A Literature Review on Near Field Antenna for RFID Applications

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***Abstract*: Radio-frequency identification (RFID) is a rapidly expanding technology that enables radio detection and recognition of the objects associated with a univocal identification code carried by an electronic chip which is attached to RFID tag. The typical design of the RFID system deals with mainly two components which are RFID tag and the RFID reader, both the system consists of an antenna. So designing an antenna is one of the key factors in RFID systems. The Near-field reader antenna is a key enabling technology for UHF Gen2 item-level tagging systems. It is optimized to read near-field tags placed on products with a variety of packaging options. This paper is a review on near-field antenna for the RFID applications with frequency range of 865-868 MHz, using near-field magnetic coupling with far field gain of 6dBi. The antenna will be designed using CST tool and it will be fabricated on the printed circuit board for the required specifications.**

***Index Terms*: Near-Field Antenna, RFID Applications, RFID Reader, CST Tool, UHF.**

I. INTRODUCTION

Radio-frequency identification uses electromagnetic fields, automatically identify and track the tags which are attached to the objects. RFID belongs to group of technologies referred as Automatic Identification and Data Capture (AIDC). AIDC methods automatically identify the objects, collect the data from the object, and analyze the data. RFID system consists of two main components a RFID tag or label and RFID reader. The tag contains electronically-stored information and it can be either passive or active tags. Passive tags collect energy from a nearby RFID reader's interrogating radio waves whereas active tags have a local power source (like battery). Unlike barcode, the tag need not be within the line of sight (LOS) of the reader.

The reader antenna transmits the electromagnetic energy to activate the tags that realizes the data transfer from the reader and sends the instructions to the tag antenna. Meanwhile, the reader antenna receives information stored from the tags. Generally, the orientation of the identified object is random. The reader converts the radio waves to more usable form of data information collected from the tags. The reader antenna should be designed with low profile and realize attenuation.

II. ANALYSIS OF NEAR FIELD REGION

The fields surrounding an antenna are divided into three principle regions: reactive near-field region, radiating near-field or Fresnel region and far-field or Fraunhofer region.
The immediate vicinity of antenna there is a reactive near-field region, the fields are predominately reactive fields, where the E and H fields are out of phase by 90º to each other and the boundary of this region is given as

$$R < 0.62\sqrt{(D^3/3)} \text{--------------(1)}$$

The radiating near-field (Fresnel) region is a region where the radiation fields predominates. The electric and magnetic fields are in phase, but the angular field distribution is still dependent upon the distance from the antenna. The operating distance R of radiating near-field antenna is

$$R < 2D^2/\lambda \text{---------------------(2)}$$

D is the diametric size of near-field antenna, and λ is the wavelength of electromagnetic wave at 865-868MHz. As the high frequency RFID system, the field energy of UHF RFID system couples strongly in near-field with short distance. So the surrounding environment has little effect on UHF RFID system which works in near-field manner.
Far-field or Fraunhofer region is a region surrounding the reactive and radiating near-field regions. It extends to infinity and represents the vast majority of the space the wave usually travels. Here, the entire field radiates, the angular field distribution is essentially independent of the distance from the antenna and can be approximated with spherical wave-fronts. Since it is very far from the antenna, its size and shape are not important and approximate it as a point source. The electric and magnetic fields are in phase, perpendicular to each other and perpendicular also to the direction of propagation.

III RELATED WORK

The design of a switchable near-field (NF) and far-field (FF) reader antenna for ultra-high-frequency (UHF) radio frequency identification applications. An antenna array comprising four dipoles can be switched via reconfigurable feeding network to help strengthen the intensity of a magnetic field in an NF zone and improve the FF gain [1].

The design of electrically large loop type antennas for ultra-high frequency near-field radio frequency identification (RFID) readers is a challenge due to the inherent limitation of loop type antennas, which can overcome by the development of the zero-phase-shift-line (ZPSL) loop antennas for UHF near-field RFID systems [2].

The specific planar 2-element yagi array with a parasitic element loaded with a self-oscillating switching circuit can be used as RFID reader antenna. A theoretical concept of a wirelessly reconfigurable antenna, where wirelessly powered switches on parasitic elements are controlled by modulating signals embedded into the antenna transmission. The difficulty with practically implementing this concept is the need for additional protocol overhead to control the switches and the complexity of such intelligent switches. A self-reconfigurable antenna where a parasitic element is loaded with self-oscillating switching circuit [3].

The ultra-high frequency Radio Frequency Identification antennas deployed in recent years are fixed reader antennas and handheld reader antennas. The development trends of UHF RFID antennas are with respect to application point of view and the technical challenges [4].

The Dipole Spiral antenna structure was used to produce for the RFID application. And an innovative approach of chip less RFID Tag was introduced, by using conductive ink technology and paper substrate to produce a typical RFID tag. So, that the replacement of EMF coil (conductive material) is done here, to eliminate the loss that occurs in the tag [5].

