Antenna Rotator Design and Control

[1]Prof. Radhika R. Harne, [2]Ruturaj S. darade, [3]Sarthak L. Khandagale

Dept of EXTC Gov. College of EngineeringAmravati.
Maharashtra, India

***Abstract*—This paper consists of design and development of rotator for antenna positioning according to the desired azimuth and elevation. The rotator must be capable of manual control(push button switch) or software operation. Rotator must have safety brake switches with position and speed sensors to soften and correct the brake position. The main principle to learn isto use the micro-controller to control the speed of the motorand find the right angle of the movement and stop the motor when the system has an emergency. The large inertia of themotor must compensate for good dynamics, as the load for the equipment is greater. A servo motor is required for position and speed control in the antenna, and a servo motor as the main drivewith appropriate connection equipment. To get better speed and position control correct rotator must be selected.**

I. INTRODUCTION

An antenna or can be called as aerial is the electrical power to radio waves conversion device and radio waves to electricalpower . The antenna communications need transmitter and receiver. The transmitter used is radio transmitter and thereceiver used is radio receiver. The radiation pattern playsthe important roles as characteristics of antenna . It can determine where the concentrated radiation been directed. The best radiation pattern is the one that has the ability to increase the signal-to-noise ratio (SNR). It will be better ifthe orientation of the antenna can be control by some device such as antenna rotator. The antenna is connected near to the controller and the rotator mounted below the antenna . Rotatorwidely used as communication installation for military and radio. It can help the antenna to receive better signal from different direction without more forces. The Antenna Rotator Design and Control project is concerned with the design and development of the rotator for positioning the antenna according to the desired azimuth and elevation. The Rotator must be manually controllable using a push button switch or software driver. It should have a safety switch with position and speed sensors for proper position and stop[6], [2].

II. LITERATURE SURVEY

Antenna can be described as the passive linear reciprocal device. It needs to be combined with active, nonlinear and nonreciprocal circuit element to make it as transmitting device.The frequency of the antenna must be specified in term of quantitative. Antenna can be both transmitter and receiver. Fortransmitter, the radio transmitter will convert electrical energyto radio energy and transmit is to the antenna's terminals. The antenna's terminals that receive the radio signal will act asthe antenna receiver and convert the radio energy to electrical energy signal [4].

The working principle of antenna is the important theoryfor design the antenna rotator. The transmitting antenna willradiate the radio signals that have been generated in transmitterto a receiver. The receiving antenna will pick up the radiosignals that have been transmit by transmitter antenna in thespace. The medium for the transmission is air in space. Thetransmitted signal in the space is in the electromagnetic form.The antenna system needs to be designed properly so that itwill be able to radiate efficiently to avoid wasted power supply.Sometimes, the antenna needs to be moved to get the better radiation pattern. Therefore, the orientation of directionalantenna can be change by using the antenna rotator device.

It is consisting of controller and rotator [7].

Rotator can be described as device that can coursesomething to rotate. In the antenna rotator project, rotatorplays the important roles and need to be constructed perfectly for better movement and rotation. Basic motor consists ofgearbox and motor (geared motor), encoder for azimuth angle and rotary joint. From the study of the past researched, the rotator has been designed based on the millimeter-wave rotatorassembly. The design was specific on the coax rotary joints andcoaxial cable. The rotator used was millimeter-wave rotator [3].

III. METHODOLOGY

The rotator basic principle needs to include the human operator, comparator and desired angle. The human operator will give the input to the micro-controller to decide the desiredangle. In the other hand, the comparator used to tally current angle with the desired angle. It will help to make sure the rotator stops in the right position. The encoder can be used as comparator.

Designs are divided to several parts of the antenna rotator. The antenna rotator is divided into rotator's body and antenna holder.

The main body of the rotator is where the antenna is placed,and it is also where the micro-controller (Arduino MEGA) andother supporting components.

Antenna holder is used to put antennas that is being measured using the antenna rotator. Antenna holder has two servo motors, Servo motor is used as the drive unit of the rotator.

