Demo Abstract: *MOOCA*: Muira-Ori Origami-Based Configurable Shelf-Liner for Autonomous Retail

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ABSTRACT

Current autonomous checkout is often enable by the use of multiple overhead cameras and/or load sensors on shelf, which is limited by the occlusion and dense deployment. We present *MOOCA*, an origami-inspired low-cost configurable surface structure as the smart shelf liner. *MOOCA* leverage conductive threads and copper wires integrated in to the origami structure to detect and recognize pick-up and put-down products. We build our prototype with 3D printed structure using elastic resin. We will demonstrate *MOOCA*'s functionality of predicting the item that is picked up from it.

CCS CONCEPTS

• Smart sensing surface → Event recognition; Object Identification;.

KEYWORDS

Configurable smart structure; smart retail; load sensing; item classification.

1 INTRODUCTION

The AI-powered autonomous retail stores generally rely on video from multiple overhead cameras to track customers' interaction with products [1]. Like any camera-based applications, they are susceptible to occlusion. This becomes a essential problem for cameras in the retail store setting, because it is difficult to use a small number of cameras to cover both customers and products on the shelf. Therefore, the overhead cameras are not efficient to track items on the shelf for customer-product interaction detection and recognition.

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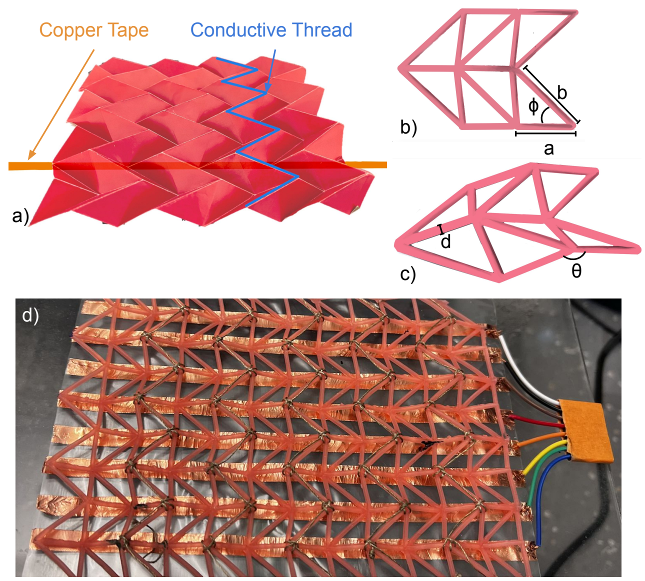

Figure 1: Origami-inspired elastic truss structure. (a) An example of paper-made Muira-Ori Origami and illustration of the switch by integrating conductive threads and copper tapes. (b, c) proposed 3D truss structure meta-structure unite. (d) *MOOCA* prototype with 3D printed elastic structure.

Other modalities, such as load sensors [2], have been explored to acquire this customer-product interaction information when there is occlusion. However, they often require expensive retrofit for the current store setup – replacing all existing shelves to customized shelf equipped with sensors. This limits the scalability of the system due to the cost in both manufacturing and labor.

We present *MOOCA* a Miura-ori origami base configurable smart shelf liner capable of event detection, product identification, and inventory monitoring. *MOOCA* is a easy to deploy shelf liner that can turn the normal retail store shelf into a smart shelf capable to sensing the pickup and put-down events and product identification using the product's bottom shape and load. The *MOOCA* consist of Muira-ori origami

Figure 2: Tuning the parameter like A and \ and 0 can change the load sensitivity of the structure.i) The structure that is not sensitive to applied load. ii) The structure that can sense same load with, higher \ value and lower A value,iii) The heatmap of the value *MOOCA* generated at different switches.

inspired auxetic structure with negative poisson's ratio[3]. Due to this property *MOOCA* structure will always undergo reversible deformation and require less maintenance.

2 *MOOCA* DESIGN

The base structure we adopt that enables configurable design over different target load is the muira-ori origami as shown in Figure 1 (a). Miura-ori origami structure has the properties of 1) quasi-static compression behavior [4], which determines its load bearing ability and leads to deformation when the load exceeds the threshold, and 2)negative Poisson's ratio [3], which determines its reversible deformation when the load is removed.

Inspired by Miura-Ori origami, we design a 3D truss structure with the meta-structure unit shown in Figure 1 (b) and (c). We 3D print this structure in the repeating pattern with the elastic resin material. Then we weave the conductive threads onto the elastic structure in the direction that is perpendicular to the copper tapes in the bottom layer, and together they form a switch grid, as shown in Figure 1 (d). When the load is applied to a meta-structure unit and deforms it, the conductive thread and the copper wire will be in contact and this switch is connected. When the load is removed, the elasticity of the structure enables the restoration of the form and disconnect the switch. This elasticity also enables a finer-grained conductivity measurement that is proportional to the weight – the more distortion to the structure, the more contacting surface it is between the conductive thread and the copper tape.

We configure *MOOCA*'s dynamic sensing range by changing the parameters of the meta-structure unit shown in Figure 1 (b) and (c). For example, by tuning the parameters like 3 and \, we change the nodal force response of the truss structure, and hence change the structure's sensitivity to different range of load. For a force applied on the meta-structure unit, it generates a shear stress component $* \cos(\backslash/2)$ along the pole of the structure. When this shear stress exceeds a threshold) B 40A, the deformation occurs. As the angle \ increase, a smaller is required to satisfy $* \cos(\backslash/2)$ i) B 40A. This) B 40A is also determined by the pole diameter 3, where a reduction in the radius will lead to a lower) B 40A. Figure 2 demonstrate an example where two structures with different configurations in (a) and (b) showing different deformation to the same load. Figure 2 (c) depicts the raw sensing output from our prototype.

3 DEMONSTRATION

MOOCA aims to converting shelves in the retail stores into smart shelves that are capable of detecting and recognizing different products' pickup and put-down events. During the demonstration we will exhibit a real world deployment. The demo will focus on the product classification with no vision data available. During the demo, audience can interact with *MOOCA*, where they can place different products on the smart shelf-liner and our predictive model will identify the product based on the sensor readings.

4 ACKNOWLEDGEMENT

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