Supplementary Materials

1. Antenna bending simulation experiment

The antenna bending model is shown in Figure S1, where the antenna is bent on a cylindrical surface with a diameter of 20 mm.

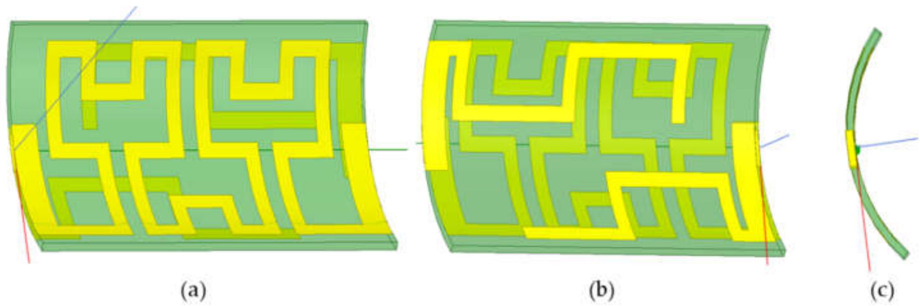

Figure S1. Antenna bending model. (a) Bending antenna front; (b) Bending antenna back; (c) Bending antenna side.

Figure S2 shows the comparison of S11 curve of bent antenna and original antenna, the S11 curve of bent antenna shows a right shift trend and the effective frequency becomes higher. When S11 < -10 dB, the effective frequency band is 2.5-2.64 GHz and 5.1-6.36 GHz, which can completely cover the two frequency bands required for 5 GHz (5.15-5.35 GHz and 5.45-5.85 GHz), but can't meet the 2.4 GHz band. When S11 < -6 dB, the effective frequency band is 2.43-2.68 GHz and 4.84-6.85 GHz, which can cover most of 2.4 GHz band, the requirement of S11 in industry is not as high as that in scientific research, and the experiment of camera in the text of the article also proves that this research has complete practical application basis, so the antenna in the article can still meet 2.4 GHz Therefore, the antenna in this manuscript can still meet the application scenario of 2.4 GHz.

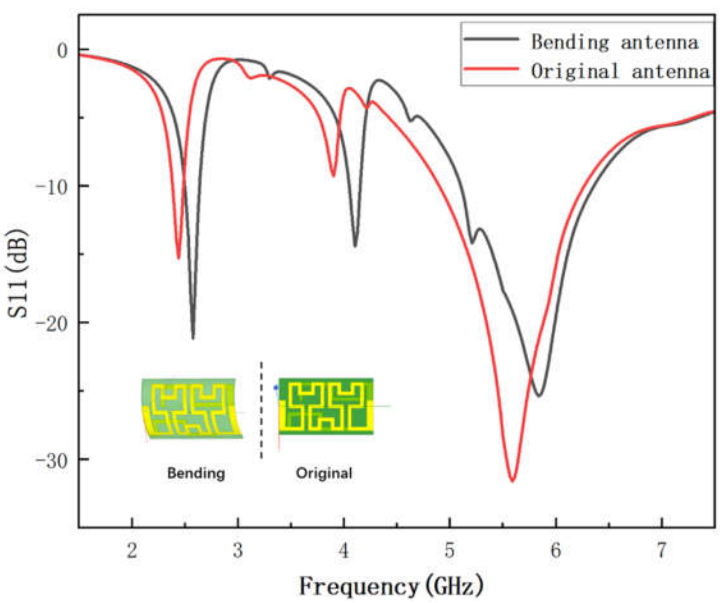

Figure S2. Bending antenna and original antenna of S11 comparison.

Figure S3 is a comparison of the radiation pattern of the bent antenna and the original antenna, and the influence of antenna bending on the pattern is very small. the E-plane exhibits a closer-to-omnidirectional pattern, and the directional curve appears smoother with fewer abrupt changes. The H-plane demonstrates better radiation characteristics at 0° and 180°. Similarly, at 5.2 GHz, the E-plane displays improved omnidirectionality, while the H-plane maintains better radiation characteristics at 0° and 180°.

