Proceedings of the 4th International Conference on Mechatronics and Smart Systems
DOI: 10.54254/2755-2721/2026.33024

Fast Stretchers Based on Water Bomb and Diamond Origami

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Abstract. Traditional folding stretchers used in emergency rescue suffer from several drawbacks, including large folded volume, complex deployment procedures, and limited adaptability to complex environments. To overcome these issues, this study introduces two new stretcher designs based on Diamond Origami and Waterbomb Origami structures. The Diamond Origami scheme adopts a single-DOF mechanism with α = 45°. It achieves a compression ratio of 19.8% with an input displacement of 26.5 cm, showing clear advantages over traditional stretchers. The waterbomb origami scheme, assisted by an external scissor frame, reduces its degrees of freedom from 3 to 1 and reaches a high compression ratio of 6.25%. Although its input displacement is 95 cm, the one-dimensional unfolding motion significantly improves adaptability in confined spaces. The results show that origami structures can effectively improve the portability, deployment efficiency, and environmental adaptability of folding stretchers, providing a feasible approach for the development of advanced emergency rescue equipment.

Keywords: origami structure, folding stretcher, compression ratio, degree of freedom, emergency rescue

1. Introduction

1.1. The urgency of rescue scenarios and the demand gap for high-performance folding stretchers

In emergency rescue scenarios, including public health emergencies, natural disasters (e.g., earthquakes, floods), and accident sites (e.g., traffic accidents, industrial accidents)—the "time is life" principle is critical. The World Health Organization notes that trauma patients have a 1-hour golden treatment window, with on-site transfer efficiency directly affecting survival rates. As core transport tools, stretchers' portability, deployment speed, and adaptability often bottleneck rescue efficiency. Current rescue challenges are threefold:

(1) Complex environment transport: post-earthquake ruins, rugged terrain, and crowded streets demand compact, lightweight stretchers, but traditional designs are too bulky/heavy for narrow passage access.

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DOI: 10.54254/2755-2721/2026.33024

(2) Emergency response timeliness: rapid deployment is vital, yet existing stretchers require cumbersome multi-step, multi-person operation, delaying critical transfers.

(3) Poor multi-scenario adaptability: stretchers need to switch states across on-site first aid, ambulance transport, and hospital movement, but most designs only serve single links, failing to balance "storage-portability-deployment-stability".

The key limitations of conventional stretchers: folding ratios below 1:5, 3–5 buckle unlocks for deployment (single-person operation over 30 seconds), and compromised folding performance in lightweight designs. Extreme environment adaptability is also to be improved.

1.2. Development status of folding stretchers

Folding stretchers are indispensable core equipment for emergency rescue and medical transport, and their design optimization has long been a key research focus in this field.

Traditional folding stretchers, such as the common straight-rod two-fold or four-fold structures, typically consist of fundamental components including support rods, a stretcher surface, and legs. These designs are characterized by their structural simplicity and low cost, fulfilling the basic function of transporting the injured in conventional environments. Relevant studies, such as folding emergency rescue stretcher [1], facilitate patient transfer by unfolding two sets of foldable rods and deploying a fabric surface. Similarly, due to the straightforward structure, traditional folding stretchers are widely utilized in scenarios such as short-distance hospital transfers and initial rescue operations on well-maintained roads [2].

In recent years, frame-type folding stretchers have developed rapidly. The Blacklite stretcher, developed by Epsilon Composite [3], utilizes a foldable carbon fiber/epoxy frame with telescopic wrapping carbon fiber tubes, emphasizing lightness, portability, and structural rigidity. Its design features two parallel poles with a series of telescopic tubes, a flexible fabric suspended in the middle, and lateral reinforcement devices. Tests have shown that the stretcher weighs less than 2.5 kilograms, with a folded size of 40×10×10 centimeters, and a rated load capacity of up to 200 kilograms. It has demonstrated strong adaptability to complex terrains during training and operational tests by French special forces.

Another area in urgent need of improvement is operation convenience. Research indicates that many traditional folding stretchers require rescuers to manually unlock multiple buckles during deployment, with single-person unfolding often exceeding 30 seconds [3]. Some further research points out that some stretchers necessitate multi-person collaboration for deployment, which is inefficient and impractical when rescuer numbers are limited [1].

