Circularly Polarized Microstrip Antenna Array for UAV Application

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***Abstract*-This paper present a circularly polarized microstrip antenna array for Unmanned Aerial Vehicle (UAV). The antenna element is designed using conventional rectangular microstrip antenna which is electromagnetically coupled fed by a microstrip line. The 1x4 element microstrip antenna array is then assembled on the surface of UAV cylindrical fuselage. The measurement result showed for 1x4 element antenna array that it operates at frequency 5.6 GHz with return loss characteristic of -22.24 dB,. The impedance bandwidth at VSWR < 2 is 720 MHz. Moreover, the radiation pattern show omnidirectional. Both simulation and experimental results show the proposed antenna radiation characteristics can be achieved as specified.**

I. INTRODUCTION

Recently UAV (Unmanned Aerial Vehicle) is becoming common in use for both civil authorities and military use. For military, the UAV can be used for spionase as well as for missile launch attack, while for civilian, UAV is widely used for exploring, mapping, monitoring and surveillance [1]. The UAV's mission usually required various link types such as telemetry, telecommand and payload communication link. Payload communication link usually needs larger bandwidth; therefore the UAV needs antenna with wideband characteristic.

In Indonesia, the UAV research has also been carried out e.g. at the Agency for Development of Research and Technology (BPPT) that has developed various types of UAV. These UAV are for civilian purposes [2].

Microwave Remote Sensing Laboratory of Chiba University has developed UAV that use linearly polarized microstrip antenna for its payload communication link [3]. However, due to the aircraft manuver, the linearly polarized antenna used will result in the disruption of data link communication. To keep data link continuiously available therefore a circularly polarized antenna is needed.

In this paper a circularly polarized microstrip array antenna is proposed in order to have communication from UAV to Ground Control Station and vice versa from any direction.

II. ANTENNA DESIGN

In the proposed antenna system, a single element circularly microstrip patch antenna is used. The geometry of antenna is shown in Fig. 1 which is a rectangular patch antenna with corner truncation to achieve circular polarization [4]. The antenna is designed to be working at ISM band 5.6 GHz. The antenna is electromagnetically coupled with microstrip line feeding system [5]. This single element antenna is first designed to perform it basic radiation characteristics.

Furthermore a 1x4 element antenna array is assembled on the surface of cylindrical fuselage as shown in Fig. 2. Each element is located at the top, bottom and the 2 sides of the fuselage to obtain omnidirectional pattern. Each antenna element then connected through 1 to 4 power divider.