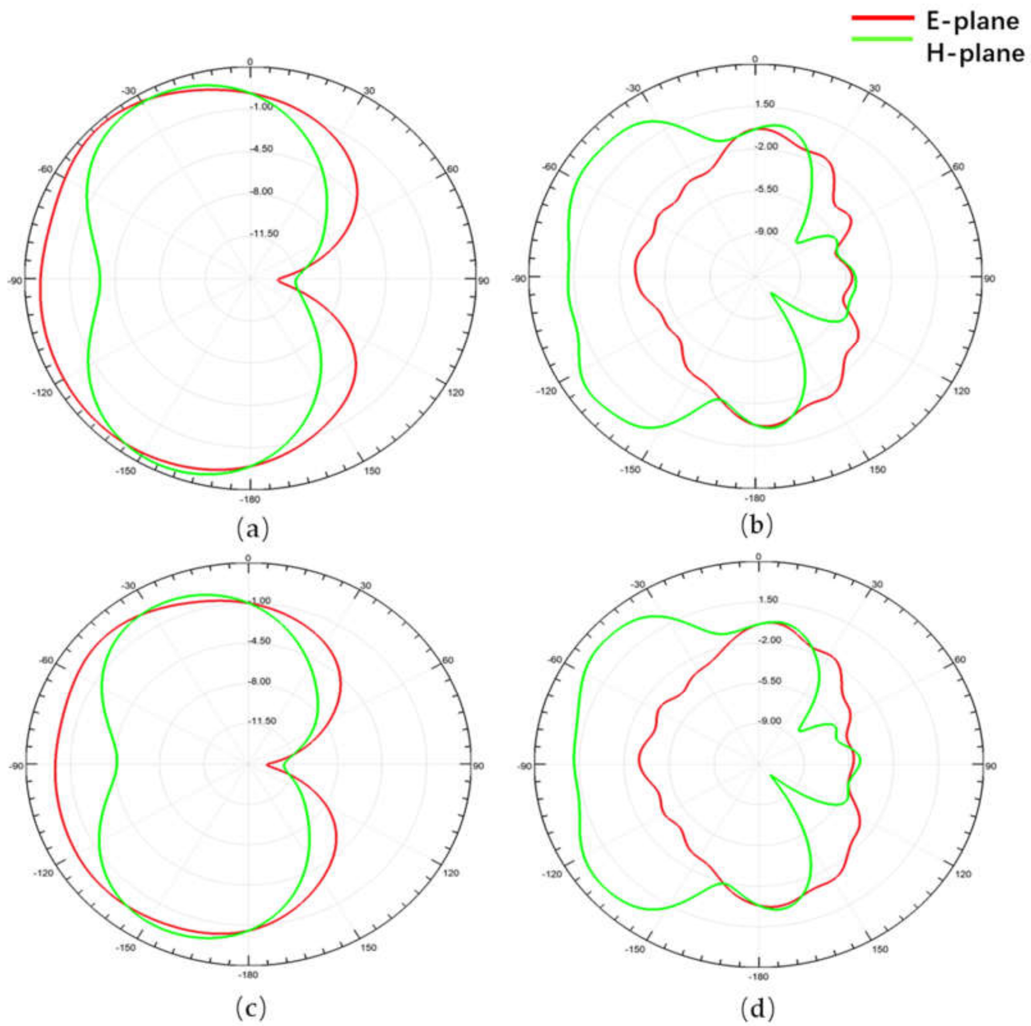

Figure S3. Comparison of the radiation pattern of the bent antenna and the original antenna. (a) Radiation pattern of the bending antenna at 2.45 GHz; (b) Radiation pattern of the bending antenna at 5.2 GHz; (c) Radiation pattern of the original antenna at 2.45 GHz; (d) Radiation pattern of the original antenna at 5.2 GHz

2. Simulation experiment of adding obstacles

In the simulation phase, a scenario with some obstacles was set up, and the effective bands obtained from the simulation in such a case are 2.38-2.48 GHz and 4.9-6.2 GHz, and the results of the radiation mode are consistent with the results when there is no obstacle. The specific simulations are shown as follows:

A cylindrical copper block is added near the antenna, which can be regarded as other electronic modules in the miniature wireless transmission system, and the S11 parameters of the antenna are compared with the directional maps of the E- and H-plane for three cases. They are: (a) two cylinders; (b) six cylinders; and (c) the antenna in the manuscript. The specific structure and model are shown in Figure S4. The simulated S11 is shown in Figure S5. It can be seen from the S11 curves that the effective frequency bands are the same in the three cases, and there is almost no difference, which indicates that the antenna performance is stable and anti-interference.

