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CDMA BASED SECURED DUAL GAIN CONTROL OF HELICAL FEED PARABOLIC REFLECTOR ANTENNA

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ABSTRACT

Antennas are used in multi-different applications to satisfy the highest gain as possible to transmit and receive the signal with high efficiency. This paper is deal with helical feed parabolic reflector antenna. Helical antennas have long been popular in applications from VHF to microwaves requiring circular polarization, since they have the unique property of naturally providing circularly polarized radiation. One area that takes advantage of this property is a satellite communications. This antenna is controlled to provide a maximum gain with dual control technique. The previous studies are carried out with direct input of the controlled values via attached keypad. But this paper to deal with input values remotely via a CDMA wireless network to provide the user a free mobility as performing the required control processes. The system is principally divided into hardware and software. The obtained results are as the same as the direct control.

Keywords: ***Cell Phone, DTMF, Microcontroller, Parabolic Reflector, Antenna Gain***

I. INTRODUCTION

The aim of the system is to improve the controlling way of dual gain of the helical feed parabolic reflector antenna which is exploited in point to point communications such as satellite. So, the dual gain control is carried out with direct input of the multi-different values [3] to rotate the stepper motors to move the antenna with maximum gain toward the target point. Accordingly, good results are obtained. In this paper, it is so good to dual control the parabolic antenna gain remotely based on CDMA wireless network to achieve a maximum gain as the direct control while the user move from site to another [1]. The antenna is normally located in far site and the signal that captured from it is being used also in far system so that the direct dual control of the antenna may experience some difficulties. Therefore, the wireless remote control facilitates the way of controlling the system and may overcome the difficulties**.**

II. PARABOLIC REFLECTOR ANTENNA

The reflector can be of sheet metal, metal screen, or wire grill construction, and it can be either a circular "dish" or various other shapes to create different beam shapes. To achieve the maximum gain, it is necessary that the shape of the dish be accurate within a small fraction of a wavelength, to ensure the waves from different parts of the antenna arrive at the focus in phase. Helical feed is implemented for the antenna [8] .Figure (1) shows the geometry of the helical feed parabolic reflector antenna

There are two gains of the system which are:

2.1 The Gain Related to the Parabolic Reflector Dimensions:

Here the gain is the ratio of the power received by the antenna from a source along its beam axis to the power received by a hypothetical isotropic antenna. The gain of a parabolic antenna is [4], [5]:

$$G = \frac{4\pi A}{\lambda^2} e_A = \frac{\pi^2 d^2}{\lambda^2} e_A \qquad (1)$$

Where: G is the parabolic reflector gain, A is the area of the antenna aperture, that is, the mouth of the parabolic reflector, D is the diameter of the parabolic reflector, λ is the wavelength of the radio waves, e_A is a dimensionless parameter between 0 and 1 called the aperture efficiency. The aperture efficiency of typical parabolic antennas is 0.55 to 0.70.

2.2 The Gain Related to the Number of Turns in the Helix Feed of the Antenna:

The gain is produced due to control the shape of the feeder of parabolic reflector by changing the spacing between turns (S) which affects directly the helical antenna gain and therefore will affect the overall system gain. Equation (2) below shows the antenna gain produced when manipulating the helix feed of the antenna.

$$G = \frac{6.2C^2NS}{\lambda^3} = \frac{6.2C^2NSf^3}{3\times 10^8} \qquad (2)$$

Where: G is helical antenna gain, C is Circumference, N is number of turns of helical antenna, S is turn spacing, f is frequency used, $c=3\times10^8$ m/s is light speed [6], [7].

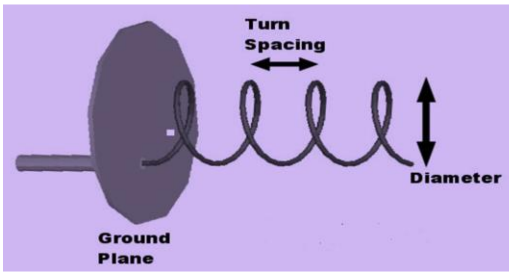

Fig1 the helical feed parabolic reflector antenna

III. SYSTEM COMPONENTS

The system components are all playing an integrated role in assisting the signal to go across the system stages. The system components interact to each other so as to help in performing the required control processes by user cell phone. The overall system is parted into two major categories

a. Hardware

b. Software

IV. HARDWARE

The main factor that acts principally in control is the controlling signal that used by the user cell phone. The employment of the cell phones provides the user with adequate span of mobility**.**

