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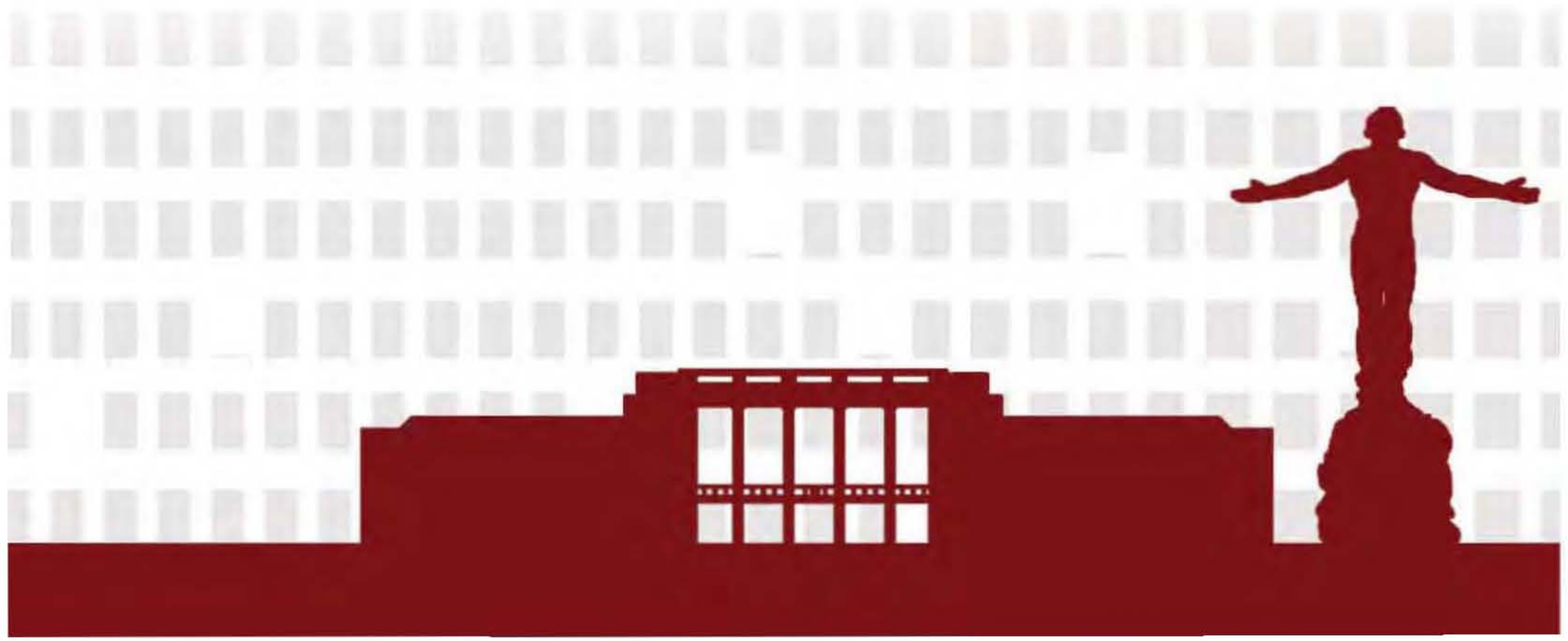

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Editors:
Dr. Joel Joseph S. Marciano Jr.
Dr. Jhoanna Rhodette I. Pedrasa
Dr. Rhandley D. Cajote

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DESIGN AND CHARACTERIZATION OF DIRECTIVE ANTENNAS FOR THE WIRELESS INTEGRATED AND SENSING PLATFORM (WISP)

Keziah B. Bartilad*, **Janette G. Salvatus, and Joel Joseph S. Marciano Jr.**

Electrical and Electronics Engineering Institute, University of the Philippines Diliman, PHILIPPINES.
*Email: keziahbartilad@gmail.com

ABSTRACT

The Wireless Integrated and Sensing Platform (WISP) is a passive Radio Frequency Identification tag implemented on a low-power integrated microcontroller, discrete RF front end and energy harvesting circuits. It also provides an interface for various sensors, such as temperature and light sensors and an accelerometer. The current WISPs are designed with dipole antennas that provide approximately omnidirectional coverage. This study describes the design of more directive antennas and their integration in the WISP. The enhanced directivity and gain is expected to help enable more applications for the WISP platform that require longer range [1].

As possible antenna designs, Ultra High Frequency (UHF) antennas with high gain and directivity were explored. One chosen design is the Yagi-Uda microstrip antenna since it has a high gain with a narrow bandwidth. The designed Yagi-Uda antenna is composed of two directors, a reflector, and a feed element. The feed element is a dipole antenna with a T-matching network. Having a matching network decreases the size of the antenna, and makes its impedance changeable [2]. Due to the desirable characteristics of the Yagi-Uda antenna, other antenna designs as possible feed elements to it were explored. The folded closed loop RFID antenna implemented in [3] was used because its resistance and reactance can be tuned separately by adjusting the antenna's dimensions. The folded dipole with a closed loop and Yagi Uda antennas were fabricated on FR4 boards with copper traces. Their radiation patterns are shown on Figure 1.