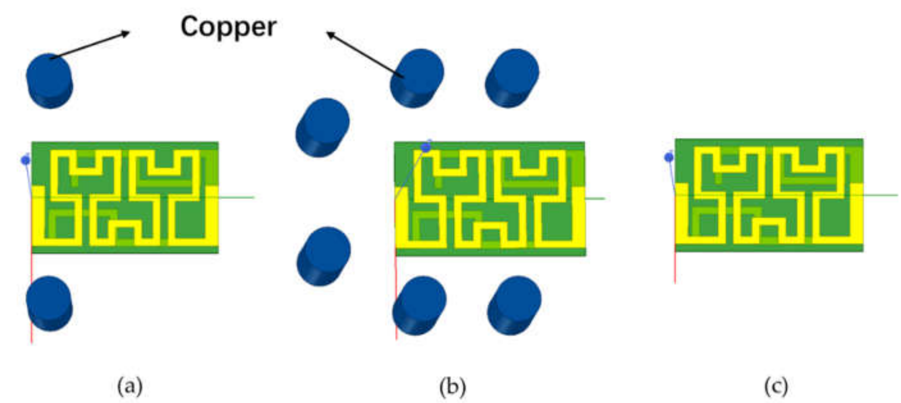

Figure S4. Comparison of antenna models before and after adding obstacles. (a) Antenna model with two cylinders; (b) Antenna model with six cylinders; (c) Original antenna.

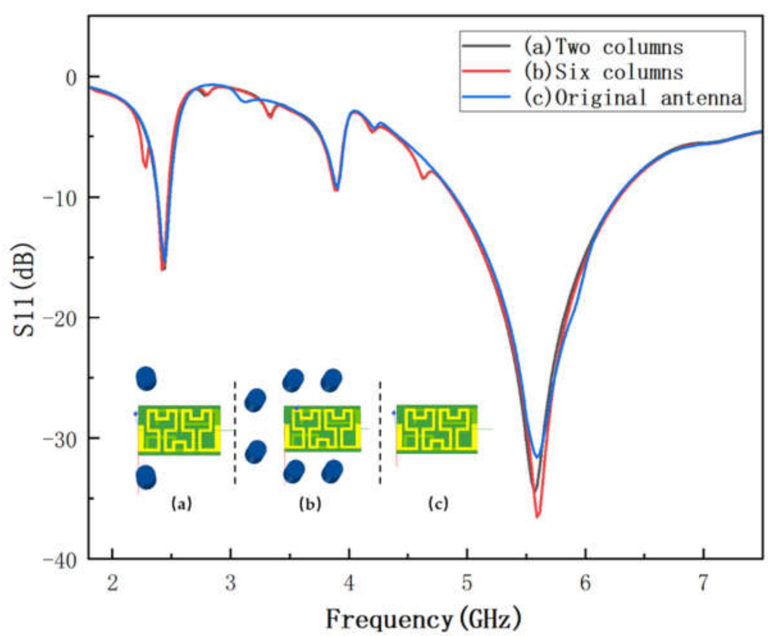

Figure S5. Comparison of S11 curves of antenna before and after adding obstacle.

Figure S6 shows the radiation pattern of the simulation in three cases, the selected frequency points are 2.4 GHz and 5.2 GHz, and the radiation pattern of the three cases are also consistent, which shows that the performance of the antenna proposed in the manuscript is stable and anti-interference, and it is suitable for micro wireless transmission system.