1. **CDMA technology**: is the environment that the controlling signal be initiated and transmitted to perform the controlling process. CDMA technology can provide the user with digital signal processor, radio transceiver, air interface to CDMA network, and DTMF generator. In addition, the wireless network is also preventing interferences phenomenon and other highly important features. The transmitted signal passes through CDMA network to the attached cell phone that resides with HM9270D [1].
2. **The HM9270D**: is a complete DTMF receiver integrating both the bandsplit filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters and dial tone rejection. Digital counting techniques are employed in the decoder to detect and decode all 16 DTMF tone pairs into 4-bit codes. External component count is minimized by on-chip provision of a differential input amplifier, clock oscillator and latched 3-state bus interface [1]
3. **Microcontroller**: it is Atmega-32 considered as a controlling heart of all the commands that initiated remotely by the user cell phone and respond as a movement via stepper motors (STMs) [3].
4. **Booster Circuits**: many different circuits are used in between the user cell phone and motors to contribute to the enhancement of the signal transition. These circuits are: HD 74LS373 and L293. HD 74LS373 is 8-bit register designed specifically for driving highly capacitive or relatively low impedance load. L293D is a dual H-bridge motor driver integrated circuit. It acts as current amplifiers as it receives a low current control signal and provides a higher current signal. This higher current signal is so adequate to drive the motor [2].
5. **Stepper motor**: a five stepper motors are used to control both parabolic reflector antenna and helix feeder [4].
6. **LCD:** is used to display the data entry and the real time data during the system processing [3].

V. DESGIN AND SYSTEM PERFORMANCE

The basic concept of the system performance in fig2 is to control the antenna remotely by means of CDMA network. The controlling signal initiated via user cell phone across the network up to the called attached cell phone that reside together with the DTMF which is attached to the microcontroller. The CDMA network provides the user with all the security issues such as authentication, confidentiality, anonymity, and integrity. Fig1 shows the block diagram of the overall wiring of the system. Attached cell phone captures the received signal and directly routed to the HM9270D via coupling capacitor [1], [2]. In the first stage of the HM9270D, the incoming controlling signal that comes from far distant user cell phone represents the input conditions to the HM9270D through the RC adjustable gain circuit to set the signal according to the application requirements. Such a function is done inside the HM9270D by the buffer circuit which is represented by operational amplifier providing a unity gain and buffer the other input components. Then, the buffer circuit followed by the band pass filter which is minimize the incoming signal bandwidth. This filter is succeeded by splitting circuit to feed high and low pass filters to drive a digital detect circuit through high gain comparators which are limiting the signal to prevent detection of unwanted low level signal. The digital detection circuit consists of digital counting technique to determine the frequencies of the incoming signal and to verify that the incoming signal components correspond to standard DTMF frequencies [1],[2]. So, a valid HM9270D signal decoded to yield the output combinations as Q1–to–Q4. The HM9270D output is connected to the microcontroller to manipulate the 4-bit controlling signal to appropriate stepper motor according to the program. The microcontroller output is directly connected to the HD74LS373. This circuit is used to buffer and boost the signal while in its way to the stepper motor driver chip L293D [2]. The first four stepper motors (STMs) are connected to the interface circuit to drive the parabolic reflector antenna and the fifth one is to control the helix feeder. The attached LCD is exploited to display the remote input values to control the motors if error entry occurred.

