Faculty of Electronics and Computer Engineering

BEAM STEERING TECHNIQUE FOR HALF WIDTH MICROSTRIP LEAKY WAVE ANTENNA

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BEAM STEERING TECHNIQUE FOR HALF WIDTH MICROSTRIP LEAKY WAVE ANTENNA

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DECLARATION

I declare that this thesis entitled “Beam Steering Technique for Half Width Microstrip Leaky Wave Antenna” 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 the candidature of any other degree.

Signature : ……

Name : Mowafak Khadom Mohsen……

Date : ……

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.

Signature :…….…….

Supervisor Name : Dr. Mohd Sa'ari Bin Mohamad Isa

Date :……...……..……..

DEDICATION

I dedicate my research work to my family, and my friends. A special feeling of gratitude to my father, my mother, my brothers, my sisters, my wife who encouraged me and a push for the tenacity to improve myself throughout all my moves in the life and whom have always been with me to overcome difficult times in my life.

I also dedicate this research to my friends to everybody whom have supported me through my life. I always miss, and I cherish the memories that we had. Thank you for giving me a chance to prove myself, I love all.

ABSTRACT

The main beam of a uniform Leaky wave antenna (LWA) steers between near broadside at low frequencies and near endfire at high frequencies. However, it has been found extremely difficult to achieve a broadside beam from a uniform LWA. Consequently, this limitation of uniform LWAs to radiate towards broadside has attracted interest from the research community. In this research, presents a new design of the uniform half-width microstrip leaky-wave antenna (HW-MLWA) array to achieve high radiation in the broadside direction. The proposed design comprises the two elements of HW-MLWA placed at straight line, and this array is fed by a single probe in the center of two elements. The proposed antenna is designed, fabricated, and validated. The measured impedance bandwidth is 10.75% (4.4 – 4.9) GHz, and the maximum measured gain at broadside is 10.02 dBi. A Modify technique to enhance impedance bandwidth of single layer (HW–MLWA) with continuous main beam scanning to increase scanning range in automotive radar. The enhancement is carried out by etching four circular slots on the radiation element. The wide main beam scanning is between $+12^{o}$ to $+70^{o}$ when operation frequency sweeping between 4.3 to 6.5 GHz. The measured impedance bandwidth of 49.9% (4.28 GHz to 7.13 GHz) with peak gain 10.31 dBi at 5 GHz. Finally, this research presents a new half–width microstrip leaky wave antenna (HW–MLWA), which can electronically control its beam at a fixed frequency using a double-gap capacitor with diodes, resulting in better impedance matching and small variation gain while scanning in altimeter radar to measure altitude of ground. The elementary building blocks of this antenna are HW–MLWA and seven control unit cells (CUCs). A reconfigurable CUC is created by combining two triangle patches as double–gap capacitors with two diodes as a switch to connect the patches with the ground plane. Control switches is used to achieve backward–to–forward beam scanning at a certain frequency, a gap capacitor in each patch cell is independently disconnected or connected by using a PIN diode switch. The reactance profile at the free edge of the microstrip is modified when the state of the patch cell is changed, which in turn, shifts the main beam direction. The proposed antenna prototype has the capability to scan the main beam forward between (+28° to +67°) and backward between (−27° to −66°) at 4.2 GHz. Furthermore, a periodic HW–MLWA array is presented. It can electronically control its beam at fixed frequency using a double gap capacitor with diodes and has good impedance matching and very small variation gain while scanning. When the state of the patch cell is changed, the reactance profile is altered at the free edge of the microstrip that caused the direction of the main beam to change. This proposed antenna prototype can scan the main beam between +22° to +63° at 4.2 GHz, and the antenna has a measured peak gain of 12.72 dBi at 4.2 GHz. The gain variation while scanning is 1.12 dB. This design is suitable to mount at the bottom of the flying aircraft, unmanned aerial vehicle UAV's and other flying objects to measure altitude from the ground surface.

