Traditional Software Development for WLAN Propagation Model

Anwar Hassan Ibrahim*, Mahamod Ismail*, Kasmiran Jumari* and Tiong Sieh Kiong**

Abstract - SPWPM traditional software development is surveyed and essential problems are investigated on the basis of system wireless link considerations. This paper presents the current state software planning tools for wireless LAN link optimization. The software directory is based on combination of MatLab and MapInfo software and measurement which gives the best grouping parameters to build up the software development. Among the requirements assumed, the WLAN site selections must be Line-of-sight (LOS) or near line of sight (NLOS) field strength prediction for either point to point or point to multi points. The results obtainable the out put of the program include two-dimensional (2D) and three dimensional (3D) plots for creating the link; design parameters through GUI representing the height and location for each antenna is depending on K-factor of the area and transmit antenna location.

Keywords: Software planning tools for WLAN propagation model (SPWPM), Wireless Local Area Networks (WLAN), Line-of-Sight (LOS), Near Line of Sight (NLOS), point to point (P2P), point to multipoint (P2MP) link optimization, K-Factor, Digital Terrain Model (DTM).

1. Introduction

Radio Propagation came a long way in the twentieth century. With the help of modern communications we can almost predict what's going to happen over any given wireless link! The exact environments study has become a significant issue to both utilities and services due to the widespread use of WLAN such as telecommunications which are sensitive to signal disturbances. It is important to measure the environments related disturbances accurately according to the exact definition of each element category. To achieve an accurate measurement, a highly software monitoring tool is needed. For such environments, ray tracing-type simulation models are adequate and their use is justifiable (Danilo Erricolo 2002), usually applied to make path loss estimates in complex environments such as those found inside cities. In fact, cities are geometrically and electrically too complex to be analyzed using full wave method. Even with ray-tracing methods, a full three dimensional (3D) investigation is very difficult to achieve and, there for, a simpler two-dimensional (2D) problem is examined (Martin pohl 2005).

Presently, there are many commercial software monitoring tools available due to the propagation model, which are based on either experiments or ray tracing tools. All these monitoring tools came with communications capabilities for data collection, data processing and results presentations. SPWPM based propagation offer several advantages such as software upgradeable, low cost and simple tools consumption. The major advantage of SPWPM-based MATLAB-GUI is that the tools are acceptable to customize any WLAN link optimization either for point to point or point to multipoint using genetic algorithm (GA), because there is almost some menu, icons and including help. Further more; SPWPM cost is cheaper than the commercial software as in TEMS planner and AirMagnet software. However, there are limitations in these software is that they do not detect and classify the environments.

So as to implement an intelligent software monitoring tools, a new SPWPM-based monitoring tool is proposed. In this project, the tools are based on MatLab-GUI

because the environment of this software is distinct to gain the purpose of propagation model in terms of having higher computing method to display the result through Graphical User Interface. Furthermore, it's more useful for mathematical functions (Paul Davis 2005) rather than other software used for general operations, and also MatLab-GUI has been used in wide applications in telecommunication, signal and image processing (Wendy L. M. 2002). The designed software architecture makes use of WLAN planner, either point to point or point to multipoint under different conditions. There are many software's done for WLAN propagation model such as simplest ray-tracing model in two-ray, which assumed signal propagation in one direct ray path between the transceiver and only one reflected path from the earth

* Department of Electrical, Electronic & systems Engineering, Universiti Kebangsaan Malaysia (anwar@eng.ukm.my, dr_mbi@eng.ukm.my, kbj@eng.ukm.my)
** Department of Electrical, Electronics Engineering, University Tenaga Nasional in Malaysia (siehkiong@uniten.edu.my)
Received 20 July 2006 ; Accepted 5 January, 2007

(Andrea Goldsmith 2005). In the same time it was applied to the site-specific for radio propagation modelling in wireless applications (Fernando Aguado Agelet, Fernando Perez), but no one combine all the specification of the environments together for propagation monitoring. The objective of developing the software-based MATLAB monitoring tool is to analyze, classify propagation of the signal and at the same time detect the link optimization using advanced digital Terrain model (DTM) technique such as building, hills and other obstacle analysis. The GUI architecture and the DTM implementation are discussed in the paper. Preliminary experimental results displaying the K-Factor analysis of the sample area in Bandar Baru Bangi (BBB) are included.

