Beam-direction and Beam-width Switchable Monopole Antenna using Smart Shape Memory Hinges based Origami Reflectors

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In this paper, a robust origami antenna with beam direction and beam-width switching capability is presented using smart shape memory (SMP) hinges based origami reflectors. The proposed antenna consists of a single monopole surrounded by four parasitic patches which are connected to the ground plane of the monopole using SMP hinges. SMP hinges upon heating allow for real time origami folding of the parasitic patches and can transform a planar antenna structure (omni-directional) into three-dimensional directional origami antenna. The parasitic patches operate as the reflectors in the folded states and act as the dummy patches in the unfolded states. With the help of the smart SMP hinges, the proposed antenna can be operated in nine different states. In the first state as shown in Fig. 1(a-b), parasitic patches are in the unfolded states and it can be served as omni-directional antenna with a gain of 4.5 dBi. In the remaining eight states, it serves as directional antenna with beam-direction and beam-width switching capability to provide a continuous beam-steering of 360° in the azimuthal plane with a step size of 45°. In the states 2 to 5, antenna can be served as beam switchable corner reflector antenna with narrow beam-width. The gain of the antenna for the states 2 to 5 is above than 10.6 dBi, having 3-dB beamwidth in the range of 38 to 52°. In the states 6 to 9, antenna can be functioned as beam switchable antenna with wider 3 dB beam-width of 130° having gain in the range of 7.8 to 8.4 dBi. Antenna provides good impedance matching for all the states. The proposed antenna concept is numerically and experimentally verified. The presented antenna is fist PCB based robust antenna using origami technology. The fabricated prototype of the antenna for the states 1, 3, 6, and 7 are shown in Fig.1 and the measured three-dimensional radiation patterns for these states are presented in Fig. 2.

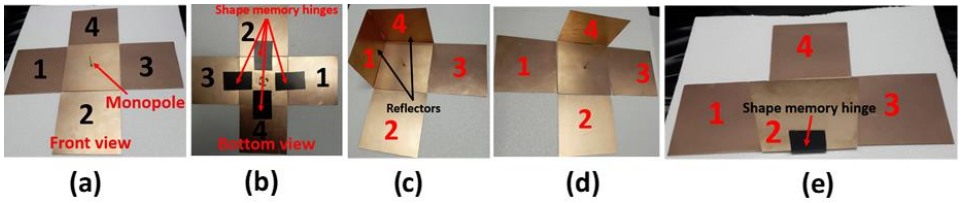

Figure 1. Picture of the fabricated antenna prototype: (a) state 1, (b) state 1 (back view), (c) state 3, (d) state 6, and (e) state 7

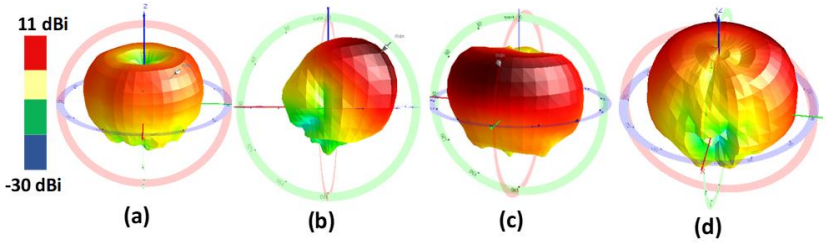

Figure 2. Measured radiation patterns: (a) state 1, (b) state 3, (c) state 6, and (d) state 7

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