A novel broadband Tag antenna for ultra-high frequency near-field and far-field radio frequency identification (RFID) applications. Near-field UHF RFID receives a lot of attention as a possible solution for item level tagging. The basic near-field UHF RFID concept is to make UHF RFID system work at short distances and on different objects as reliably as LF/HF RFID. In most of the near field RFID applications, the interaction between the RFID reader and tags is based on inductive coupling. The limitations of RFID systems are that they do not operate at short distances (near-field). To overcome this problem, a novel RFID reader antenna for simultaneous near-field and far-field operations at UHF band [6].

The use of simple transmission lines as near-field antenna for Ultra High Frequency Radio Frequency Identification (RFID) applications. The limitation of the reading/identification zone to the near-field region of the antenna is a challenging problem for UHF RFID application. Several solutions have been proposed during past years but most of them are complicate and expensive in the final implementation. A transmission line concept will show that is possible to achieve a limitation of the reading zone in a simple and effective way by using very simple antenna or coupling mechanism system between RF signal generated by RFID reader and UHF RFID Tag [7].

The Confinement of the detection region is a critical issue for some important RFID applications, where the coarse location of the object is required along with its identification. In the UHF band, it's a challenge to confine antenna radiation to reasonably sharp interrogation volumes, $< 10\ \lambda^3$, without resorting to physical barriers. A novel approach for RFID reader radiating structures that self-confine tag detection to a desired volume, avoiding undesired readings outside the interrogation volume was proposed [8].

The near-field coupling RFID system has steady performance in any environment, and is quite fit for item-level tagging. The near-field coupling antenna is based on near-field antenna, which has bending folded-dipole structure for antenna size-reduced and impedance-increased. For reducing effect of surrounding objects and antenna size-reduced, a near-field antenna of UHF RFID systems is researched , which works in magnetic field coupling manner and operates on near field of antenna[9].

IV PROPOSED METHODOLOGY

The RFID systems distinguish from each other by system usage, operating frequency, reading distance, protocol, power transfer to the tag, the procedure for sending data from the tag to the reader, and so on. The most general classification is so called "near-field" and "far-field" RFID, which is categorized by the method of power transfer between the reader and the tag. These two systems adopt different approaches, namely inductively/capacitive coupling and electromagnetic (EM) wave capturing. The near-field reader antenna is a key enabling technology for UHF Gen2 item-level tagging systems. The near-field antenna is designed for operation to enable reading of Item Level Tag which works with UHF Gen2 RFID tags that incorporate an inductive near-field component with high performance, low cost antenna solution which can be mounted top or bottom of the table.

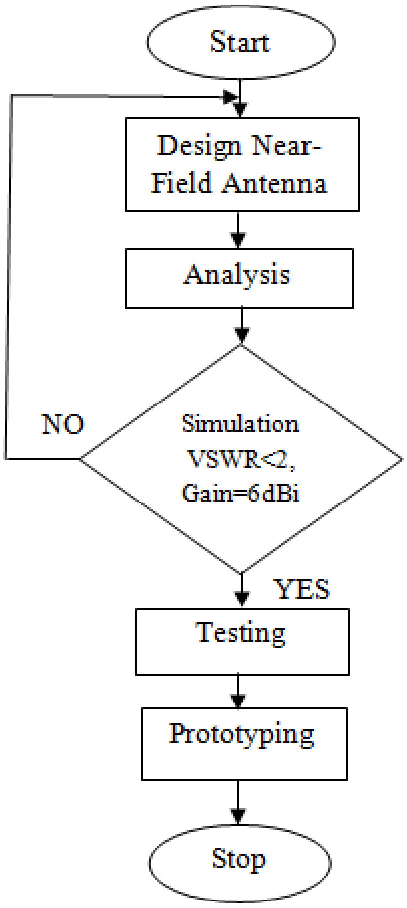

Figure 1: Flow chart of proposed methodology

V TOOLS USED

CST MICROWAVE STUDIO (CST MWS) is a powerful tool for the 3D electromagnetic simulation of high frequency components. CST MWS offered unparalleled performance, making is first choice in technology leading research and development departments.

CST 3D EM simulation software is user-friendly and enables to choose the most appropriate method for the design and optimization of devices operating in a wide range of frequencies. CST offers accurate, efficient computational solutions for electromagnetic design and analysis.

CST offers a multitude of simulation acceleration options such as multi-CPI processing, GPU processing, cluster computing, and distributed computing. CST MICROWAVE STUDIO is seen by an increasing number of engineering as an industry standard development tool. Accurate conformal methods improve simulation performance by orders of magnitude compared to standard approaches. Additionally, efficient implementation on powerful hardware delivers ax competitive edge.

VI CONCLUSION

The research motivation for this paper is to design and develop a near-field reader antenna for RFID application for the given specifications. The near-field antenna will be designed using CST tool and is analyzed using network analyzer.

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