Joint Design for Finite Thickness Miura Folded Antenna Arrays

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Designing antenna arrays with physical reconfiguration allows for additional degrees of freedom in operation, as well as providing useful capabilities in folding larger structures into smaller volumes. Origami antenna structures are particularly attractive due to their packing and folding ease. However, traditional origami is based on the manipulation of thin sheets, making physical reconfiguration of finite thickness origami sheets very laborious.

Recent authors have begun to investigate folding structures with finite thickness (Lang, R.J., et al. Applied Mechanics Reviews, Vol. 70). Such finite thickness Miura folding prototypes have utilized offset, sliding, dual hinges, or tapered panels to allow separate sections to fold. However, the approach has yet to been applied to antennas. The approach relies on adding discontinuities and surface discrepancies through the middle of each cell. Alternatively, hinges can be introduced to slide along the edge of each cell. This precludes placing the antenna at the center of the cell, making it undesirable.

In this paper, we present a folding 3×3 Miura patch antenna array on a continuous 59 mil thick Rogers RT/duroid 5880 printed circuit board (PCB). Spacing between each Miura cell is optimized with respect to the acute angle, γ, substrate thickness, t, and desired folding angle, α. Various joints are then designed with respect to these tolerances and optimized with respect to spacing and cut process into the PCB. The designed foldable Miura patch array allowed for repeatable folding (i.e. hundreds of cycles), and delivered a radiation pattern that scanned from $\theta = 0^{\circ}$, when fully deployed up to $\theta = \pm 100^{\circ}$ when fully stored. Closed form analytical expressions for the radiation pattern and measurements will be presented at the conference.