At the core of their mechanical design, existing folding stretchers struggle to reconcile high deployment ratios with low degrees of freedom. A higher deployment ratio requires more folding joints, which inherently increases structural DOF. This added complexity makes deployment and folding harder to control, leading to common issues like jamming and misalignment. On the other hand, designs that limit DOF for better structural stability almost always compromise on deployment ratio, falling short of portability requirements.

In summary, current folding stretcher designs exhibit notable deficiencies in portability, operational convenience, environmental adaptability, and the optimization of key technical indicators. They struggle to meet the demanding performance requirements of complex rescue scenarios, which call for a high deployment ratio, easy portability, rapid deployment, and robust environmental adaptability. There is an urgent need for innovative designs to overcome these challenges.

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1.3. Feasibility analysis of designing new folding stretchers using origami structures

1.3.1. Origami structures and their core advantages

The origami structures are a structured system that realizes the transformation between two-dimensional and three-dimensional forms through regular folding of planar materials such as paper, metal sheets, and composite materials. Their core characteristics are that creases serve as "kinematic pairs" and facets as "rigid links". Structural deformation is achieved through geometric folding, which combines light weight, high deployability, and multi-stability. From a kinematic perspective, origami structures can be equivalent to spatial linkage mechanisms. The rotational constraints of creases and the rigidity of facets enable them to naturally have the dual functions of "folding for storage - unfolding for bearing".

To conduct systematic research and evaluation of origami structures, Meloni et al. [4] has given the common qualities that are studied by global researchers in their research:

(1) Deployability: the capacity to transform the origami from its initial state to fully folded state.

(2) Scalability: the capacity to retain the core function as the dimension changes.

(3) Self-actuation: the capacity to maintain accurate deployment without external intervention.

(4) Reconfigurability: the capacity of the origami to alter its shape dynamically with predefined constraints.

(5) Tunability: the capacity of origami to be tailored for specific tasks.

(6) Easiness in manufacturing: A key advantage of origami-based designs. The design work starts with a 2D planar crease pattern, followed by assembly to form the final 3D configuration.

1.3.2. Cross-domain application of origami structures and their blank in the medical field

Origami was a form of folk art in its early stage; thus at that stage, origami was mainly for visual aesthetic purposes. However, with the development of science and continuous exploration, modern origami has incorporated a common notation system (Yoshizawa–Randlett system [5]) and math analysis methods, which are regarded as two critical turning points of the development of origami [4]. Consequently, the engineering applications of origami have increased accordingly. Several typical types of origami patterns, such as Miura-ori, Waterbomb origami, and Kresling origami, have been developed, and this has given rise to a series of subsequent studies. Moradweysi et al. [6] studied the effective properties of Miura-ori in consideration of the thickness of the facets. Chen et al. [7] analyzed the motion behavior of Waterbomb origami. Zhang and Chen [8] developed two vertex-splitting schemes to reduce the DOF of Diamond origami (i.e. Waterbomb origami). Zhang et al. [9] presented a model to investigate the mechanical behavior of Kresling origami.

Now, origami structures have seen engineering breakthroughs in various fields such as aerospace, architecture, and robotics. Recent instances include the application of origami structure on light weight antenna [10], and robotic designs – waterbomb origami robot [11], Kresling-pattern-based continuum robot [12], and Biomimetic soft robotic origami crawler [13].

However, the application of these in medical facilities, particularly stretcher design, remains under-researched: existing literature only sporadically mentions origami, with no in-depth exploration of its engineering value for core needs like portability, operational efficiency, or multi-scenario adaptation.

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1.3.3. Targeted selection of diamond origami and waterbomb origami

Among numerous origami topologies and relevant studies [7,8], diamond origami and waterbomb origami are selected as the basis for stretcher design due to their unique geometric characteristics:

(1) Diamond origami: Composed of repeated diamond units, it achieves a high folding ratio through "shear deformation" of adjacent units during folding and has significant single-degree-of-freedom deformation characteristics. The grid structure formed after unfolding can evenly disperse the load, adapting to the "stable bearing" demand of the stretcher.

(2) Waterbomb origami: With a six-crease vertex as the core unit, it has an extremely high compression ratio in the folded state (capable of reaching 1:15), but it is necessary to solve the problem of "difficult control of high degrees of freedom" (subsequently optimized through external frame constraints). Its curved surface structure, after three-dimensional unfolding, can adapt to the body curve of the injured, improving the comfort of transportation.