2. Line of Sight Characterization

Line of sight is commonly used to refer to telecommunication links that rely on a line of sight between the transmitting antenna and the receiving antenna. Such capability is necessary for high frequency microwave links that offer relatively high bandwidth communication circuits. Typical operating frequencies are in the gigahertz frequency range where the radio path is not reflected or refracted to any great extent.

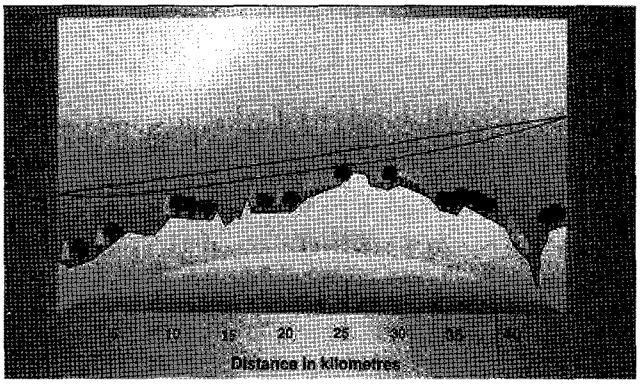


Fig. 1. Example path profile

Radio waves travel in a straight line, unless something refracts or reflects them. But the energy of radio waves is a big deal; they spread out the farther they get from the radiating source, like ripples from a rock thrown into a pond. Microwave bands will likely be used in fourth-generation multimedia mobile communication systems (H. Masui, 2001). Some research, however, still needs to be done on propagation characteristics.

3. The Research Method

The work involves design of software development for WLAN propagation model and link optimization. The architecture of the software in terms of a flow chart is shown in Fig. 2. The prototype of chart uses a conditioning module for mains input and output simulation. A MATLAB-GUI running simulation is interfaced with GeoIfno software and data collect from the field.

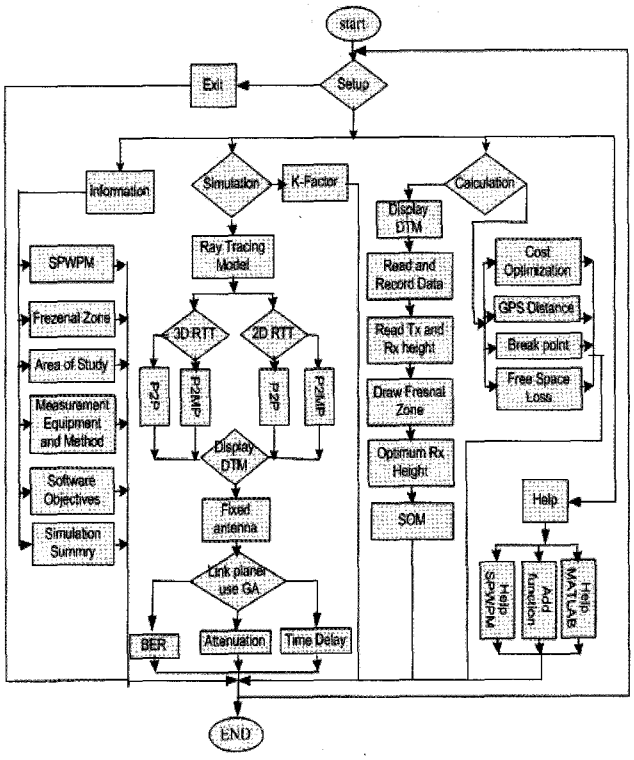


Fig. 2. Flow chart architecture of the prototype SPWPM monitoring tools

The areas concerned in this study consist of Bandar Baru Bangi (BBB) as set of digital terrain model (DTM) was produced, using site survey. The counters from theses maps were digitized manually and the heights information was then converted to a DTM in which terrain heights were stored as mean height. Heights along straight-line paths between any two given points in the study region were recorded using GPS device. it is fair to say that; they have been a great deal of ongoing research in this area. It is also fair to conclude that much of the available information need improvements particularly. This includes the desire to develop a physics-based deterministic models that take into account propagation environments such as mountains, building and atmospheric regions. For this model, Fig. 3 shows the main window of the software using the MATLAB version 6.5 programme. And Fig. 4 explain the way of the measurement tools with the base station. The GUI is to determine suitable input values.

