Compact UHF RFID Tag Antenna for Application of Domestic Animals Management

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***Abstract*—This paper proposes a new design of compact UHF RFID tag antenna for the application of domestic animals management. Such tag antenna is derived from the regular dipole with bent half-circular-shape arms and deposed on the low-cost FR4 substrate. The designed tag antenna can be hung on the ears of the domestic animals for timely and effectively tracking the status of animals.**

Keywords—compact; dipole antenna; domestic animals; tag antenna

I. INTRODUCTION

Radio frequency identification (RFID) is the use of tags applied to various targets for the purposes of identifications and tracking by radio waves, which was developed around World War II. It is recently already widely used in supply chain management, animal tagging, and electronic payment in the Public Transportation Card. Recent years, radio frequency identification (RFID) has been developed to be a fundamental and important technique of the Internet of Thing (IoT), a vision in which the Internet extends into our everyday lives through a wireless network of uniquely identifiable objects [1]. Various kinds of RFID systems have been proposed in the past several decades, such as the active, passive and semi-passive frames operating at low frequency, high frequency, ultra-high frequency, and microwave ranges. The passive RFID system operating at ultra-high frequency (UHF) is anticipated as being the most practical because it offers a good balance between range (typically up to a few meters) and the ability to read multiple tags at speed [2].

Many kinds of UHF RFID tag antennas have been reported and used in the industries [3-6]. Those tag antennas can be mounted on elastic materials and metals with flexible shapes. Usually, the low frequency tags are used to track the status of pigs, cows, sheep and a other domestic animals, but however, these tags suffer from very short identification distance (just a few millimeters), which seriously affects the management efficiency. In this paper, we propose a new design of UHF RFID tag and its antenna for the high-efficiency management of domestic animals. The antenna of such animal tag is derived from the regular dipole with bent half-circular-shape arms and deposed on the low cost FR4 substrate. The designed tag antenna can be easily hung on the ears of the domestic animals for timely and effectively tracking the status of animals. Numerical simulations and experimental investigations are performed to demonstrate the proposed tag antenna.

II. UHF RFID TAG ANTENNA DESIGN

The proposed UHF RFID tag antenna for the application of domestic animals is shown in Fig. 1. The regular dipole is bent to half circular shape and placed on the one side of low cost FR4 substrate (εr=4.4 and tanδ=0.02) with thickness of 0.8 mm and hole shape. The tag chip is located at the inner edge of the hole substrate. For such design, the tag antenna can be hung on the ears of domestic animals using the fastener shown in Fig. 1(c). To make the tag antenna working properly at UHF band

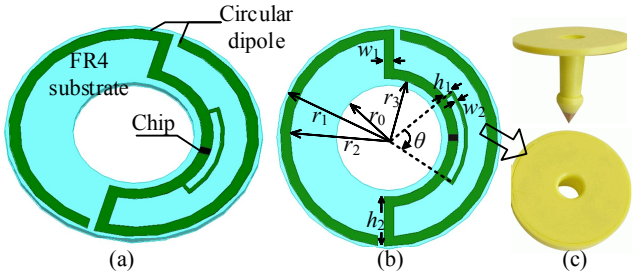

Fig. 1. The proposed UHF RFID tag antenna.

(915 MHz), the structure parameters are optimized by high frequency structure simulator (HFSS) and the values are concluded in Table I.

TABLE I. OPTIMIZED STRUCTURAL PARAMETERS (UNIT: MM)

r_0	r_1	r_2	r_3	h_1	h_2	w_1	w_2	θ
7.75	16.75	14.75	8.75	7.51	1.50	1.50	0.50	69 deg

III. TAG ANTENNA PERFORMANCE INVESTIGATIONS

After HFSS optimization, the obtained port return loss for the UHF RFID tag antenna is shown in Fig. 1(a). It should be noted that the antenna port impedance used here is set as 11+143j Ω to match the tag chip input impedance. As can be seen, the return loss is larger than 15 dB in the entire 900 MHz to 930 MHz range, and the maximum return loss is located at 915 MHz. So the proposed antenna can work properly at a wide frequency range in the UHF band.