Based on this, this paper proposes two design schemes for the basic frame of the stretcher:

(1) Pure diamond origami frame, which utilizes its characteristics of single degree of freedom and high folding ratio to realize the integration of "portability - rapid unfolding - stable bearing".

(2) Waterbomb origami + external constraint frame, which limits the redundant degrees of freedom of the waterbomb origami through the frame, retains its advantage of high folding ratio, and simplifies the operation process.

Both schemes provide theoretical support and engineering guidance for the mechanical structure design of the new folding stretcher through geometric parameter optimization (such as crease angle, unit size) and kinematic analysis (degree of freedom calculation, unfolding efficiency verification).

2. Analysis of core requirement indicators for folding stretchers

For folding stretchers, the two most critical performance requirements are portability and usability. This paper uses folding speed and compression ratio as the main evaluation indicators: folding speed reflects operational efficiency and directly affects emergency response time, while compression ratio determines how easily the stretcher can be stored and transported. When designing origami-inspired stretcher structures, the impact of different design parameters on these two indicators must be fully considered to achieve an optimal balance.

3. Analysis of the relationship between degree of freedom, operation process, and folding speed

3.1. Degree of freedom

The degree of freedom (DOF) of a rigid origami structure refers to the minimum number of inputs needed to control its full motion, which directly determines its operational complexity and folding speed. For emergency rescue equipment, a single-DOF design is critical, as it allows fast and reliable one-handed operation, eliminating the need for complex coordination and reducing human error in high-stress scenarios.

3.2. Evaluation criteria for ease of operation process

The operation process of deploying and folding a folding stretcher also affects the deployment speed of the equipment. In this study, the operation process of the folding stretcher is defined as the movement path of the point of application of the input force during the folding process. The complexity of this path can serve as a reference for evaluating the operational difficulty. Since both

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design schemes in this paper adopt linear paths, the path length (i.e., the distance moved by the input force) becomes the sole comparative indicator.

4. Evaluation method for compression ratio of stretcher plane

In this evaluation, the compression ratio is defined as the area ratio of the folding stretcher in its folded state to that in its unfolded state. The compression ratio of conventional metal-frame folding stretchers is mostly in the range of 1:3 to 1:5, and they still occupy a space of approximately 0.2-0.3 m^3 after folding. In contrast, stretchers based on diamond or waterbomb origami structures can achieve a compression ratio of 1:8 to 1:12, with their volume reduced to 0.05-0.1 m^3 after folding, which allows them to be stored in backpacks or equipment cases, significantly reducing the carrying burden. Therefore, the compression ratio is a key indicator for evaluating the mobility of stretchers in complex environments. To simplify the calculation, the thickness of the stretcher is ignored, and the formula for calculating the compression ratio can be expressed as:

$$\eta = \frac{S_f}{S_p} \tag{1}$$

Herein, η denotes the compression ratio, Sf represents the surface area of the stretcher in its folded state, and S_p stands for the surface area of the fully unfolded stretcher. The compression ratio of the traditional four-fold stretcher is approximately 25%.

5. Design of folding stretcher base frame based on diamond origami

Diamond origami (also known as the Yoshimura pattern) is a classic rigid origami pattern. Its core feature is that it forms a periodic tessellation structure through the regular arrangement of multiple congruent six-crease vertices, where each vertex is intersected by 6 creases. However, in most cases, when the origami is fully folded, a hole is formed in the center (see Figures 2 and 3), which may reduce the compression efficiency and cause space wastage. Therefore, it is necessary to study the geometric characteristics of diamond origami and eliminate the central hole by adjusting the geometric parameters.

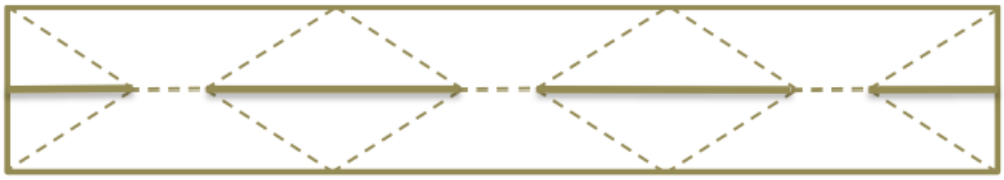


Figure 1. Example diamond pattern

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Figure 2. Half-folded diamond origami



Figure 3. Fully folded diamond origami

Figs. 4 and 5 illustrate the structure of the origami in these two states with color-matched lines. In this example, the hole is a triangle enclosed by the red lines AB, BE, and EA. It should be noted that the chain is not connected end-to-end as shown in Fig. 4. Point A in Fig. 5 is formed under the special condition where the chain forms a closed polygon.

