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EM Study of Novel UHF RFID Application: Along-the-Metal Short Range Communication

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This work presents the preliminary study and the results of EM simulation of a short-range wireless communication for the new-type of UHF RFID applications. In a typical UHF RFID scenario, free-space communication from an interrogator antenna is utilized to activate the tags attached to various objects. Specifically designed so-called on-metal tags should be used if placed on metallic surfaces but the interrogation signal is still coming through the free space from the reader antenna located a few meters away from metal objects. Because of shadowing effects and strong interference from the large size metal objects, passive RFID tags often cannot be activated if the required identification of various 3D metal parts of construction equipment and machinery are attempted.

We present the modeling of the along-the-metal short-range wireless communication and propose to use it for the unconventional UHF RFID tracking of the large metal parts being used in the construction machinery. The physical foundations of the proposed communication method are related to the electric field-type human body communication being studied at different frequency bands with the practical application reported for example in [1]. In the application scenario considered in this work, both the reader antenna and UHF RFID on-metal tag are placed on the surface of a large steel bar while a standard UHF reader is used. To make the proposed communication possible, EM radiation from the reader antenna should be coupled to the special mode propagating along the lossy metal object with the electric field vector being normal to the metal surface and strong E-field amplitude is supported until the point where a tag is located. Taking into account the system application conditions, an 8 to 10m communication distance between the passive tag and reader antenna (the read range as measured along the metal) is required to make the system practically feasible. It is achieved by designing the reader antenna which is able to efficiently excite the propagation mode along metal surface and optimizing the antenna parameters and its exact placement close to the metal.

The advantage of the proposed communication is that the tag activation is not limited to the line-of-sight application scenario. Generally, the utilized E-field mode can propagate along the solid metal bar of arbitrary 3D shape to activate the passive UHF RFID tag placed in a spot where a conventional free space reader-to-tag interrogation is not possible. Depending on the mutual orientation and polarization of the reader antenna and the tag, in some cases the RFID interrogation can be assisted by the conventional direct reader-to-tag wave propagation but the most important contribution providing the 100% tag activation rate comes by the special mode propagating along the metal surface.

The results of EM simulation of the 2-element (i.e. reader antenna and tag) antenna system communication along the surface of 3D metal bar will be shown to illustrate the wave propagation and tag activation. Time-domain E-field distributions help to visualize the wave propagation mechanism and the required mutual placement of reader antenna and RFID tag. Some preliminary experimental results confirming the performance of the produced prototypes will also be presented.

1. T. Washiro, “Electric RFID communication via human body,” *Proc. of 2016 IEEE Conference on RFID Technology and Applications (RFID-TA 2016)*, September 2016, pp. 129-132, doi: 10.1109/RFID-TA.2016.7750748.