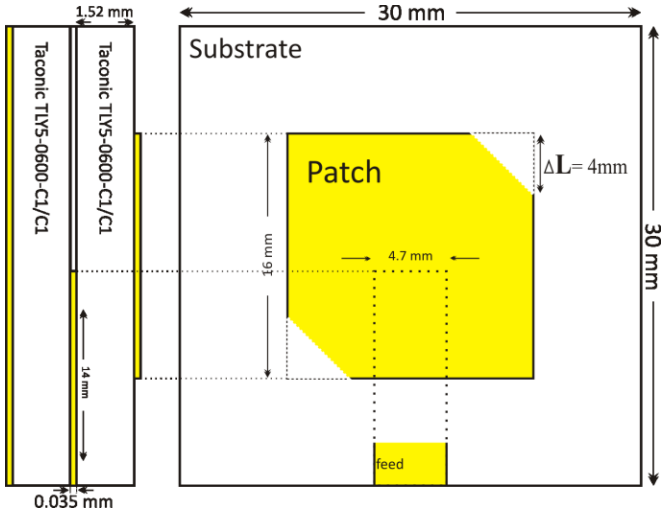

Figure 1. A single element circularly polarized microstrip patch antenna

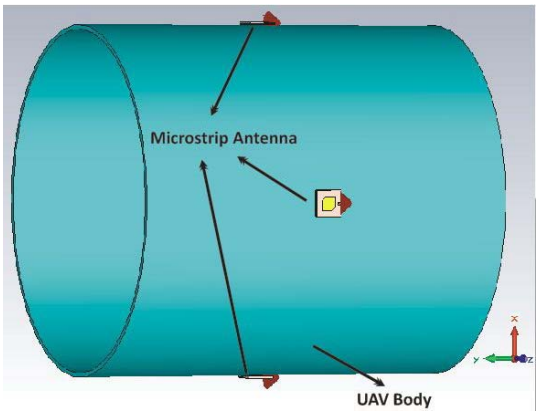

Fig. 2 Antenna array configuration on the surface of cylindrical fuselage

III. RESULTS AND DISCUSSION

The proposed single element antenna was simulated using CST Microwave Studio software with excellent radiation characteristics. Furthermore the antenna element is arrayed on the surface of cylindrical fuselage. The simulation results showed the return loss characteristic and the radiation pattern characteristics. The simulated return loss characteristic exhibit value of – 14.25 dB at the design frequency. The result also showed the antenna array impedance bandwidth is about 952 MHz at VSWR < 2 as depicted in Fig. 3. Radiation patterns showed almost omnidirectional for both phi = 0 and phi = 90 as expected as shown in Fig. 5 and Fig 6, respectively.

The proposed antenna array was then fabricated and measured. The antenna was fabricated using Taconic dielectric substrate with relative permittivity of 2.2, thickness of 1.52 mm and tanδ = 0.0009. The measurement of return loss characteristic was performed using a HP 8753D network analyzer. The result is shown in Fig. 2 where exhibit return loss value of -22.24 dB and VSWR < 2 impedance bandwidth of 720 MHz. The measured radiation patterns showed omnidirectional for both phi = 0 and phi = 90.

The simulated and measured radiation characteristics are displayed in Fig. 2 to Fig. 4. It can be seen that the results showed very good agreement in the desire frequency range. Both radiation pattern at phi = 0 and phi = 90 were measured at 5.6 GHz.

Furthermore, the antenna array gain was also measured which show 5 dB. The circularly polarized radiation pattern shows in Fig. 7.

Fig. 3. The photograph of fabricated assembled antenna on the surface cylindrical fuselage

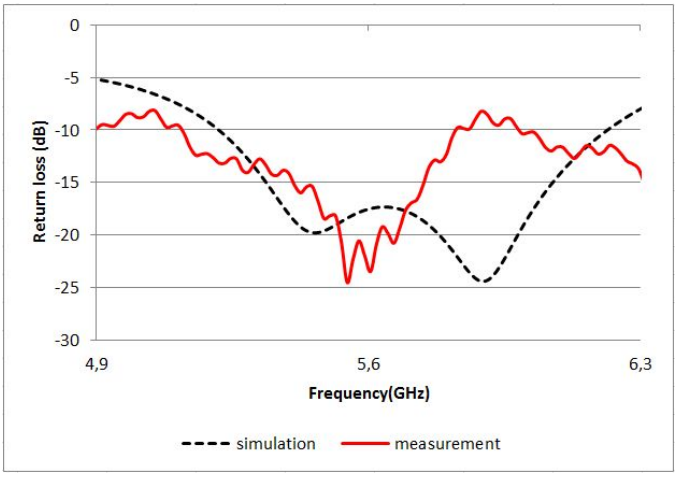

Fig. 4. Return loss characteristic comparison of 1x4 microstrip antenna array.