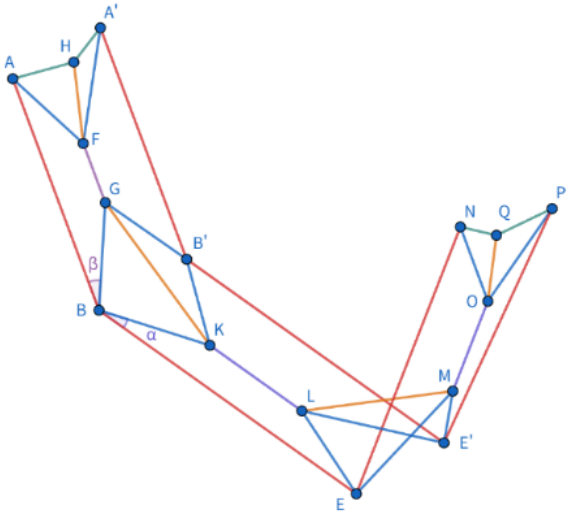


Figure 4. Half-folded diamond origami

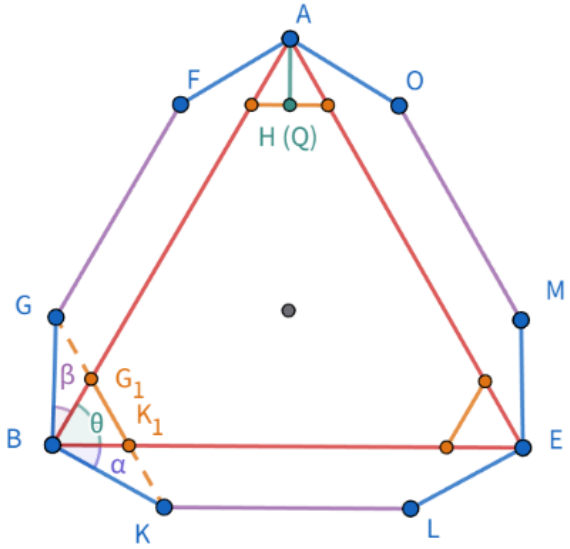


Figure 5. Fully folded diamond origami

As shown in Fig. 5, the following relationship can be derived:

$$\theta = \angle GBK - \alpha - \beta \tag{2}$$

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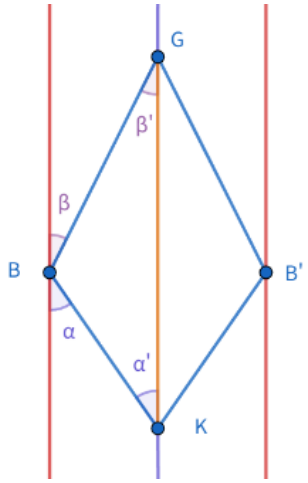


Figure 6. Local view of the pattern at point b of the unfolded origami

Fig. 6 shows a local view at point B when the origami is in the unfolded state. It can thus be derived that:

$$\angle GBK = 180^\circ - \alpha - \beta \tag{3}$$

Since the diamond origami is a rigid origami, the triangle △GBK maintains its shape unchanged during the folding process. Therefore, ∠GBK is constant. Through equations (2) and (3), the following relationship can be obtained:

$$\theta=180^\circ\text{-}(2\alpha+2\beta)$$

$\theta \geq 0^\circ$ give

$$\theta = 180^\circ - (2\alpha + 2\beta)(\alpha + \beta \leq 90^\circ) \tag{4}$$

Eq. (3) describes the relationship among θ, α, and β. Among them, α and β determine the shape of the diamond pattern, while θ represents the included angle at the vertices of both ends of the diamond when the origami is fully folded. This equation enables the mutual derivation of the shapes between the unfolded pattern and the folded pattern at each vertex, making it possible to customize the fully folded pattern. Under normal circumstances, the diamond pattern unit is designed to be a symmetrical structure, i.e., α = β. In this case, it can be simplified as:

$$\theta = 180^\circ - 4\alpha(\alpha \leq 45^\circ) \tag{5}$$

To eliminate the hole, the area of the central polygon in the fully folded pattern must be reduced to zero. There are multiple approaches to achieving this. In Design Scheme 1, based on the triangle shaped hole in Fig.5, the solution is implemented by setting both ∠ABE and ∠AEB to 0°. According to Eq. (5), this condition can derive that the α value of each vertex is 45°. When the origami is fully folded, point A will move onto line segment BE, thereby reducing the area of the hole to zero.