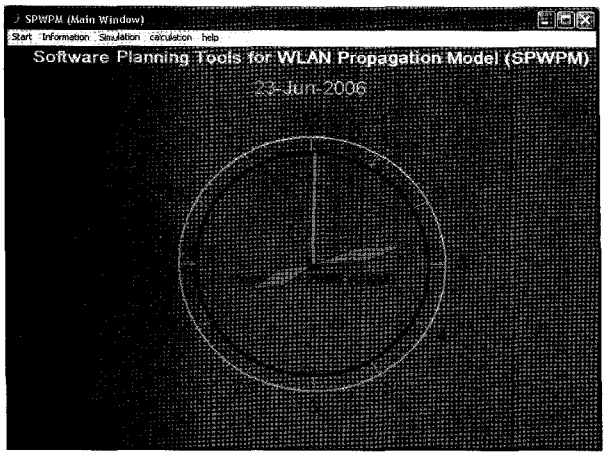
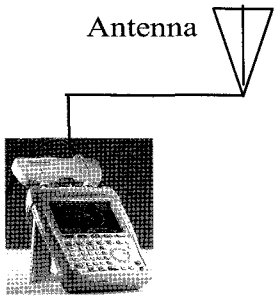
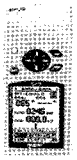


Fig. 3. Main window of SPWPM



(a) Spectrum analyzer



(b) GPS device

Fig. 4. Measurement tools

Programming with measurements is by means of using the MATLAB software development. MATLB has graphical capabilities provide an integrated development environment in which to incorporate the software tools for code generation, such as a DTM and link optimization. For future work, genetic algorithm will be used for a more complete system to better conFig. the measurement parameters, manage data and display the wave guide. The GUI used to control and obtains output from the MATLAB function converter to display the graph. Thus, the main application of the SPWPM is to execute all the codes on it. In this work, propagation model with measurements and ray tracing tools as well as GA will be used for ray detection and automatic system recognition. It is used because the ray arrival processing which represents signals in terms of time delay is often unsuitable for processing signals and it does not transparently represent the variation of wave content with time.

4. K-Factor Calculation

The required path clearance is usually expressed, for a particular *k*-factor, as some fraction of the first Fresnel zone radius (ashraf. G 1995). Radio transmission loss in tropospheric propagation depends on characteristics of the atmosphere and the terrain. The most important atmospheric parameter is the refractive index gradient near the earth surface. This surface gradient largely determines the bending of a radio ray through the atmosphere.

The refraction index of air is very close to unity. The radio refractivity, N, is defined as:

$$N = (n-1)\times 10^6 \tag{1}$$

where n is the index of refraction.

At radio frequencies, the radio refractivity may be approximated by [Bean 1966]:

$$N = 77.6\frac{AP}{T} + 3.73\times 10^5\,\frac{H}{T^2} \tag{2}$$

where AP: atmospheric pressure (mbar).
T: absolute temperature (Kelvin).
H: water vapor pressure (mbar).

The effective earth radius K which is a function of the refractivity gradient or of the mean surface refractivity, N_S, is chosen to characterize average atmospheric conditions. The effective earth's radius for regional difference in average atmospheric conditions is defined as:

$$K = 6370[1 - 0.04665\exp(0.005577N_S)]^{-1} \tag{3}$$

The actual radius of the earth was taken to be 6370 kilometer. The refractivity, N_S, represents the surface refractivity reduced to the sea level. The Fig. produced by Bean, Horn and Ozanich (Ashraf G. 1995) shows minimum monthly mean values of radio refractivity, N, through the world. The corresponding surface refractivity N_S is then:

$$N_S = N_o\exp(-0.1057h_S) \tag{4}$$

where h_S is the elevation of the earth's surface in kilometer above the mean sea level.