ABSTRAK

Pancaran utama LWA seragam boleh dikendalikan antara jarak sebelah lebar pada frekuensi rendah dan berhampiran hujung pancaran pada frekuensi tinggi. Walau bagaimanapun, ia telah didapati sangat sukar untuk mencapai pancaran sebelah lebar dari LWA seragam. Oleh itu, had LWA seragam untuk memancarkan ke arah sebelah lebar telah menarik minat daripada komuniti penyelidik. Kajian ini membentangkan reka bentuk baru jajaran gelombang mikro serat bulat (HW-MLWA) seragam untuk mencapai radiasi yang tinggi dalam arah sebelah lebar. Reka bentuk yang dicadangkan terdiri daripada dua unsur HW-MLWA yang diletakkan pada 180°, dan jajaran ini diberi masukkan oleh satu siasatan tunggal di pusat dua unsur. Antena yang dicadangkan direka dan diuji. Jalur lebar impedan yang diukur adalah 10.75% (4.4-4.9) GHz, dan gandaan diukur maksimum pada sebelah lebar adalah 10.02 dBi. Teknik baru untuk meningkatkan lebar jalur impedans lapisan tunggal (HW-MLWA) dengan pengimbasan pancaran utama berterusan dibentangkan dalam kajian ini. Peningkatan ini dilakukan dengan menggores empat slot bulat pada elemen radiasi. Pengimbasan pancaran utama yang luas adalah antara +12^{o} hingga +70^{o} apabila frekuensi operasi antara 4.3 hingga 6.5 GHz. HW-MLWA yang dicadangkan telah direka dan diuji. Jalur lebar impedans yang diukur sebanyak 49.9% (4.28GHz hingga 7.13GHz) dengan gandaan puncak 10.31dBi pada 5GHz. Akhirnya, penyelidikan ini membentangkan antena gelombang bocor mikrostrip separuh lebar (HW-MLWA), yang boleh mengendalikan pancaran secara elektronik pada frekuensi tetap menggunakan kapasitor dua jurang dengan diod. Pembinaan asas antena ini ialah HW-MLWA dengan tujuh unit kawalan (CUC). CUC yang boleh dikonfigurasikan dicipta dengan menggabungkan dua tampalan segitiga sebagai kapasitor dua-gap dengan dua diod sebagai suis untuk menyambung tampalan dengan satah pembumian. HW-MLWA direka, dan disahkan. Ia menggunakan suis mengawal untuk mencapai pengimbasan pancaran ke belakang dengan frekuensi tertentu, kapasitor jurang dalam setiap sel tampalan secara berasingan diputuskan atau dihubungkan dengan menggunakan suis PIN diod. Profil reaktansi di tepi bebas mikrojalur diubahsuai apabila keadaan sel tampalan diubah, dan seterusnya, ditukarkan arah pancaran utama. Prototaip antena yang dicadangkan mempunyai keupayaan untuk mengimbas pancaran utama ke hadapan di antara (+28° hingga +67°) dan ke belakang antara (-27° hingga -66°) pada 4.2GHz. Tambahan pula, tatasusunan HW-MLWA berkala dibentangkan. Ia secara elektronik dapat mengawal pancarannya pada frekuensi tetap menggunakan kapasitor dua jurang dengan diod dan mempunyai padanan impedans yang baik dengan gandaan variasi yang sangat kecil semasa pengimbasan. Apabila keadaan sel tampalan diubah, profil reaktan diubah di tepi bebas mikrojalur yang menyebabkan arah pancaran utama berubah. Prototaip antena yang dicadangkan ini boleh mengimbas pancaran utama antara +22° hingga 63° pada 4.2GHz, dan antena mempunyai gandaan puncak diukur sebanyak 12.72 dBi pada 4.2GHz. Variasi gandaan semasa pengimbasan adalah 1.12dB. Reka bentuk ini sesuai untuk dipasang di bahagian bawah pesawat kapal terbang, kenderaan udara tanpa pemandu (UAV) dan objek terbang yang lain bagi mengukur ketinggian dari permukaan tanah.

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