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The folding effect after setting α to 45° is shown in Fig.7. The calculated compression ratio is 19.8%, which represents a considerable improvement compared to the 25% compression ratio of traditional four-fold stretchers. It is estimated that for a standard stretcher with dimensions of 53 cm × 190 cm, the distance moved by the input force in Design 1 is 26.5 cm, indicating that this design features favorable operational simplicity.

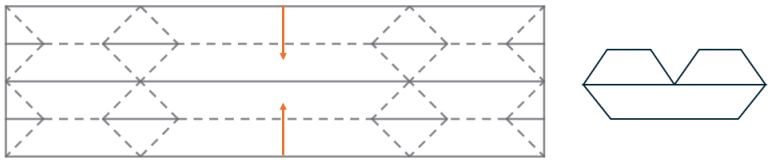


Figure 7. Diamond pattern prototype with the fully folded pattern and folding directions

Due to its relatively complex motion behavior, the next step is to make an analysis of the structural displacement and angular changes of Diamond Origami during the folding process. Since Diamond Origami in this research is an array of identical units, it is convenient to take out a local part for analysis.

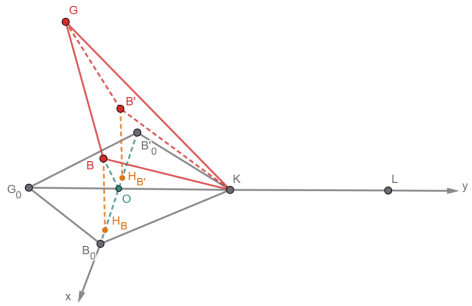


Figure 8. Local view of folding of diamond origami

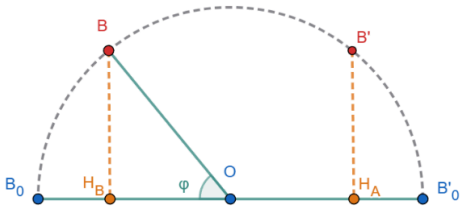


Figure 9. Planar view of point B series

Figs. 8 and 9 present the local part of the origami structure, with the labeling of points referenced in Fig. 4. In Figure 8, a rectangular coordinate system is established with point O as the origin. The lines where OB_0 and OK lie serve as the x-axis and y-axis, respectively, while the direction perpendicular to plane OKB_0 and pointing upward (not shown in the figure) is designated as the z-axis. Denote $\angle BOB_0$ as φ, $\angle B_0OK$ as α, $\angle GKO$ as γ, the radius of the arch B_0B as r. The relationship between φ and γ can be representative to describe the folding motion, thus it is selected as the target in this analysis.

In the folding process, φ increases from 0° to 90°, BK and B_0K rotate about line OK; meanwhile, plane GKG_0 remains perpendicular to plane OKB_0 due to the symmetrical condition, i.e., the x-

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coordinate value of point G (x_G) remains 0.

Assume that

$$G\,(0,\ y,\ z) \qquad (z \neq 0)$$

$$B(r\cos\theta, 0, r\sin\varphi)$$

Fig.8 gives $K\left(0, \frac{r}{\tan\alpha}, 0\right)$, thus

$$\vec{KB} = (rcos\varphi, -\frac{r}{tan\alpha}, rsin\varphi) \tag{6}$$

$$\vec{KG} = (0, y - \frac{r}{tan\alpha}, z) \tag{7}$$

$$\vec{OK} = (0, \frac{r}{tan\alpha}, 0) \tag{8}$$

The angle between $\overrightarrow{KB}$ and $\overrightarrow{KG}$ is equal to $\angle G_0B_0K = \alpha$; the length $KG = KG_0$ thus

$$cos < \vec{KB}, \vec{KG} >= cos\alpha = \frac{\vec{KB} \bullet \vec{KG}}{|\vec{KB}||\vec{KG}|} = \frac{-\frac{r}{tan\alpha}(y - \frac{r}{tan\alpha}) + rzsin\varphi}{\sqrt{r^2cos^2\varphi + (-\frac{r}{tan\alpha})^2 + r^2sin^2\varphi}\sqrt{(y - \frac{r}{tan\alpha})^2 + z^2}} \tag{9}$$

$$|\vec{KG}| = |KG_0| = \sqrt{(y - \frac{r}{tan\alpha})^2 + z^2} = \frac{2r}{tan\alpha} \tag{10}$$

