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ROBOTIC VEHICLE USING ORIGAMI CONCEPT A RIVEW

1. Prof. Saket R. Burkul D.Y. Patil College of Engineering Ambi, Pune
2. Mohak Sharma D.Y. Patil College of Engineering Ambi, Pune
3. Md Saif Ali D.Y. Patil College of Engineering Ambi, Pune
4. Bhushan Patil D.Y. Patil College of Engineering Ambi, Pune
5. Imteyaz Alam D.Y. Patil College of Engineering Ambi, Pune

Abstract- Origami is the traditional Japanese art of paper folding. Due to its fascinating properties, several attempts are being actively made to expand applications of origami-inspired designs in engineering. This paper presents the design of a deformable wheel based on an origami structure that was integrated with a small-scale mobile robot. All segments of the structure are connected by links-i.e., folding lines-and this linked structure provides advantages in terms of maintaining geometry and force transmissibility. These two advantages enable control of the shape or size of the wheel by activating a certain portion of the structure. With this property, the wheel diameter of the robot is reduced from 11 cm to 4 cm by four SMA coil spring actuators. Two plate springs are embedded in the wheel to maintain stiffness and allow the wheel to recover from contraction. With the deformable wheel, the robot can pass through a 5 cm gap despite having an 11 cm wheel in its normal state. This deformable wheel concept can be used to build mobile robots that can move quickly with large wheels and move through small gaps when required.

Keywords- Origami, Deformable wheels.

1. INTRODUCTION

Origami is the traditional Japanese art of paper folding. A paper can be folded into thousands of different three-dimensional shapes depending on the positions of the folding lines, order of folding, and way of the folding. This fascinating property has attracted many artists and mathematicians. Not only artists and mathematician, but engineers are also fascinated by these unique properties of origami and actively attempt to expand the application of origami designs in engineering.

A robot with a deformable wheel has the potential to overcome different types of obstacles, from narrow gaps to high steps. There have been studies about deformable wheel to achieve these advantages. The two important issues in deformable wheel design are building an effective wheel deforming mechanism and guaranteeing the stiffness in various states of the wheel. One approach that can provide a solution to these issues is to use origami concept.

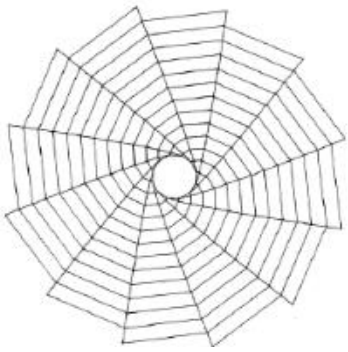

Fig.1 Designed folding pattern when the hub has 12 vertices.

The wheel is built using paper reinforced with carbon fiber at the edges and two plate springs are embedded in the wheel to maintain stiffness and allow it to recover from contraction. Four SMA spring actuators are installed for contraction. The diameter of the wheel is 11 cm in its normal state and reduced to 4 cm when contracted. This deformable wheel concept can be used to build mobile robots that can move quickly with large wheels and move through small gaps when required.

2. LITERTURE REVIEW

P. H. Le, J. Molina, [1]

In this work, we propose the application of Japanese "Origami" art for a floating function of a small aerial vehicle such as a hexa rotor. A preliminary experiment was conducted using Origami magic balls mounted under a hexa rotor. This magic ball can expand and shrink using an air pump during free flying. Using this interesting and functional concept, it promises to reduce the resistance of wind as well as reduce the energy consumption when the Origami balls are deflated. This approach can be particularly useful in rescue emergency situations. Furthermore, there are many unexpected reasons that may cause the multi-rotor has to land on the surface of water due to problems with the communication between the aircraft and the ground station. In addition, a complementary experiment was designed to prove that the hexa rotor can fly maintaining the stability and also, takes off and lands on the surface of water using air balloons.

Gowtham Rajan R , Rajanish N [2]

The utilization of origami in materialistic engineering designs has fascinated engineers and researchers. The structural stability provided by the 3D origami design can be applicable as a wheel for the robot. The origami structure is used as a deformable wheel, which aids in increasing and decreasing the height of the robot. A special ball bearing and cable driven mechanism is used in deforming the wheel. A mobile robot with deformable origami wheel has been built and tested to show its ability to deform and maneuverability to overcome obstacles.

2. ADVANTAGES

1. Transformers are toys that change from cars into bipedal machines. They make for great movies and toys. But there is another side to the idea behind them. What if we could create a robot that can begin as a tiny object and unfold into a device capable of doing real work in remote places like the surface of Mars or Titan or Europa.

2. That's the inspiration behind Pop-Up Flat Folding Explorer Robots, or PUFFERs. At NASA's Jet Propulsion Laboratory (JPL) these small origami-inspired robots consisting of printed circuit boards, wheels, and multiple sensors, that lie flat during transport and upon arrival at a mission location, unfold and drive off to do their thing.

3. Inspired by work at the uc berkeley biomimetic millisystem lab, jaakko karras has brought puffer to jpl as a concept for future space and earth-based exploration. The beauty of puffer is that these devices could even change shape in transit to manage obstacles and tight spaces. Watch the puffer prototype with 3d-printed wheels do its thing on this video posted on you tube. it impressively can alter shape on the fly and as the four images below show; this provides significant advantages in circumnavigating variable terrain.

3. APPLICATION :

Our interest in the Folded Textured Sheets is diverse. Firstly, they can undergo large global deformations as a result of the opening and closing of the folds. Furthermore, these folds provide flexibility in certain deformation modes, whilst still providing an increased bending stiffness. This combination of flexibility and rigidity is of interest in morphing structures, such as the skin of morphing aircraft wings. Another interesting property of the folded sheets is their ability to change their global Gaussian curvature, without stretching at material level. This is of interest in architectural applications, where it may be used as cladding material for doubly-curved surfaces, or, at a larger scale, as flexible fa¸cades. Furthermore, the use of the sheets as reusable doubly-curved concrete formwork is being explored; work is still ongoing to determine the range of surface curvatures that these sheets can attain. Applications for the remarkable behaviour of the oppositely signed Poisson's ratios under bending and stretching are still being sought. Nevertheless, the folded sheets add a new category to the field of auxetic materials.

Another Application

1. Artificial stomach fabrication
2. Ulcer formation
3. Robot architecture
4. Ice capsule transportation

CONCLUSION: This paper has presented the idea of Folded Textured Sheets, where thin walled sheets are textured using a fold pattern, inspired by Origami folding. When considering the resulting sheets as a plate or shell, the two example sheets exhibit several remarkable properties: they can undergo large changes in shape and can alter their global Gaussian curvature by virtue of the folds opening and closing; they also exhibit unique behavior where the apparent Poisson's ratio is oppositely signed in bending and extension. The proposed modelling method, which represents the partially folded sheet as a pin-jointed bar framework, enables a nice transition from a purely kinematic to a stiffness matrix approach, and provides insight into the salient behavior without the expense of a full Finite Element analysis. It captures the important behavior of the two example sheets, and indicates that the dominant mechanics are a result of the geometry rather than the exact material properties.

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