Gaiting-Based Dexterous Manipulation," *IEEE International Conference on Robotics and Biomimetics*, pp. 2214–2219, 2014.
- [11] L. Odhner, L. Jentoft, M. Claffee, N. Corson, Y. Tenzer, R. Ma, M. Buehler, R. Kohout, R. Howe, and A. Dollar, "A Compliant, Underactuated Hand for Robust Manipulation," *The International Journal of Robotics Research*, vol. 33, no. 5, pp. 736–752, 2014.
- [12] J. Spiliotopoulos, G. Michalos, and S. Makris, "A Reconfigurable Gripper for Dexterous Manipulation in Flexible Assembly," *Inventions*, vol. 3, no. 1, 4, 2018.
- [13] Y. Kim, H. Song, and C. Maeng, "BLT Gripper: An Adaptive Gripper With Active Transition Capability Between Precise Pinch and Compliant Grasp," *IEEE Robotics and Automation Letters*, vol. 5, no. 4, pp. 5518–5525, 2020.
- [14] D. Chappell, F. Bello, P. Kormushev, and N. Rojas, "The Hydra Hand: A Mode-Switching Underactuated Gripper With Precision and Power Grasping Modes," *IEEE Robotics and Automation Letters*, vol. 8, no. 11, pp. 7599–7606, 2023.
- [15] Z. Lu, H. Guo, W. Zhang, and H. Yu, "GTac-Gripper: A Reconfigurable Under-Actuated Four-Fingered Robotic Gripper With Tactile Sensing," *IEEE Robotics and Automation Letters*, vol. 7, no. 3, pp. 7232–7239, 2022.
- [16] M. Kopiccki, S. Ansary, S. Tolomei, F. Angelini, M. Garabini, and P. Skrzypczyński, "Underactuated Dexterous Robotic Grasping With Reconfigurable Passive Joints," *IEEE Robotics and Automation Letters*, vol. 10, no. 1, pp. 48–55, 2025.
- [17] M. Khalid, M. Jilich, M. Frascio, B. Lévesque, A. Zanella, and M. Zoppi, "Design and Development of a Novel Universal Gripper Having Rigid Mechanics With Self-Adaptable Fingers for Industrial Applications," *IEEE Access*, vol. 13, pp. 119789–119809, 2025.
- [18] M. Baggetta, O. Pennacchio, S. Pirozzi, and G. Berselli, "A Reconfigurable Four-Finger Gripper for Versatile Application in the Agri-Food Industry," *IEEE/ASME Transactions on Mechatronics*, vol. 30, no. 4, pp. 2999–3007, 2025.
- [19] M. Higashimori, H. Jeong, I. Ishii, M. Kaneko, A. Namiki, and M. Ishikawa, "A New Four-Fingered Robot Hand with Dual Turning Mechanism," *IEEE International Conference on Robotics and Automation*, pp. 2679–2684, 2005.
- [20] A. Nurpeissova, A. Malik, S. Kabitkanov, A. Zhilisburyev, and A. Shintemirov, "An Open-Source Reconfigurable Robotic Gripper with Detachable Fingers," *IEEE/ASME International Conference on Mechatronic and Embedded Systems and Applications*, pp. 1–6, 2022.
- [21] D. Prattichizzo, and J. Trinkle, "Grasping," *Handbook on Robotics*, B. Siciliano and O. Kathib, Eds. Springer, pp. 671–700, 2008.
- [22] E. Rimon, and A. Blake, "Caging Planar Bodies by One-Parameter Two-Fingered Gripping Systems," *The International Journal of Robotics Research*, vol. 18, no. 3, pp. 299–318, 1999.