The value of γ can be obtained by:

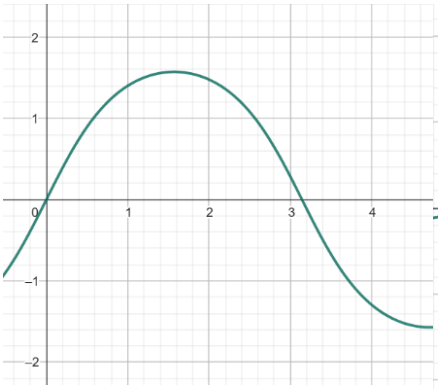
$$\gamma = cos^{-1}cos\gamma = cos^{-1}cos < \vec{KG}, \vec{OK} >= cos^{-1}\frac{\frac{r}{tan\alpha}(y - \frac{r}{tan\alpha})}{\frac{r}{tan\alpha}\sqrt{(y - \frac{r}{tan\alpha})^2 + z^2}} \tag{11}$$

γ can be obtained by Eqs. (9), (10) and (11):

$$\gamma = 2tan^{-1}(sin\varphi tan\alpha) \tag{12}$$

Then $\gamma - \varphi$ graphs can be drawn as Figs. 10, 11 and 12 shows:

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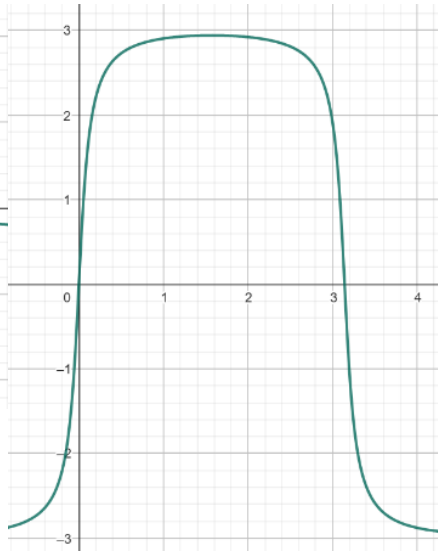


Figure 10. graph 1($\tan\alpha = 1$) Figure 11. graph 2($\tan\alpha = 0.1$) Figure 12. graph 3($\tan\alpha = 10$)

In the folding process, the range of φ is $\left[0, \frac{\pi}{2}\right]$. Angel γ reaches the maximum value when φ is $\frac{\pi}{2}$, i.e., the origami structure is fully folded. These graphs suggest that:

1. The maximum value of γ increases as α increases. This indicates that for this type of origami design, a higher α value at the diamond patterns will result in a larger twist angle at each diamond unit.

2. A higher α value at the diamond patterns enables the origami structure to respond more quickly to folding actions.

In the design developed by this research, $\tan\alpha = 1$. The $\gamma - \varphi$ graph is a relatively smooth curve, which reduces the risks of hitting the operator during the deployment while keeping the compression ratio.

6. Design scheme of folding stretcher based on waterbomb origami

6.1. Geometric characteristics and parameter analysis of waterbomb origami units

The waterbomb origami is a classic origami pattern, whose basic structure consists of multiple identical origami units. Each unit is centered on a vertex where six creases intersect. These creases divide a rectangular sheet of paper into several triangular regions, which can be folded along the diagonals and their axes of symmetry. The folding sequence of a single waterbomb origami unit is shown in Fig.13.

