Four Elements Array of Lungs Shape Patch Antenna for Nanosatellite Telemetry

Elyas Palantei and Syafruddin Syarif
Telecommunication and Information Engineering
Department of Electrical Engineering
Faculty of Engineering, Universitas Hasanuddin
Makassar, Indonesia
E-mail: elyas_palantei@unhas.ac.id

Bayu Topalaguna and Zakiy Ubaid
Student Association of Electrical Engineering Department
Faculty of Engineeing, Hasanuddin University, Makassar,
South Sulawesi, Indnesia
E-mail: usil.suka@gmail.com, bayu047@gmail.com

***Abstract*—The paper discusses some technical issues on the construction of antenna system incorporated with a designed nano satellite. The preliminary LEO satellite model has been developed for the environmental telemetry application. The designed four elements lungs patch structure was initially installed outside the prism body of nano satellite. The lungs antenna array was constructed in such away for electronic rotateable along 90^0 rotation, vertical or horizontal orientation. Both the numerical and experimental evaluations of 2.4 GHz lungs array confirmed a sufficient operation bandwidth suitable for long distance telemetry application, abruptly, 50 MHz could be achieved. The elliptical polarization property was verified via the numerical computation where the axial ratio was slightly greater than 5 dB.**

I. INTRODUCTION

The development of antenna technology today has grown rapidly and is applied to a very wide field of life. One area of application which is very attractive and has huge benefits for mankind is the application of various types of antennas as the integrated part of the satellite communication system intended for remote sensing purpose. One type of satellite technology that received much attention is nano satellite. Various types of nano satellite has been successfully constructed and tested since several years ago. These include the one that have been published, for example, by [1-6]. All the constructed satellite has the broad applications such as remote sensing, atmospheric transmission of data, and global environmental monitoring (i.e. weather and rain distribution and intensity).

The appropriate design of patch array is vitally important to be incorporated with a nano satellite system. The constructed antenna must be robust in minimizing some effects such as Faraday rotation, rain and any other depolarization phenomena which might be encountered along the communication link. The antenna must be designed to have the good polarization characteristic. This study evaluates the great potential properties of the so-called lungs patch array structure to act as the external antenna of the current assemblied nano satellite to be applied for the environmental monitoring telemetry.

II. NANO SATELLITE AND ARRAY ANTENNA DESIGN

The preliminary constructed nano satellite is shown in Figure 1. The satellite is initially designed to perform as a low orbit monitoring space station. It can be functioned for sensing and collecting various data such as image, temperature, humidity, light emission and so on. As visualized in Figure 1 (a), the physical size of the nano satellite is approximately 11.75 cm width and 25 cm height. Its casing body forms a prism. The antenna array is enable for the electronic rotation 90^0 changing from the horizontal to the vertical orientation and vice versa (see Figure 1 (a)). Inside the nano satellite box cover, a number of main electronic parts were installed. These include various sensors (i.e. light, temperature, humidity, etc), power supply system, 2.4 GHz transceiver module, mechanical unit, and other supporting units.

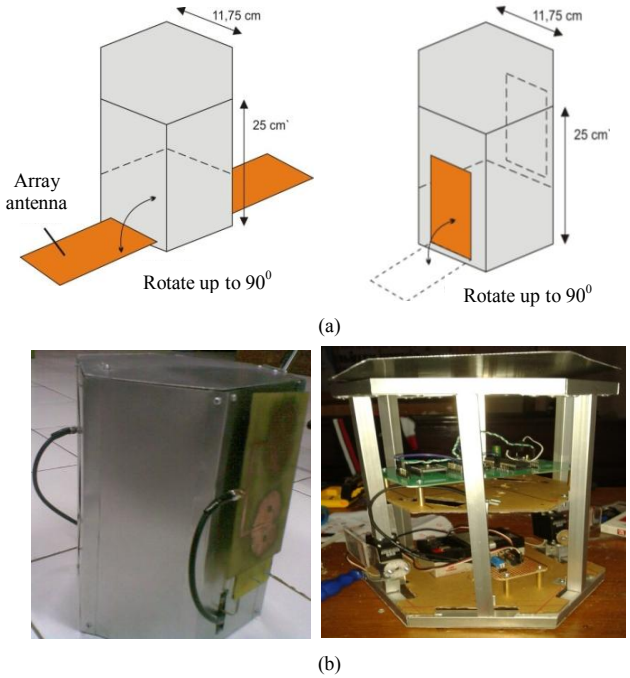
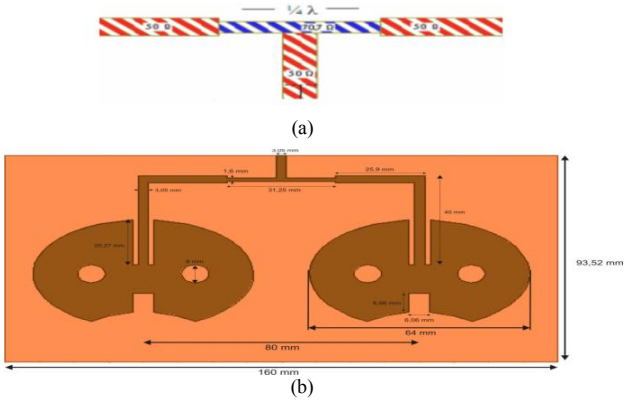