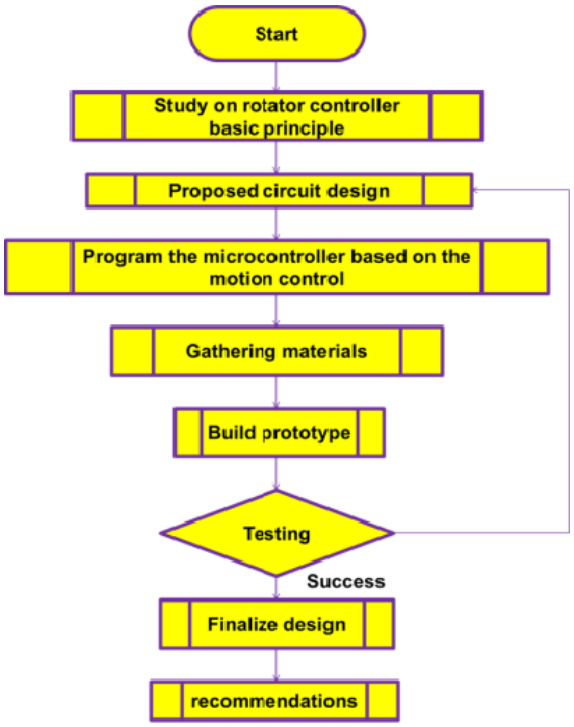


Fig. 1. Flow Chart

The antenna rotator uses controller which consists of push buttons and potentiometer. That all controlling parameters are connected to Arduino MEGA. The materials used dosent have any side effect that would distract the process of the antenna rotation measurements.

A. Motor Parameter

The servo motor used is MGR995 which has high torque.In order to use this servo motor, servo code or library are usedto control and store all kind of servo's movements command.Servo motor is a motor that can rotate with precision. Most motors of this type include an electronic control that providesfeedback on the current position of the motor. This feedbackcauses the servo motor to actually rotate at desired angles.

If you want to rotate an object at some specific angles or distance, then you use a servo motor.

It is a closed-loop system where it uses a positive feedback system to control motion and the final position of the shaft. Here the device is controlled by a feedback signal generatedby comparing output signal and reference input signal. Here reference input signal is compared to the reference outputsignal and the third signal is produced by the feedback system. And this third signal acts as an reference signal to the control the device. This signal is present as long as the feedback signalis generated or there is a difference between the reference input signal and actual output signal. So the main task of servomechanism is to give the output of a system at the desiredvalue at presence of noises.

Fig. 2. Servo motor MG9

- Weight: 55g
- Dimension: 40.7*19.7*42.9 mm approx.
- Stall torque: 9.4 kgf.cm, 11 kgf.cm (6v)
- Operating Speed: 0.17 s/60°(4.8v), 0.14 s/60°(60)
- Operating Voltage: 4.8v & 7.2v
- Running Current: 500A-900A (6v)
- Stall Current: 2.5A (6v)
- Dead Bandwidth: 5µs
- Stable and Shock proof double ball bearing design
- Temperature: 0° to 550°

B. Arduino MEGA 2560

The Arduino Mega 2560 is a controller board based on the ATmega2560 micro-controller . It has 54 digital pins (of which15 can be used as PWM outputs), 16 analog inputs to read analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection to upload the program,a power jack to supply power, an ICSP header, and a reset button to reset the controller . It contains all necessary parts that required for controller ; simply connect it to a computer with a USB cable or give power it with a AC-to-DC adapteror battery to get started. The Mega 2560 board is compatible with most shields designed for the MEGA.

Fig. 3. Arduino MEGA Board

Arduino MEGA 2560 is an open source development boardbased on Atmega2560 AVR micro-controller. This micro- controller is an 8- bit Micro-controller. It uses ATmega16U2 Microchip Technology. This board can be programmed using programmed using wiring/ processing language[5].

Figure 3 shows picture of Arduino MEGA, Arduino MEGAused as the controller of the antenna rotator. Arduino MEGA stores three rotation features program that is able to updateand to add another features in anytime. In figure 4, showsthe electronic rotator antenna circuit consisting of several push buttons, potentiometers, switches, Arduino, MEGA and resistors[1].