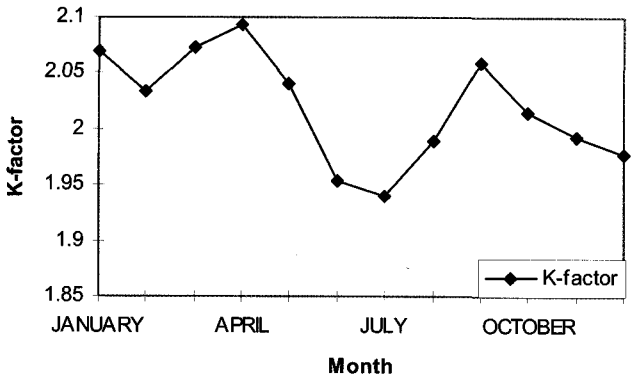


Fig. 5. The k-factor at Bandar Baru Bangi in 2004

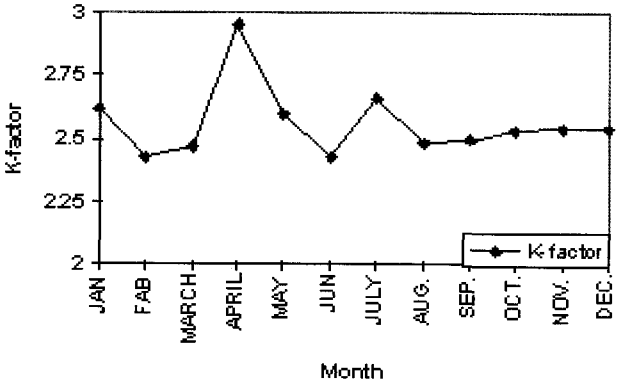


Fig. 6. The k-factor at Bandar Baru Bangi in 2005

Table 1. The maximum and the minimum K-factor values in Bandar Baru Bangi.

year	*Min K-Factor*	*Max K-Factor*
2004	*1.95*	*2.1*
2005	*2.4*	*2.82*

5. Result and Discussion

Using MapInfo and MatLab language program, the wave in the path link optimization between point-to-point and point-to-multipoint optimization system during path resources are rapidly calculated and viewed while modifying the input parameters conveniently using the main graphic window. The results were displayed in excel. A Graph-mode window can open up to the list of the results, with additional information. Help window includes information of the various parameters and calculation about the link. In this version, the software display a screen consisting of different menus should come into a view after run and setup the system to display the full information statement, only need to press the icon as shown in Fig. 7. The graphical window use to draw the path profile and automatic antennas build with the first Fresnel zone ellipse will come out in the screen. The inputs parameters are chosen from the main window are considered and analyzed depend on K-factor value. Fig. 8

