UNIVERSITI TEKNOLOGI MARA

DESIGN AND IMPLEMENTATION OF ULTRA HIGH FREQUENCY 921 MHZ READER ANTENNA FOR INDOOR PROPAGATION

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ABSTRACT

In recent years, Radio Frequency Identification (RFID) technology is highly demanded in various applications, requiring a rapid development in the RFID technology. The Ultra High Frequency (UHF) RFID reader was selected for this research due to its further detection distance compared to the High Frequency (HF) and Low Frequency (LF). The research described in this thesis focuses on the development of the UHF RFID reader microstrip antenna designs to meet the requirements of certain applications which are long read range detection and in a small area. The proposed reader antenna has a unique and innovative design as it uses a combination of circular polarized technique, array, parasitic elements and complementary split ring resonator (CSRR) in order to increase gain and miniaturized the reader antenna. In this project, four designs of UHF-RFID reader antenna were proposed namely an UHF reader antenna (UHF-RA), an UHF reader array antenna (UHF-RAA), an UHF reader parasitic array antenna (UHF-RPAA), and miniaturized UHF reader parasitic array antenna (UHF-MRPAA). In the UHF-RA configuration, the behaviour of the circular polarized technique of single element was investigated. The objectives and target of this structure were to prove that the circular polarized method are achieved. At this stage, the design focused on the effects of the truncated patch at the corner to achieved the circular polarized reader antenna. Meanwhile, once the design of circular polarized reader antenna have been proven, the same antenna was upgrade to a 2 x 2 array structure known as UHF reader array antenna (UHF-RAA) in order to increase the gain. The parasitic elements were then added to the left and right of the every patches to increase the gain known as UHF reader parasitic array antenna (UHF-RPAA) which is produced higher gain 11.15 dBi as compare to UHF-RAA 10.04 dBi. Finally a miniaturized UHF reader parasitic array antenna (UHF-MRPAA) structure attached with the CSRR constructed from a UHF-RPAA was introduced. The CSRR elements were added to the ground of the UHF-RPAA and obtained a size reduction of 33.3% which was 208 mm x 208 mm x 1.6 mm. However, due to size reduction the gain dropped to 8.285 dBi. The simulation process was carried out using CST Studio Suite software, while the measurement of S_{11} and radiation pattern was done using Vector Network Analyzer and Spectrum Analyzer. The antennas were verified and validated by using two types of measurement which were Antenna Propagation Measurement and RFID System Measurement. The Antenna Propagation Measurement was done to make sure that the proposed antenna has the ability to transmit the signals and waves to the receiver (R_x) side. Nine types of UHF tag were used in RIFD System Measurement. From measurement, an UHF-RPAA with Frog 3D-UPM tag has achieved the longest read range distance with the value of 5.7 m. Meanwhile, an UHF-MRPAA gives 3.4 m of read range distance. Hence, the research has developed a high gain miniaturized UHF RFID reader microstrip antenna for Malaysian operating Frequency (921 MHz) in indoor propagation.

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TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

Recently, Radio Frequency Identification (RFID) technology has gained much attention from all over the world. Now RFID finds many applications in various areas such as electronic toll collection, asset identification, retail item management, access control, animal tracking, and vehicle security [1]. RFID is a technology that provides wireless identification and tracking capability and is more robust compared to barcode. RFID system is more flexible due to its ability to transfer the data-carrying device and the reader wirelessly using radio waves. Therefore, the amount of time needed to input the data manually can be reduced and also can increase the efficiency and accuracy of the operation [2].

Essentially, the system of RFID consists of a tag, reader, antenna, computer host and communication network. Reader (RFID interrogator) as radio frequency (RF) transmitter and receiver, controlled by a microprocessor or digital signal processor [3-4]. A RFID reader emits electromagnetic signals where a RFID tag draws power from it. This power is then used to energize the microchip's circuits. The chip then modulates the waves and sends back this modulated wave to the reader. This process is called backscattering where the reader sees the tag [5].

In RFID system, the role of antennas for reader and tag is very important to ensure the performance especially the read range distance. Antenna allows chip to transmit information that is used for identification. Though tremendous research is emerging on RFID reader antennas at Ultra High Frequency (UHF), this research is focusing on designing reader antenna which have circular polarization and high gain. The UHF offers greater read range distance over other frequency ranges. Circularly polarized reader antennas are widely used for RFID systems to ensure the reliability of communications regardless of tag orientation. The reader antenna should have circular polarization (CP) characteristic because the tag antenna can be arbitrary