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REAL-TIME AUTOMATIC DUAL GAIN CONTROL OF THE HELICAL FEED PARABOLIC REFLECTOR ANTENNA

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ABSTRACT

The helical feed parabolic reflector antenna is greatly used in wide application areas such as satellite communications. These antennas are providing highest gain more than 30dB with high efficiency. The previous work of dual control of helical feed parabolic reflector antenna is performed remotely to assist in obtaining the required gain easily as well as providing mobility feature to the user. This paper presents the automatic mechanism to the previous work to control the dual gain of the parabolic antenna adding flexibility feature to the overall system as the user moving freely from site to another. The heart of the system is the PC together with microcontroller. The system is grouped into; wireless system, processing unit, interfaced circuits, stepper motors, and the antenna.

Keywords: PC, Microcontroller, GSM Modem, Stepper Motor, Antenna.

I. INTRODUCTION

The notion of this paper is to enhance the way of controlling the parabolic antenna. The controlling system is mainly divided into different stages to assist in performing the controlling processes. The antenna in this paper is composed of parabolic reflector antenna and helix feeder. The parabolic reflector antenna is being controlled via four stepper motors and the helix feeder is controlled by only one stepper motor [1].

II. SYSTEM COMPONENTS

1. **GSM technology**: is the environment that the controlling signal be initiated and transmitted to perform the controlling process. GSM technology can provide the user with digital signal processor, radio transceiver, air interface to GSM network, and DTMF generator. In addition, the wireless network is also preventing interferences phenomenon and other highly important features. The transmitted signal passes through GSM network to the attached GSM modem that resides with MT8870 [2], [3].
2. **Parabolic reflector antenna**; 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. The gain can be calculated as follows:

3. **The MT8870**: 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. [11].
4. **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].
5. **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], [10].
6. **Stepper motor**: a five stepper motors are used to control both parabolic reflector antenna and helix feeder.
7. **LCD:** is used to display the data entry and the real time data during the system processing [3].
8. **PC:** The exploitation of computers in this work made most of the operational and maintenance aspects of the system easy, feasible, and flexible. The PC program software is well-interfaced with the user and controlled devices.

III. THE SYSTEM PERFORMANCE

The fundamental notion of the performance is to control the antenna automatically as shown in fig 1. First of all, there predetermined value that could be entered to the microcontroller remotely via mobile user through air interface to determine the predefined direction in which the receiving end is located. Accordingly, the system automatically will look for the right direction to achieve a maximum gain. The wireless communication provides the system with multi-different advantages such as security features and

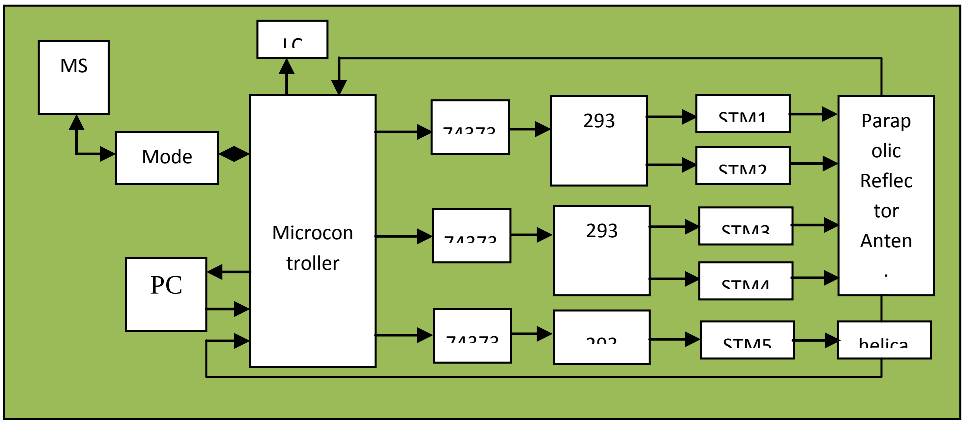

Fig. 1 Shows the System Diagram

mobility. The initial values that transmitted by mobile user is then received by the attached modem which is located together with the microcontroller. The microcontroller route the controlling signal to the PC which is has a program code in order to estimate the gain. As a result, the program code try to localize the antenna to new position and recalculate the gain and compare it to the previous value and then decide whether to localize the antenna into next position or backward in order to better gain. The program codes obtain the maximum parabolic reflector antenna gain according to the following equation:

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

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. The maximum gain is directly proportion to the effective area of the parabolic reflector antenna.

When the predefined sector got no gain value, the system drives the second STM2 till the gain up to the maximum. At the parabolic reflector maximum gain value, the related STM stopped moving and then the helical feed STM5 start to move to inward or outward direction to obtain the maximum helical feed gain value according to the following equation:

$$G = \frac{6.2C^2NS}{\lambda^3} = \frac{6.2C^2NSf^3}{3\times10^8} \quad (2)$$

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=3×108 m/s is light speed. The maximum helical feed gain is directly proportion to the turn spacing S.

