RECONFIGURABLE SLOTS ANTENNA BASED ON MECHANICAL MOVEMENT FOR SMART COMMUNICATION SYSTEM

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DOCTOR OF PHILOSOPHY

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electronics and Computer Engineering

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Doctor of Philosophy

2021

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A thesis submitted
in fulfillment of the requirements for the degree of
Doctor of Philosophy

Faculty of Electronic and Computer Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this thesis entitled "Reconfigurable Slots Antenna Based on Mechanical Movement for Wireless Communication System" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Doctor of Philosophy.

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Supervisor Name : PROFESOR MADYA DR. MOHAMAD ZOINOL ABIDIN BIN ABD. AZIZ

Date :……………………………………….

DEDICATION

Dedicated to ALLAH Almighty, my loving wife, parents, and my families for your infinite and unfading love, sacrifice, patience, encouragement, and best wishes

ABSTRACT

Nowadays, the increasing number of mobile users has exponentially increased mainly due to new applications' demand by users, such as video streaming, media social communication applications, online banking or e-wallet, and multiplayer online gaming. Thus, the cellular provider needs to provide the best coverage direction to the specific clients. Radiation pattern reconfigurable antennas are a solution that enables changes in radiation pattern while maintaining the frequency bands based on the system requirements. Therefore, the objective of this research was to design a new reconfigurable co-planar waveguide (CPW) slot antenna based on parasitic element movement. All antennas were designed, simulated and analysed using Computer Simulation Technology (CST) Microwave Studio. Then, the antennas were fabricated in a fabrication laboratory. The next step was to measure the fabricated antenna for several parameters in the laboratory. The research started with an investigation of a multi-layer slot on a microstrip patch antenna. The results showed that the multi-layer slot did not improve the bandwidth of the microstrip patch. By adding the three-shaped slot, it created a triple band as compared to only two bands obtained for the microstrip patch without 3-shaped slots. For example, for microstrip (MS) Antenna *B1* and MS Antenna *B2*, they maintained the first resonant frequency at 2.52 GHz. For the second resonant frequency, they shifted from 5.01 GHz to 4.97 GHz and created a third band at 6.18 GHz. Next, the studies on the CPW slot antenna were done by using three different basic geometry slots, which consisted of a rectangular slot, a plus-shaped slot and a circular slot. In CPW Antenna *C*, it was shown that the effect of increasing the number of small rectangular slot from a single slot at CPW Antenna *C1* to three slots at CPW Antenna *C3* could improve 500 % for the second bandwidth of the resonant frequency from 120 MHz to 720 MHz and improve 88.36 % of return loss from 14.26 dB to 26.84 dB. It also changed the shape of the radiation pattern. In CPW Antenna *F*, the change of the T-slot location from CPW Antenna F1 to CPW Antenna F3 could affect the main lobe to change the direction that was opposite to each other. From the observation, for CPW Antenna *I*, the beam of the main lobes could be controlled or tuned from 90^0 to 270^0 by changing the location of the single square parasitic element from CPW Antenna *I1* to CPW Antenna *I4*. This also showed that at CPW Antenna *L*, the changes of slots could change the radiation pattern direction. For the first resonant of CPW Antenna *L3* and CPW Antenna *L4*, it reflected the opposite main lobe direction changes. Besides that, the second resonant of CPW Antenna *L3* and CPW Antenna *L4* was also reflected to change to the opposite side of lobe direction. This design can be used for a developed smart antenna system for the future wireless communication system, such as a radar system.