In terms of gain and directivity, significant improvement is seen when compared to the dipole antenna that has a gain of 2.41 dB. The gains of the folded dipole with a closed loop and the Yagi Uda are 5.1dB and 6.19dB respectively while the front-to-back ratios are 8.22dB, and 10.42dB respectively. For WISP 5.0, a minimum output voltage of 2.2V is needed to power it up. The output voltage is measured from the voltage regulator and is the input voltage to the microcontroller. Figure 2 shows the read distance against the WISP 5.0 output voltage. It was observed that the WISP could no longer be read at distances where the output voltage dropped below 2.2V. With the designed antennas integrated to the WISP 5.0, its range is enhanced from 2.75m to 4.25m for the folded dipole with closed loop, and to 4.5m for the Yagi Uda antenna both without sacrificing its performance.

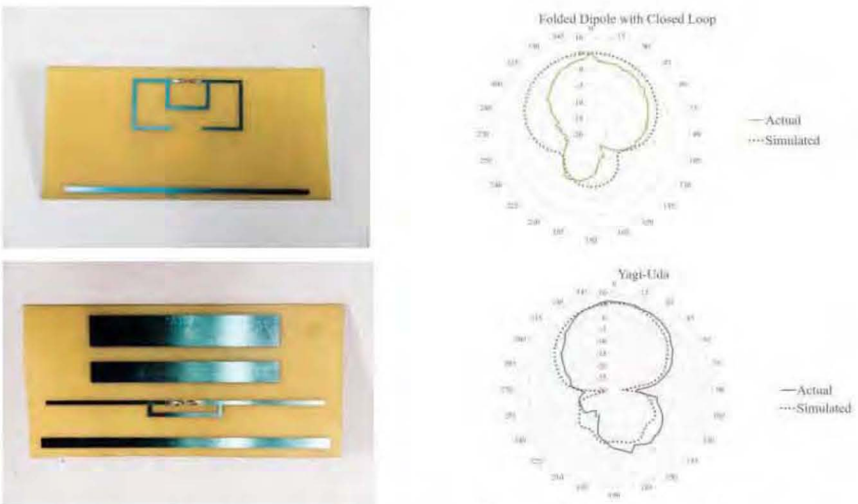

Figure 1. Antenna Designs and Radiation Patterns: Folded Dipole with Closed Loop (top), Yagi-Uda (bottom)

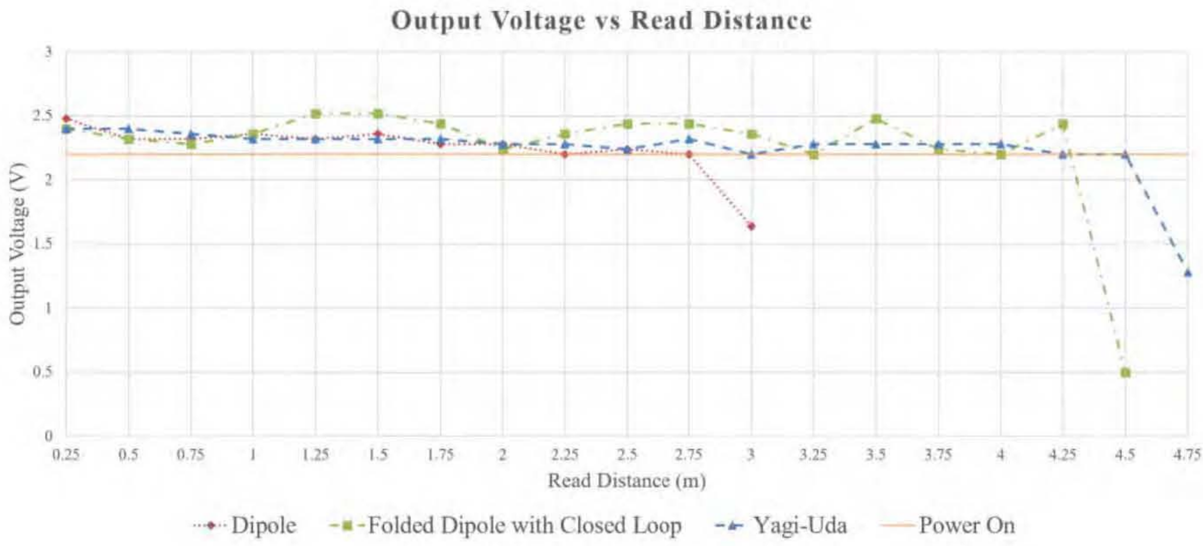

Figure 2. WISP 5.0 Output Voltage

Keywords: Antenna, Directive, Folded dipole, High Gain, UHF band, Yagi-Uda

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