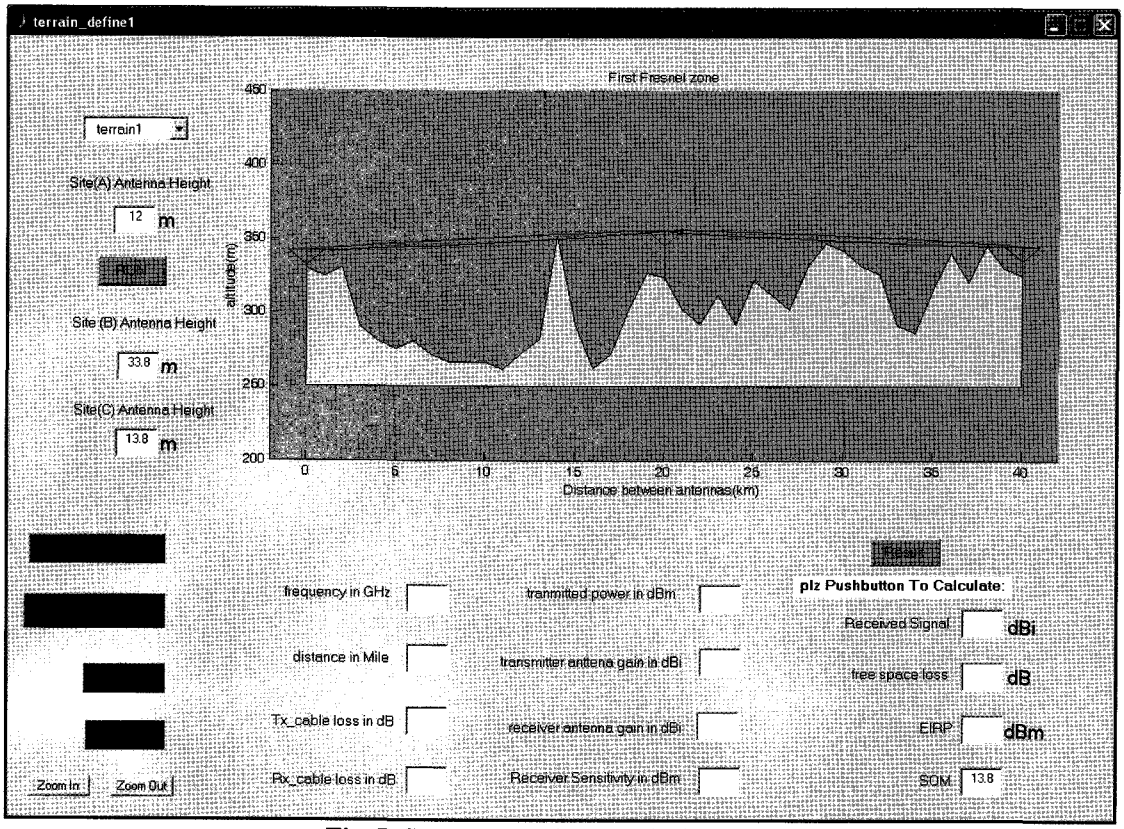


Fig. 7. System operating margin for WLAN

display the average K-factor in 5 years; Fig. 6 show the outdoor testing power level prediction at UNITEN University as apart of the software using measurements by the spectrum analyzer and GPS. Fig. 10-a & b shows ray tracing tools for 2D and 3D, simulation.

