Analysis of Microwave Signal Attenuation through Oil Palm Trees

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***Abstract*—This paper is a preliminary study to investigate the attenuation of microwave propagation on the oil palm trees at three different frequencies, which are 0.9 GHz, 1.8 GHz and 2.3 GHz. The purpose is to analyse the travelling wave behavior by determine the signal strength through vegetation. A test site of homogeneous planted oil palm trees was chosen to get the valid and reliable measurements. The experiments were also carried out the analysis with consistent transmission paths under different number of trees (1, 2, 3 and 4) at distance of 4 m which obstructing the signal path with different height (trunk, fruit and leave). The findings obtained reveal the characteristics of received signal as the distances and number of trees increasing.**

***Keywords*—Analysis; Microwave; Signal; Attenuation; Oil Palm Trees**

INTRODUCTION

Absorption of wave, normally known as attenuation is the loss in the received signal when it propagates through obstacles. It is extremely an important issue that needs to be considered in the planning of telecommunication networks especially for offering the good area of coverage, reducing the unwanted signals, improving and enhance the quality, performance also quality of service in rural areas.

Propagation effects on the communication systems in the microwave frequency bands have been investigated in many years with different features of vegetation medium such as species, length, diameter, thickness, orientation, distribution, shape, size, moisture, volume density, geometry, frequency, height, humidity etc. (Selim et al, 2010, Cuinas et al, 2009 and Joshi&Sancheti, 2008). Many previous scientific papers on the microwave path loss induced by reflection, polarization, refraction, scattering, diffraction, absorption, propagation, etc. on the radio channel performance at different frequencies have been presented. It is relating to the variations of terrain contours, environment, wavelength, propagation medium, the distance, position, location, incident and elevation angle of the transmitter and receiver antennas etc. (Tishchenko et al, 2007).

The objective of this pilot analysis is to study the electromagnetic wave attenuation spectral behaviors by obtaining the signal strength under a volume of oil palm trees using the same transmission paths start from tree 1 until tree 4 at a distance of 4 m which is obstructing the radio signal link at the level height of trunk, fruit and leave. The findings show a great importance where the microwave rays experience an excess attenuation due to the the effects of the obstacle presence such as tree (Khan et al, 2008 and Tishchenko et al, 2007).

MEASUREMENTS

Transmitter

A MARCONI signal generator generates the ultra high frequency of 0.9 GHz, 1.8 GHz and 2.3 GHz which was fed to a Yagi Uda antenna with the direction of antenna angle was set to 0°. The antenna was mounted on a mast where the height can be adjusted following the level of trunk, fruit and leave of oil palm trees. The signal generator produces 1 mW transmitted power.

Receiver

The reception signal was received by a Yagi Uda antenna. It was mounted on a mast with the setting of height was same with the transmitter antenna. The angle of 180° was used as a direction of antenna which gives the maximum power received signal. The received signal was displayed on a spectrum analyzer.

Test site

The analysis were performed at a homogeneous planted oil palm trees estate at Batu 9, Kampung Kebun Baru, Kuala Langat, Selangor. The length between the trees in rows and columns are about 8 m and 7 m with the high up to 8 m. The average size of the leave are 11 cm long with wide of 5 cm and the trunk diameter is

approximately 25 cm. The transmitter and receiver positions in the test site is shown in Figure 1.

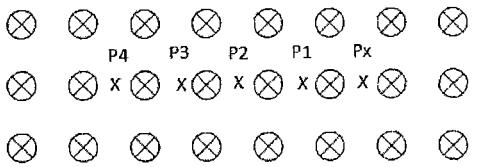

Figure 1. Transmitter and receiver positions in test site.

⊗: oil palm tree
P_1, P_2, P_3 and P_4: receiver position
P_X: transmitter position

Measurements Campaign

The created experiments campaign set up of microwave attenuation for horizontal polarization waves transmitted through the oil palm trees were conducted at 0.9 GHz, 1.8 GHz and 2.3 GHz. The transmitting antenna was placed inside the estate at a static center position between oil palm trees. The receiving equipments was also located inside the estate. The receiver antenna was placed at the fixed center location of about 4 m distance with different number of trees, i.e at tree 1, 2, 3 and 4 with different height at level of trunk (1.5 m), fruit (4 m) and leave (5 m). Both transmitter and receiver antennas were located at the same heights which facing to each other. They are in line-of sight (LOS) which obstructed by the oil palm trees between them.

RESULTS

Table 1 : Received signal for distance 4 m with frequency at 0.9 GHz

Number of trees	Received signal (dBm)			Power level (pico watt)		
	trunk	fruit	leave	trunk	fruit	leave
1	-78.27	-75.18	-73.27	18.53	37.52	47.14
2	-79.83	-78.67	-77.33	8.57	10.79	18.24
3	-85.17	-81.67	-79.17	4.54	6.80	7.63
4	-88.83	-86.67	-85.33	2.15	3.04	3.98

Table 2: Received signal for distance 4 m with frequency at 1.8 GHz

Number of trees	Received signal (dBm)			Power level (pico watt)		
	trunk	fruit	leave	trunk	fruit	leave
1	-87.46	-86.94	-85.42	3.58	3.57	3.91
2	-89.33	-88.17	-87.67	2.89	2.04	2.58
3	-90.53	-89.73	-88.53	1.28	1.36	1.69
4	-92.57	-91.35	-90.67	0.97	0.97	0.89

Table 3: Received signal for distance 4 m with frequency at 2.3 GHz

Number of trees	Received signal (dBm)			Power level (pico watt)		
	trunk	fruit	leave	trunk	fruit	leave
1	-90.15	-87.14	-86.14	1.84	2.47	2.85
2	-91.33	-88.67	-88.33	1.65	1.76	1.12
3	-92.25	-89.69	-89.53	0.65	0.86	0.71
4	-93.79	-91.35	-91.54	0.63	0.53	0.58

DISCUSSION

The analysis exhibits the significant reduction of the received signal power through the oil palm trees with different frequencies, height and number of trees. This distinct differences of attenuation are related to the propagation of microwave ray on the structure features of the tree (Wright et al, 2008 and Cuias et al, 2007) between transmitter and receiver (Khan et al, 2008 and Alejos et al, 2007).

Based on the results, it shows the trend that the strength of received signal degrades as the frequency and the number of trees increasing. Averagely, the power level is also decreasing from the leave, fruit to trunk. The decrement of received power at the frequency of 0.9 GHz is rapidly. The attenuation is high for the distance of the first two trees measurements compared with the last two trees. But, at 1.8 GHz and 2.3 GHz, the received signals power are reducing gradually. So, conclusion, the power level is high for the leave medium rather than trunk and fruit.

CONCLUSION

It is clearly observed that the received signal attenuation from the oil palm trees is larger for the high frequency (Selim et al, 2010 and Cuinas et al, 2009) also the depth and density area of trees (Horak et al, 2010, Takahashi et al, 2008 and Khan et al, 2008). The variations of the loss are due to the water content which give the moisture condition to the wooden trunk and unpredictable continuous movement of the foliages effected by the wind (Cuias et al, 2007). The attenuation decreased when frequency decreased (Selim et al, 2010).

For the future work research, the expanding measurements will focus on different elevation and incidence angle by extending the variety depth of vegetation media, path geometries and frequencies with different locations, positions, conditions, time and situations. It will give more information in understanding the characteristics of path loss effects on radio signals around the vegetations.

ACKNOWLEDGMENT

Thanks a lot to all who supporting and contributing to this paper.

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