IV. THE SOFTWARE

The system is regarded as a control tool to develop the dual gain control of parabolic reflector helical feed automatically. The system performance is mainly depends on the software that drive the controlling process. So, the automatic control process has to be carried out according to the following predefined scenario of algorithm in fig 2:

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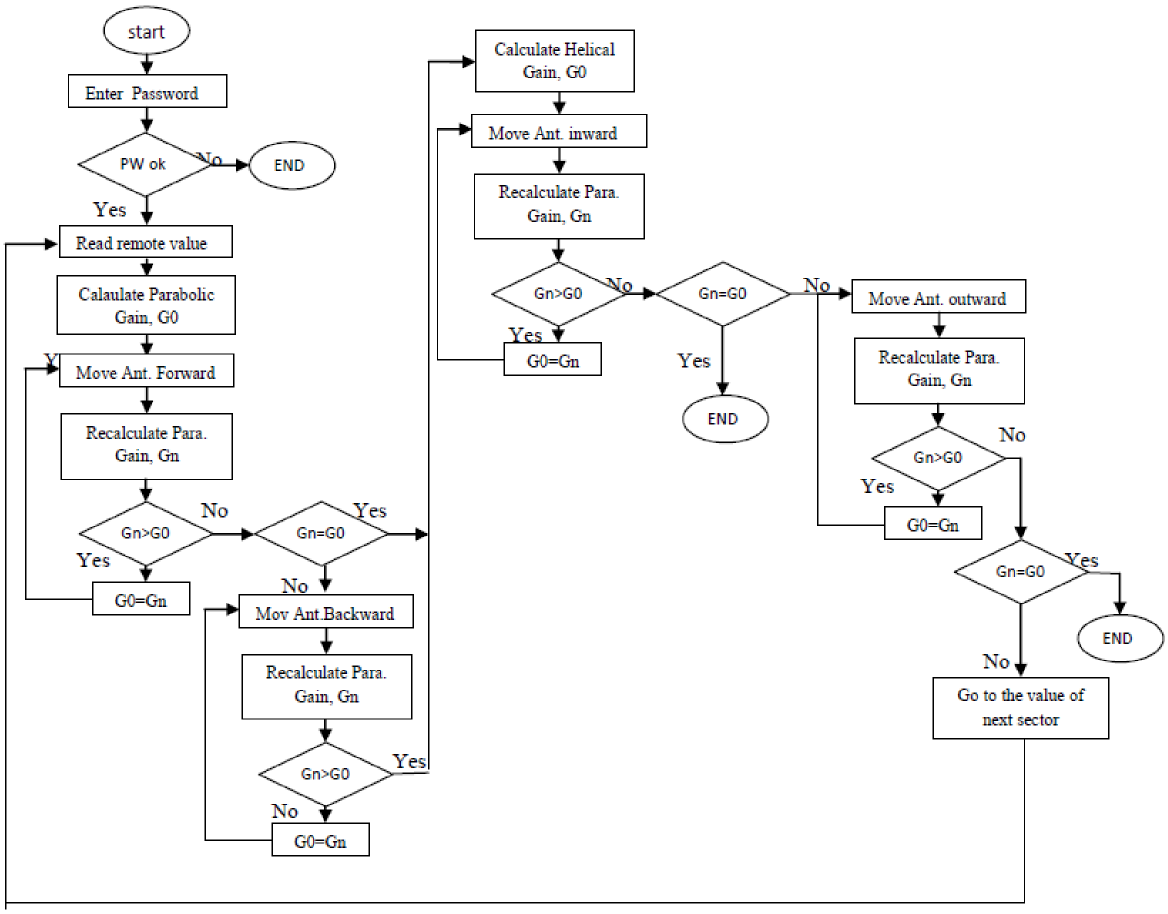

Fig. 2 The System Algorithm

The codes

Start

Enter the correct password, otherwise go to the end.

Put all the stepper motors in an idle state.

Enter the number of steps for stepper motor.

Enter the predefined value via remote user.

Check the address of the stepper motor.

If the (Predefined value is=n), call subroutine of STMn.

Increase the value n by 1 to go the next sector.

Subroutine of STMn

Calculate the current gain, G0.

Rotate the STMn forward for one step.

Recalculate the gain, Gn.

If Gn>G0 then rotate STMn for one step.

Let G0=Gn.

If Gn<G0, then rotate STMn backward for one step.

Recalculate the gain, Gn.

If Gn equal to G0, call subroutine STM5

Let G0=Gn.

Return

subroutine 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

End

V. RESULTS

The system is tested under some conditions that made it work in the first sector when the predefined value equal to 1 made the STM1 rotate clockwise to get maximum gain and when the value became 2 the system enabled STM2 with a unlimited movement tried to get maximum gain because the maximum gain value only in the first sector. So, the system is well-equipped to freely control the dual gain of antenna.

VI. CONCLUSION

The real – time automatic dual gain of the helical feed parabolic reflector antenna is proposed and tested for only sector one. It provides good results that can be reliable on in many different applications that depend on telecommunications. There are many different defects that might affect the system performance such as network congestion in peak hours and the devices response.

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