The simulated far-field 3-D radiation pattern is shown in Fig. 2(b) which indicate a regular radiation feature of dipole, with "8"-like pattern in the E-plane and omnidirectional

radiation in the H-plane, as shown in Fig. 2(c) and (d). It means

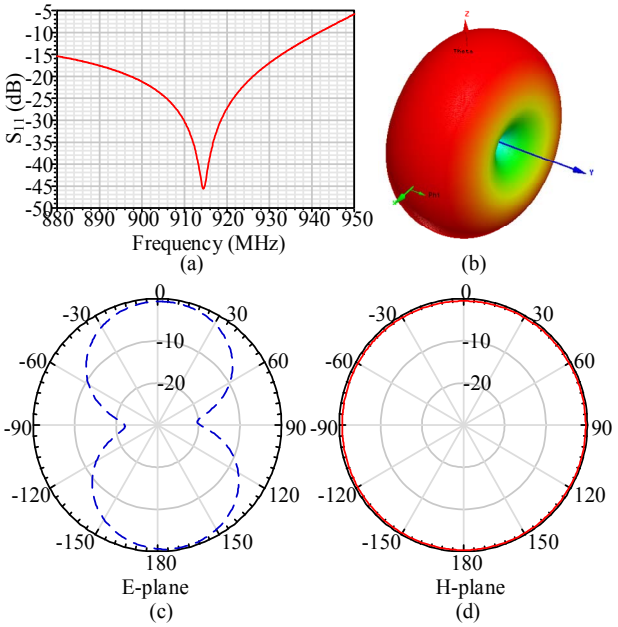

Fig. 2. The simulated performance for the UHF RFID tag antenna.

the designed tag antenna with bent half-circular shape did not affect the operating performance. So it can be used to hang on the ears of domestic animals for real applications.

Then the proposed antenna is fabricated and one sample is shown in the right side of Fig. 3. To characterize the antenna performance, we will not measure the antenna radiation pattern in chamber, but we directly measure the reading range by using a commercial UHF RFID reader. The whole measurement environment is shown in Fig. 3, including the control computer, UHF RFID reader module, measurement motherboard, UHF reader antenna, and the fabricated tag antenna with tag chip. One commercial UHF tag antenna is also measured for the comparisons. After measurements, the

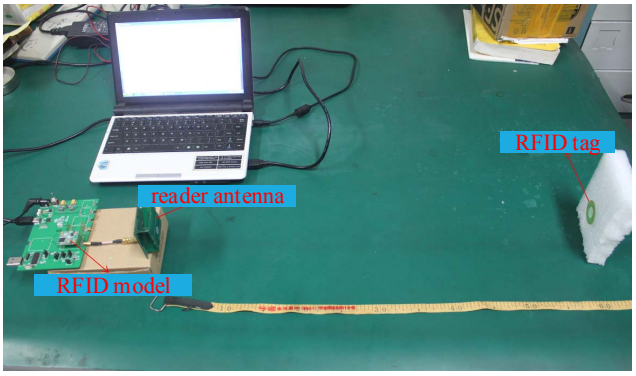

Fig. 3. The measurement envirements.

results are concluded in Table II. It can be seen that the proposed tag antenna in this paper has the similar reading performances compared with the commercial one. The communication range of the designed tag antenna has 60 cm range, which is suitable for most of the real environment applications.

TABLE II. MEASUREMENT RESULTS

distance / reading performance / types of the tag antenna	30 cm	50 cm	60 cm	80 cm
Reference tag antenna	10time/s	6times/s	1time/s	0time/s
The proposed tag antenna	10time/s	6times/s	1time/s	0time/s

IV. CONCLUSIONS

In this paper, a new miniaturized UHF RFID tag antenna composed of bent half-circular shape dipole is proposed and demonstrated for the animals management. The HFSS simulations and optimizations are performed firstly to get the tag antenna structure petameters, and then the designed antenna porotype is fabricated. The reading performances of the tag antenna with tag chip is experimentally measured by using the regular UHF RFID communication measurement environments, and the obtained results show the comparable performance with commercial tag antenna. The proposed antenna can be used for the status tracking of domestic animals.

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