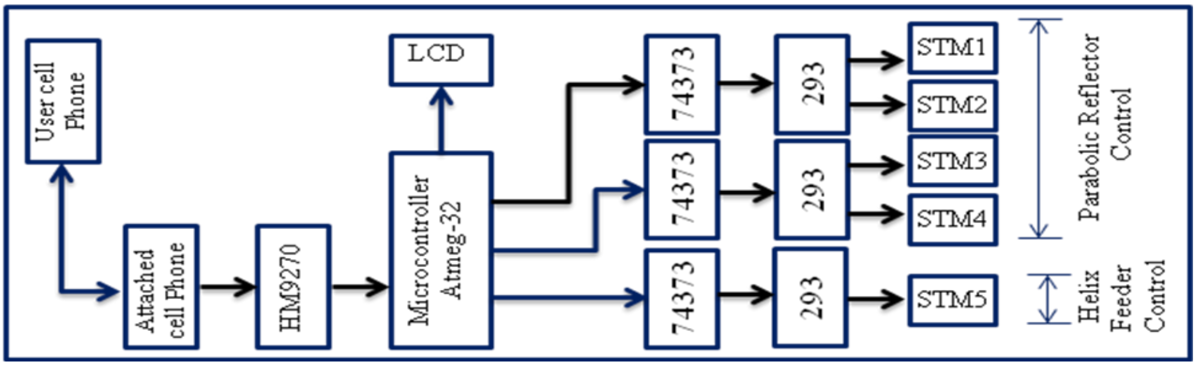

Fig2 Shows the System Design

VI. THE SOFTWARE

The system design includes five stepper motors divided into two parts. Part one is concerned with the control of the parabolic reflector while part two controls the helix feeder of the antenna .In part one; each stepper motor (STM) controls a sector of (90 degrees) of the parabolic antenna. In part two, the stepper motor control the helix feeder of the parabolic antenna. The algorithm is;

Start
Initialization:
- Enter the correct password; otherwise go to end of program
- Put all stepper motors at initial state.
- Wait for an input from the user cell phone.
--- Enter data from the user cell phone:
- Enter the number of steps for STM1.
- Enter the number of steps for STM2.
- Enter the number of steps for STM3.
- Enter the number of steps for STM4.
- Enter the number of steps for STM5.
- If the (address = *), Go to end of program.
--- Check the addresses of the stepper motors
- If the (address = 1), call subroutine of STM1.
- If the (address = 2), call subroutine of STM2.

- If the (address = 3), call subroutine of STM3.
- If the (address = 4), call subroutine of STM4.
- If the (address = 5), call subroutine of STM5.

--- Go to enter data from the user cell phone.

--- End

--- Subroutine of STM1:

- Apply calculations to specify the number of step angles required.
- Rotate the STM1 one step.
- Wait for few seconds.
- Decrement the number of steps.
- If the number of steps becomes zero, terminate the subroutine.

--- Return.

--- Subroutine of STM2:

- Apply calculations to specify the number of step angles required.
- Rotate the STM2 one step.
- Wait for few seconds.
- Decrement the number of steps.
- If the number of steps becomes zero, terminate the subroutine.

--- Return.

--- Subroutine of STM3:

- Apply calculations to specify the number of step angles required.
- Rotate the STM3 one step.
- Wait for few seconds.
- Decrement the number of steps.
- If the number of steps becomes zero, terminate the subroutine.

--- Return.

--- Subroutine of STM4:

- Apply calculations to specify the number of step angles required.
- Rotate the STM4 one step.
- Wait for few seconds.
- Decrement the number of steps.
- If the number of steps becomes zero, terminate the subroutine.

--- Return.

--- Subroutine of STM5:

- Apply calculations to specify the number of step angles required.
- Rotate the STM5 one step.
- Wait for few seconds.
- Decrement the number of steps.
- If the number of steps becomes zero, terminate the subroutine.

--- Return.

VII. RESULTS

The wireless remote secured gain control is presented and tested with the same and different values that used with the direct values. It provides the same results in both table1 and table2. It is assumed that the initial diameter of the parabolic antenna is equal 100 cm and the wavelength $\lambda = 10$ cm. By applying equation1, it is found that the gain is approximately equal to 225 (23.52 dB). When the four stepper motors move one step inwards or outwards, the parabolic antenna gain increases or decreases by 10 % respectively as shown in table1.

Table1 Results of Parabolic Reflector Antenna

Stepper motors	No. of inward Steps	No. of outward steps	The gain (dB)
All	1		23
All	2		22.6
All	3		22.1
All	4		21.7
All		1	23.9
All		2	24.3
All		3	24.7
All		4	25.1

Table2 Results of Helix Feed

No. of outwards steps	No. of inwards steps	Helical gain (dB)
1		19. 5
2		19
3		18.6
4		18.1
	1	21
	2	21.32
	3	21.5
	4	21.65

Table2 above shows the results obtained when the equation2 is applied. It is assumed that the initial gain of the helical antenna is equal approximately 100 or 20dB. Any step the stepper motor changes the gain also changed by ± 10%.

VIII. CONCLUSION

The system is proposed and tested according to the predefined scenario. It provided adequate results that capacitate the system to be a reliable and applicable in many different areas of remote control such as tracking systems, satellite communications, microwave link applications, and industrial complex. But it may experiences some constrains relevant to the CDMA wireless such as network diverge.

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