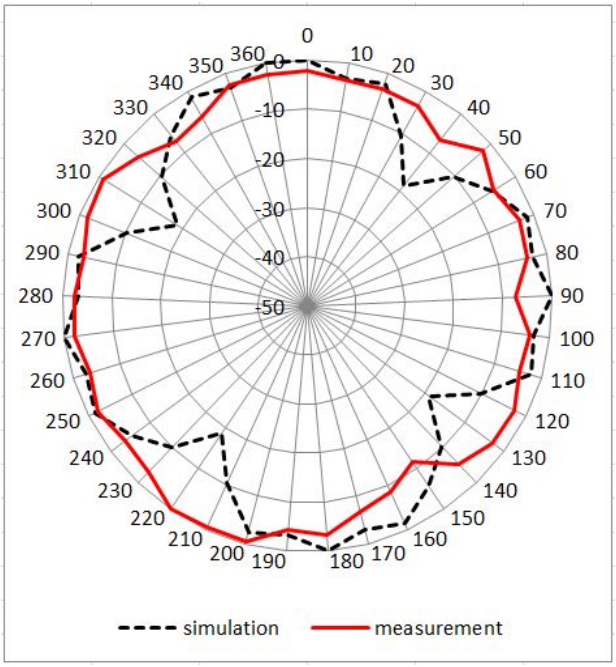

Fig. 5. Radiation pattern comparison between simulation and experiment result at phi = 0.

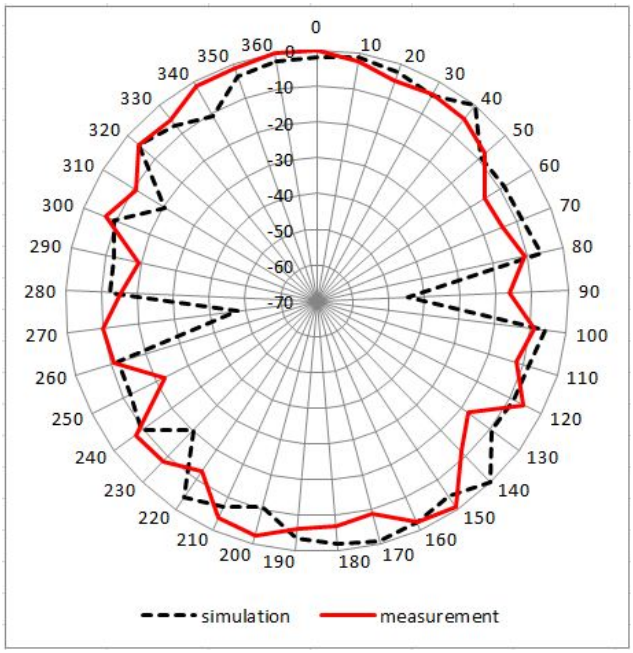

Fig. 6. Radiation pattern comparison between simulation and experiment result at phi = 90

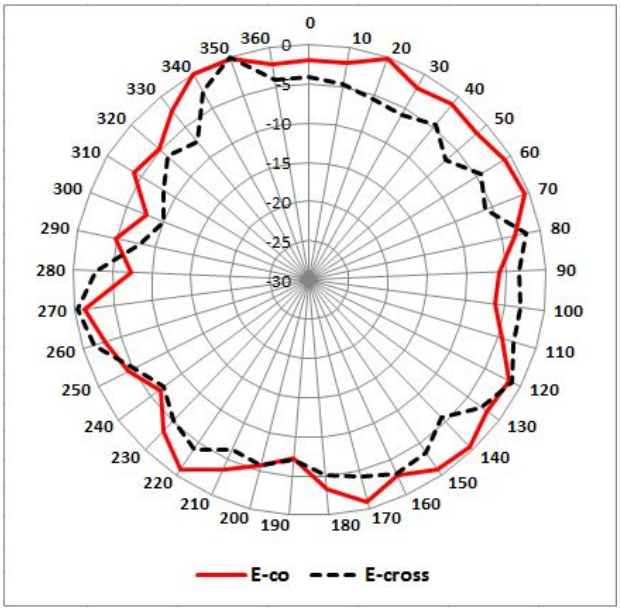

Fig. 7. Circularly polarized radiation pattern measurement for microstrip antenna array on UAV fuselage

IV. CONCLUSION

This paper proposed a circularly polarized 1x4 microstrip antenna array for small UAV. The proposed antenna has been designed, simulated and measured using Taconic dielectric substrate with dielectric permitivitty 2.2. Both simulation and experiment results of the proposed antenna radiation characteristic using cylindrical model fuselage show a good agreement. Further study will be carried out to study for original size of UAV.

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