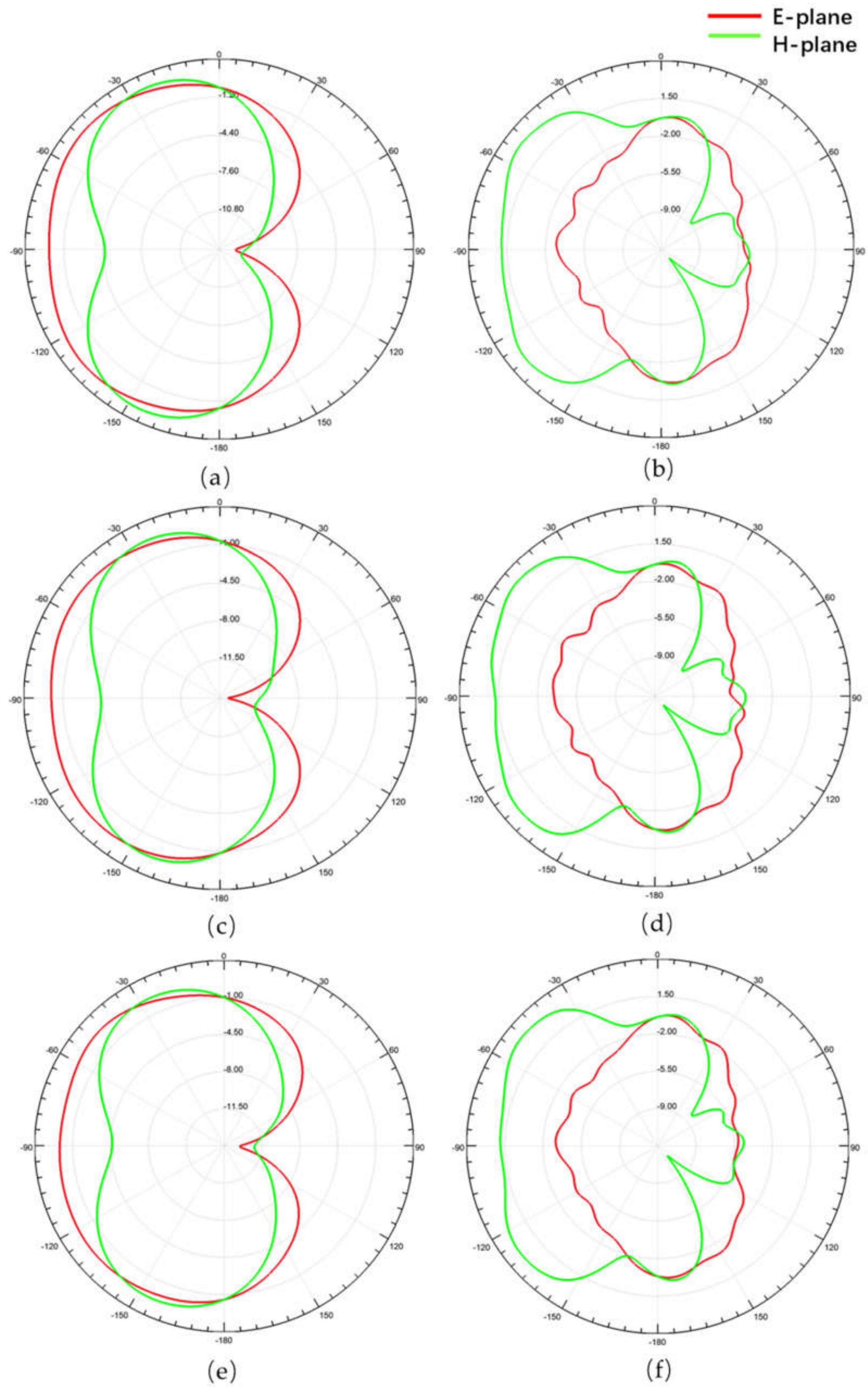

Figure S6. Comparison of Radiation pattern of antenna before and after adding obstacle. (a) Radiation pattern of the two columns at 2.45 GHz; (b) Radiation pattern of the two columns at 5.2 GHz; (c) Radiation pattern of the six columns at 2.45 GHz; (d) Radiation pattern of the six columns at 5.2 GHz; (e) Radiation pattern of the original manuscript at 2.45 GHz; (f) Radiation pattern of the original manuscript at 5.2 GHz.