ANTENA SLOT BOLEH DIKONFIGURASI SEMULA BERDASARKAN PERGERAKAN MEKANIKAL BAGI SISTEM KOMUNIKASI WAYARLES

ABSTRAK

Pada masa kini, peningkatan bilangan pengguna mudah alih telah meningkat secara eksponen terutamanya disebabkan oleh permintaan aplikasi baru oleh pengguna, seperti streaming video, aplikasi komunikasi sosial media, perbankan dalam talian atau e-wallet, dan permainan atas talian berbilang pemain. Oleh itu, pembekal selular perlu menyediakan liputan yang terbaik kepada pelanggan mengikut keperluan. Antena yang dapat dikonfigurasi semula dengan pola radiasi adalah penyelesaian yang memungkinkan perubahan corak radiasi sambil mengekalkan jalur frekuensi berdasarkan keperluan sistem. Antena yang boleh dikonfigurasi adalah salah satu penyelesaian yang dapat mengoptimumkan liputan terbaik untuk lokasi yang dikenal pasti tanpa menggunakan antena yang banyak. Oleh itu, matlamat projek ini adalah untuk merekabentuk antena padu gelombang satah (CPW) beralur yang boleh dikonfigurasikan melalui pergerakan elemen parasit. Semua antena adalah direka bentuk, disimulasi dan dianalisis menggunakan CST Microwave Studio. Kemudian antena difabrikasi di makmal fabrikasi. Langkah seterusnya adalah untuk mengukur beberapa parameter bagi antena yang telah difabrikasi di makmal. Penyelidikan bermula dengan penyiasatan alur berbilang lapisan pada antena tampalan mikro jalur. Hasil kajian menunjukkan bahawa alur berbilang lapisan tidak menunjukkan penambahabaikan pada jalur lebar antena tampalan mikro jalur. Melalui penambahan slot berbentuk 3, ia membentuk tiga jalur berbanding dua jalur yang diperolehi pada tampalan mikro jalur tanpa slot berbentuk 3. Sebagai contoh, untuk Antena MS B1 dan Antena MS B2, ia mengekalkan frekuensi resonan pertama pada 2.52 GHz. Untuk frekuensi resonan kedua, ia beralih dari 5.01 GHz ke 4.97 GHz dan mencipta jalur ketiga pada 6.18 GHz. Seterusnya, kajian yang telah dilakukan pada alur antena CPW dengan menggunakan 3 slot geometri asas yang berbeza, terdiri daripada alur segi empat, alur berbentuk tambah dan alur bulat. Dalam Antena CPW C, ia menunjukkan bahawa kesan peningkatan bilangan slot segi empat kecil dari slot tunggal pada Antena CPW C1 menjadi tiga slot pada Antena CPW C3 dapat meningkatkan 500 % untuk lebar jalur kedua frekuensi resonan dari 120 MHz hingga 720 MHz dan meningkatkan 88.36 % kerugian pulangan dari 14.26 dB kepada 26.84 dB. Ia juga mengubah corak radiasi yang dibentuk. Dalam Antena CPW F, perubahan lokasi T-slot dari Antena CPW F1 ke Antena CPW F3 dapat mempengaruhi lobus utama untuk mengubah arah yang berlawanan antara satu sama lain. Dari pemerhatian, untuk Antena CPW I, pancaran lobus utama dapat dikendalikan atau ditala dari 90^0 hingga 270^0 dengan mengubah lokasi elemen parasit persegi tunggal di dalam Antena CPW I1 menjadi Antena CPW I4. Ini juga menunjukkan bahawa pada Antena CPW L, perubahan slot dapat mengubah arah corak radiasi. Untuk resonan pertama Antena CPW L3 & Antena CPW L4, ia mencerminkan perubahan arah lobus utama yang berlawanan. Selain itu, resonan kedua Antena CPW L3 dan Antena CPW L4 juga mencerminkan untuk berubah ke arah lobus sisi yang bertentangan. Reka bentuk ini boleh digunakan untuk membangunkan sistem antena pintar untuk sistem komunikasi tanpa wayar masa depan, seperti sistem radar.

ACKNOWLEDGEMENTS

In the Name of Allah, Most Gracious, Most Merciful

First and foremost, I would like to thank ALLAH for giving me the strength and courage to complete this thesis, as well as giving me the opportunity, courage and patience to carry out this work. I feel privileged to glorify His name in the sincerest way through this small accomplishment. I seek His mercy, favour and forgiveness.

I would like to express my deepest gratitude to my supervisor, Associate Professor Dr. Mohamad Zoinol Abidin Bin Abd. Aziz for his constant patience, support and constructive guidance for this research. I would also like to thank the technician at laboratory for his cooperation and support.

Last but not least, I would like to express my appreciation to my beloved parents, my wife and my family for the unconditional love and support that let me through the toughest days of my life. To all my friends who shared ideas to make my thesis better, I hope we can obtain a good grade for our effort. To those who are not stated here, I would like to thank you for your help, friendship and countless support to me. May Allah S.W.T. bless all of you for your support and kindness.

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