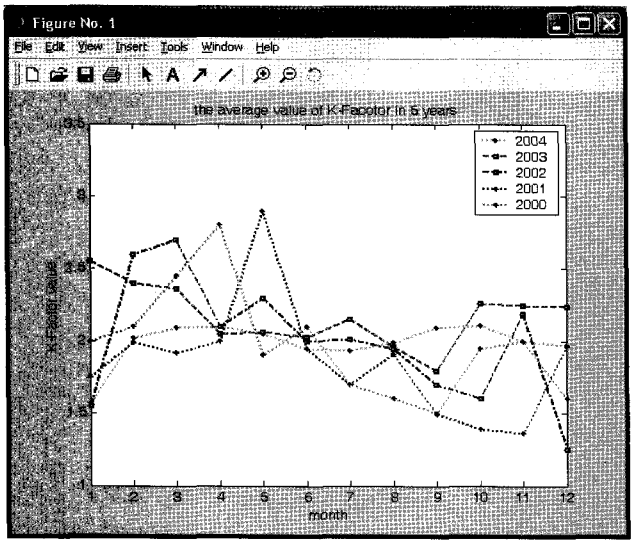


Fig. 8. K-factor value in 5 Years

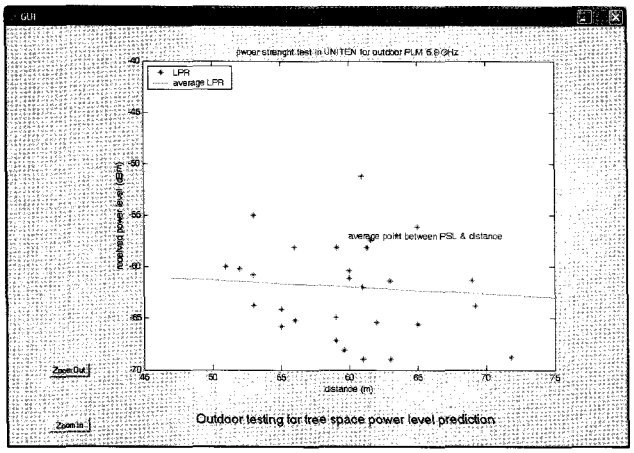


Fig. 9. Outdoor testing for power level prediction

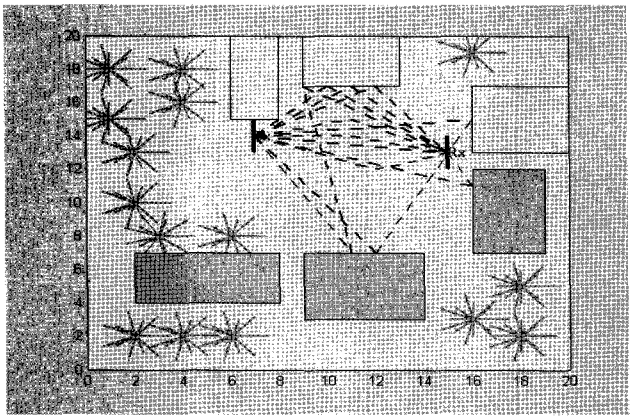


Fig. 10-a. Two dimension

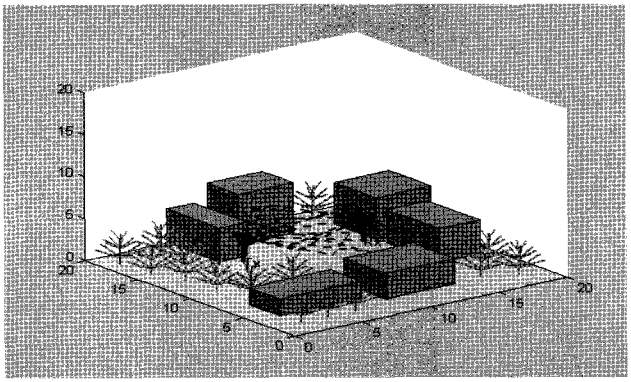


Fig. 10-b. Three dimension (3-D)

6. Conclusion

A SPWPM monitoring tools based on MATLAB-GUI and MapInfo has been designed for the purpose of evaluation and analysis signal propagation model. The software architecture clarifies the structure of the system in terms of component and interaction among them to accomplish the desired requirements. SPWPM depend on ray tracing method, detailed topographical information, it is fully integrated design, measurement, optimization, and management tools characterized by combined bottoms in each window to access the others. Fig. 3 show the interface specification of the system, which allow user to define the value needs, and Fig. 10-a & b gives the result of ray tracing tools for two and three dimensions. Additional work is going to carry out to take into account other propagation mechanisms present in outdoor environments, for example, to model scattering by big objects such as building, trees, rain, etc. and also simple elements such as cars, poles, humidity and temperature will be introduced in the simulator to represents real objects. Furthermore, wall or front spread scattering effects will be introduced using MATLAB programme.

For future work, the AirMagnet and a genetic algorithm representation as well as GPS and spectrum analyzer will be used to get better configuration processing.

Acknowledgment

The authors wishes to thank and appreciate acknowledge to the support and assistance which provided by government of Malaysia. This project contributed endlessly to the field of study under IRPA 04-99-03-0001PR0059/09-09.

Reference

[1] Andrea Goldsmith. 2005. Wireless Communications. Stanford University.

[2] Ashraf, G. E. A, & Faizal, A. Z. (1995). A software tool for cost Optimization of microwaveradio relay link. New Peach, Calafornia, USA (IEEE AP-S International Symposium and URSI Radio Science).

[3] Ashraf, G. E. A., & Faizal, A. Mohd. Z. 1995. Optimizing the cost of Microwave Radio Networks. Proceeding of 2nd. IEEE Malaysia Conference on Communication 2 (12.6): 1-4.

[4] Danilo Erricolo, Giuseppe D'Elia & Pieriorgio L E Uslenghi. 2002. Measurements on scaled methods of urban environments and comparisons with ray-tracing propagation simulation, IEEE transaction on antennas and propagation, vol. 50, no.5, Pages: 727 – 735, may 2002.