Figure 1. Nano satellite prototype and its corresponding four elements lungs shape linear array: (a) The schematic illustration, (b) The manufactured satellite

The schematic lay-out of the lungs shape antenna is depicted in Fig.2. It consists of three layers, i.e. the top conducting layer which has a lungs likely shape, the dielectric material inserted about one layer below the top layer, and the bottom layer acting as the ground plane. On numerical

computation and fabrication processes, the relative dielectric constant 2.17 and the loss tangent 0.0005 substrate were used. The thickness *h* of the dielectric material is 1.6 mm. The ground plane and the dielectric substrate size of one set lungs array are approximately 160 mm length and 93.52 mm width.

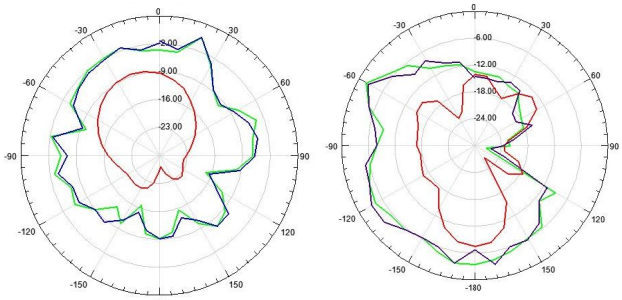
The four elements array of lungs shape patch antenna was built by configuring two sets of an identical two elements lungs shape structure (see Figure 2 (b)) in the linear array configuration as previously described in Figure 1 (a) and (b). These identical two elements array are connected each other from single feeding line using a T-junction network (see Figure 2 (a)). Each set of lungs shape array is connected to 50-Ohm RF-coaxial.



(a) (b)

Figure 2. Two elements of lungs shape array: (a) T-junction, (b) schematic lay-out.

III. ANTENNA EVALUATIONS



(a) (b)

Figure 3. The pattern properties of lungs shape array: (a) Azimuthal pattern, (b) Elevation pattern, Note: the red-line (simulated), the blue and green lines (measured)

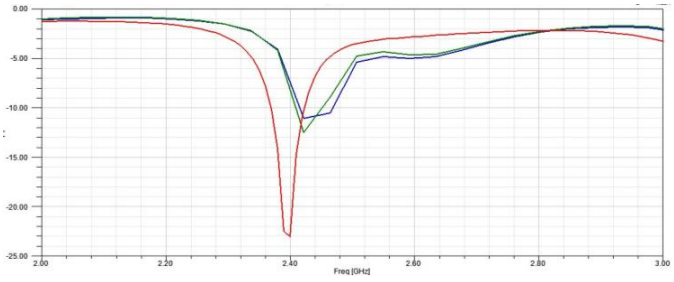


Figure 4. The reflection coefficient property (S_{11})

The radiating element of a lungs shape patch antenna model has been constructed utilising the addition and subtraction algorithms to the commonly known forms of a patch metal layer including four elliptical and some rectangular forms in the numerical computing process using FEM-HFSS Version 13. The experimental evaluation were also performed to all antenna models. Several numbers of lungs shape array properties are described in Figures 3. The constructed antenna pattern is still has the broad beampattern. The beamwidth is greater than 20^0. According to the simulated and measured S_{11} depicted in Figure 4, it is found that the average bandwidth is approximately larger than 50 MHz.

IV. CONCLUSIONS

Four elements of the lungs shape patch array antenna has been designed, fabricated and tested. The bandwidth that the antenna system can provide is in average 50 MHz. The operation frequency is at around 2.4 GHz and axial ratio slightly greater than 5 dB suitable for the incorporation with the constructed nano satellite system.

ACKNOWLEDGEMENT

The authors would like to thanks to Faculty of Engineering (FoE), Universitas Hasanuddin for providing a sufficient R&D funds. This research activity is partly funded through Mandiri research grant via 2012 DIPA budget of FoE UNHAS.

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