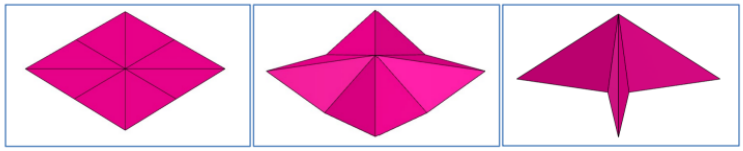


Figure 13. Motion sequence of waterbomb origami vertices in linear and plane-symmetric folding

The core parameters of the waterbomb origami unit are the side length l and the planar folding angle α (as shown in Fig.14). The folding surface of the stretcher is designed as a combination of a flat array of waterbomb origami units. Given that the total dimensions are fixed and the waterbomb

DOI: 10.54254/2755-2721/2026.33024

units have a symmetrical structure, the overall design configuration can be determined once the total number of units n is specified. Assuming the folding surface of the stretcher has a length of a and a width of b, there exists the following relationship between α, l and n:

$$l = \frac{a}{n} \tag{13}$$

$$\alpha = tan^{-1}\frac{a}{nb} \tag{14}$$

where $a = 190\text{cm}$, $b = 53\text{cm}$.

6.2. Kinematic characteristics of waterbomb origami

If the creases of the waterbomb origami are regarded as revolute joints and the rigid paper panels as links, kinematically, a single vertex of the waterbomb origami can be considered as a spherical 6R linkage mechanism with three degrees of freedom (DOF) [14]. This means that without additional constraints, the motion of the vertex exhibits high flexibility, and its motion state needs to be described by three independent variables. However, research has shown that when certain symmetrical conditions are imposed on the waterbomb origami, its motion characteristics will change [8]. For instance, applying linear symmetry and plane symmetry conditions to the vertex, i.e., restricting some motion variables to be equal—the motion equations of the spherical 6R linkage mechanism can be derived using matrix methods. By adopting the Denavit-Hartenberg (D-H) notation, converting motion variables into more intuitive dihedral angles, equations describing the folding characteristics of the waterbomb origami under symmetric conditions can be obtained. Under such symmetric conditions, the motion of the waterbomb origami becomes regular, and the originally three-degree-of-freedom motion may be constrained to a single-degree-of-freedom motion, meaning that given one input angle, the other angles will be determined accordingly.

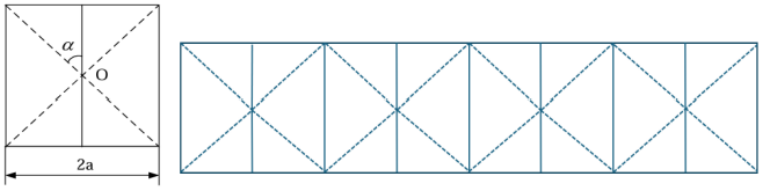


Figure 14. Waterbomb origami pattern

6.3. Framework design of folding stretcher with "waterbomb origami substrate + external driving frame"

Each unit of the waterbomb origami has 3 degrees of freedom, and the degrees of freedom accumulate as the number of units increases. Therefore, it is necessary to reduce its degrees of freedom to 1 to achieve convenient folding and deployment. In this paper, a method for reducing the degrees of freedom is proposed, and a basic configuration of the stretcher based on the "waterbomb origami base + external driving frame" is designed to realize a mechanical whole with a single degree of freedom.

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6.3.1. Design of stretcher surface based on waterbomb origami substrate

The folding process of the waterbomb origami can be equivalent to the motion of a spherical linkage mechanism [14]. When the folding unit is a square unit, its geometric characteristics enable it to satisfy the constraint of "stable folding with a single degree of freedom". In terms of crease symmetry, the two diagonals and two midlines form a "cross-shaped" symmetrical crease pattern (4 main creases + 4 secondary creases), allowing the overall synchronous deformation to be achieved with only one driving input during folding. In terms of constraint closure, the side length and angle constraints of the square ensure that the "unfolding-folding" motion of the triangular units during the folding process satisfies the closed-loop equations of the spherical mechanism (such as Denavit-Hartenberg matrix constraints), guaranteeing that the sides and angles of the folded triangles are strictly closed without "misalignment" or "interference". Therefore, the most ideal state is when a single waterbomb origami unit is a square. For a folding surface of 53 cm × 190 cm, the aspect ratio is 3.58. Thus, when designed as a 4-unit origami structure, each folding unit is closer to a square. Hence, the number of units n is designed to be 4, and through calculation, the value of α is 41.8° and l is 47.5 cm. The data above is derived from theoretical model calculations, and the actual design can be adjusted according to specific circumstances. The fully folded effect of this stretcher surface is shown in Fig.15, and the calculated compression ratio is approximately 6.25%, which is significantly smaller than that of the diamond origami scheme.