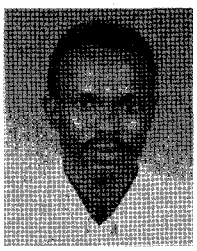
[5] Fernando Aguado Agelet, Fernando Perez & Arno Formella. Radio- Tracer. Atool for Deterministic Simulation of wave Propagation, url= citeseer.ist.psu.edu/147096.html.

[6] H. Masui, M. Ishi, S. Takahashi, H. Shimizu, T. Kobayashi, and M. Akaike "Microwave propagation characteristics in an urban quasi line-of-sight environment under different traffic conditions," *IEICE Trans. Commun.*, vol. E84-B, pp. 1431–1439, May 2001.

[7] Martin Pohl. 2005. Cosmic ray propagation. IDS report SWG meeting SLAC Low state University, September 2, 2005.

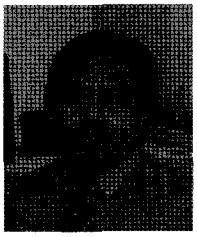
[8] Paul Davis. 2005. Differential Equations: Modeling with MATLAB.

[9] Wendy L. Martinez & Angel R. Martinez 2002. Computational statistics handbook with MATLAB, Chapman & Hall/CRC.

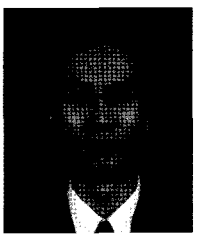


Anwar Hassan Ibrahim
He is currently PhD student and Research Assistance in the Department of Electrical, Electronic & systems Engineering, Universiti Kebangsaan Malaysia. He received the B.Sc(Hons). degree in Electrical from Sudan University for Science and Technology in 2000, the M.Eng. degree in Communication and Computer Engineering from Universiti Kebangsaan Malaysia in 2004. His research interests Wireless propagation and artificial intelligent. He is committee member of IEEE UKM Student Branch, Malaysia, holding the Vice Chapter Chair 2005/2006 and 2006/2007.

Mahamod Ismail
He is currently Associate Professor Dr. senior lecturer with the Department of Electrical, Electronic and Systems Engineering, faculty of Engineering, University Kebangsaan Malaysia. He received his B.Sc. (Hons),. from University of Strathclyde, United Kingdom, 1985, the M.Sc. degree UMIST, Manchester, United Kingdom, 1987, and the Ph.D. from University of Bradford, United Kingdom, 1995. His research interests include Mobile, Personal and Satellite Communication beside Wireless Networking and Broadband and Multimedia. He is IEEE member in Vehicular Technology Society. He is with the first Malaysian Microsatellite (Tiungsat-1) team engineer. He is also actively involved in Working Party 1/1 ITU-R Malaysia and chaired Task Group 2 of that working party who study on International Mobile Telecommunication for year 2000 at frequency 2000 MHz (IMT-2000). He also involve in giving courses under Celcom Academy such as on Wireless Communication, Analog and Cellular Radio, Antenna, Satellite Communication, Teletraffic Engineering and others..



Kasmiran Jumari
He is currently Professor Dr. senior lecturer with the Department of Electrical, Electronic and Systems Engineering, faculty of Engineering, University Kebangsaan Malaysia. He received his B.Sc.(Hons),. from University Kebangsaan Malaysia 1976, his M.Sc. degree University of Aberdeen, 1977, and the Ph.D. from University of Kent, UK 1985. His research interests include Image Processing, Multimedia Communication, Computer Networking, Network Security and Instrumentation. MIPM, MIEE.



Tiong Sieh Kiong
He is currently senior lecturer with the Department of Electrical, Electronics Engineering, University Tenaga Nasional in Malaysia. He received the B.Sc. degree in Electrical and Electronics Engineering from Universiti Kebangsaan Malaysia in 1997, the M.Sc. degree in Communication Engineering from University Kebangsaan Malaysia in 2000, and the Ph.D. from Universiti Kebangsaan Malaysia in 2006. His research interests include mobile communication, wireless networking and artificial intelligent. He is committee member of IEEE Communication Society, Malaysia, holding the post of treasurer.