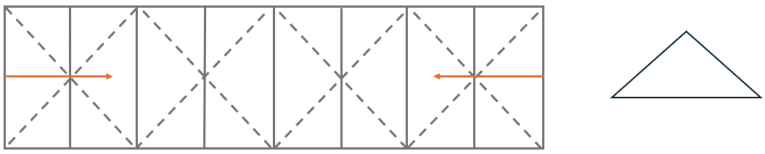


Figure 15. Waterbomb pattern prototype with the fully folded pattern and folding directions

6.3.2. Design of external driving frame based on scissor structure

As shown in Fig.15 and 16, the 4-unit waterbomb origami configuration is in a fully unfolded state, which can be regarded as a plane. A_i-B_i (i=1,2,3,4,5) are the two sides of each origami unit, serving as ridges during the folding process. Points S_1, S_2, and S_3 are the nodes of a scissor unit, where the two rods of a unit are fixed at S_3 to act as the revolute joint of the scissor unit. Since the folding configuration of the stretcher surface consists of 4 units, and each unit requires a scissor unit on each side, 4 scissor units are needed on both the A side and B side of the origami plane. On the A side of the waterbomb origami, A_i is fixed to S_1 and A_{i+1} is fixed to S_2, and the combination of the four units with the scissor units is completed in sequence. By repeating the operation on the B side as done on the A side, the integration of the entire origami structure with the external scissor frame is achieved. The deployment and folding of the folding stretcher can be driven by controlling the deployment and closure of the single-degree-of-freedom scissor structure. It is estimated that for a standard stretcher with dimensions of 53 cm × 190 cm, the distance moved by the input force is approximately 95 cm, which is greater than that of the first design. However, since the deployment direction of this design is one-dimensional, the space required for deployment in practical operations is significantly smaller than that of the first design, effectively improving the adaptability of the stretcher in special environments.

DOI: 10.54254/2755-2721/2026.33024

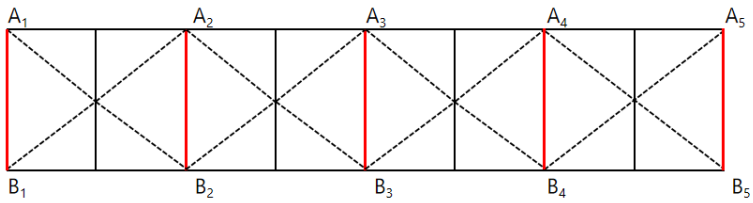


Figure 16. Waterbomb pattern prototype with the fully folded pattern and folding directions

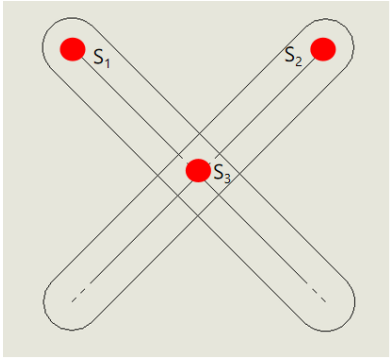


Figure 17. Waterbomb pattern prototype with the fully folded pattern and folding directions

7. Conclusion

7.1. Achievement

This study analyzed the limitations of current folding stretcher designs, including large storage volume, cumbersome deployment processes, and poor environmental adaptability, and presented preliminary designs with Diamond origami and Waterbomb Origami structures as mechanical design reference.

The Diamond Origami scheme features single-DOF characteristic, enabling rapid deployment, and relatively high compression ratio (19.8%, compared with 25% of traditional four-fold stretchers). The input force displacement of 26.5 cm further confirms its operational simplicity.

The Waterbomb origami scheme achieves a remarkable compression ratio of 6.25%, but requires an additional external scissor-driven frame to reduce its DOF from 3 to 1. Although its input force displacement of 95 cm is larger, its one-dimensional deployment direction greatly reduces the required operating space, improving adaptability in complex environments.

7.2. Future work

Manufacturing physical prototypes and conduct experimental test to validate the real-world feasibility of the proposed origami stretcher designs in rescue operation.

Investigating critical performance indicators such as load capacity and patient comfort to systematically optimize the geometry parameters.

Evaluating high-performance materials such as advanced composites to enhance the structural rigidity and harsh environment resistance.

This work will promote the translation of origami-based folding stretcher technology from laboratory concept to engineering product, and help improve emergency rescue capabilities.

DOI: 10.54254/2755-2721/2026.33024

Acknowledgement

Hangfeng Su and Hao Li contributed equally to this work and should be considered as co-first authors.

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