All of components are assembled so that they become antenna rotator control devices.[9]

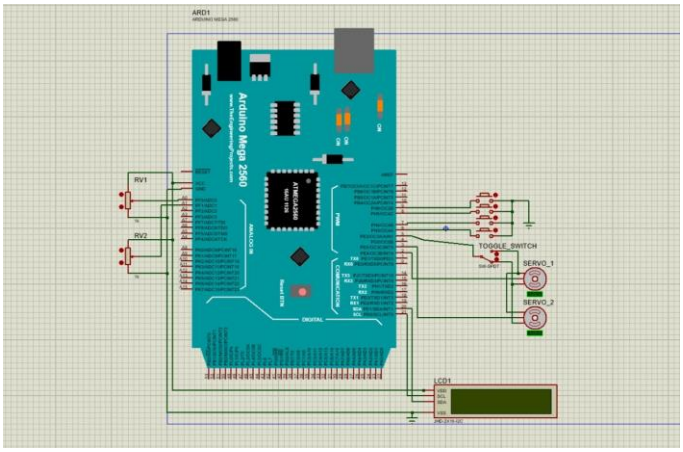


Fig. 4. Schematic

We can control rotation of antenna here by two methods

1. By Potentiometer
2. By push buttons

Antenna rotation by push buttons gives us more accuracy than rotation by potentiometer. by push buttons we can vary (change) the angle by 1° or with more precision.

To make this project user friendly we give 2 options of control in case of any failure happens in any of one method then we must

have second one to do work.
To switch from one control method to second control method we use toggle switch. depending on position of toggle switch either we can control rotator by potentiometer or push buttons[8].

C. rf433 Transmitter and receiver module

Here for transmitting purpose rf433 transmitter and receivermodule is used. To show some signal is transmitting or receiving . range of this device is limited to 30 meters inopen space.
this project is prototype so the range is limited but atapplication end range is too large this project is used totransmit or receive signals from satellite. so the range is more.this module serves as transmitter and receiver both. module contains separate transmitter and receiver module fortransmitting and receiving data. by using this module we execute transmission and reception process.

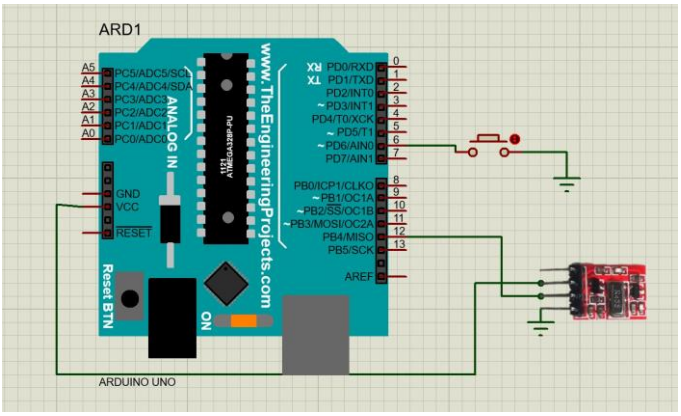


Fig. 5. Transmitter module

1) Transmitter: This small module is works as transmitter
. It is very simple to use .This module is tuned to operate at 433MHz. Apart from that, it has a switching transistor and some passive components.
When the DATA input is high, the oscillator generates a constant RF output carrier wave at 433Mhz frequency, and when the DATA input is low, the oscillator stops operation; resulting in an amplitude modulated wave. This technique is known as Amplitude Shift Keying.

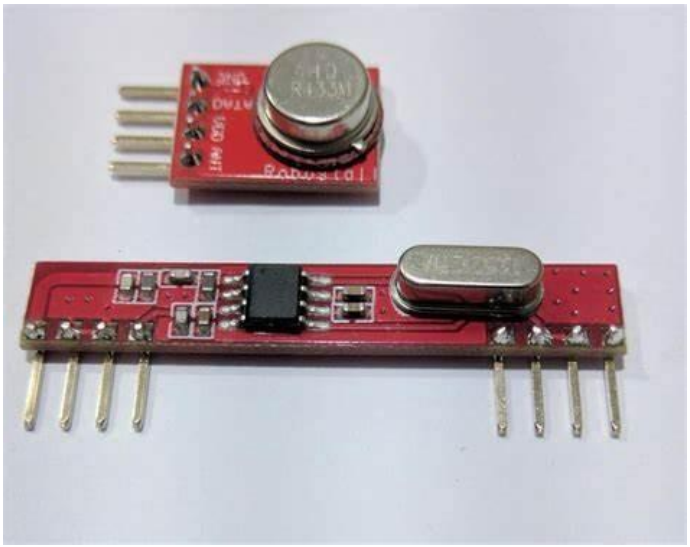
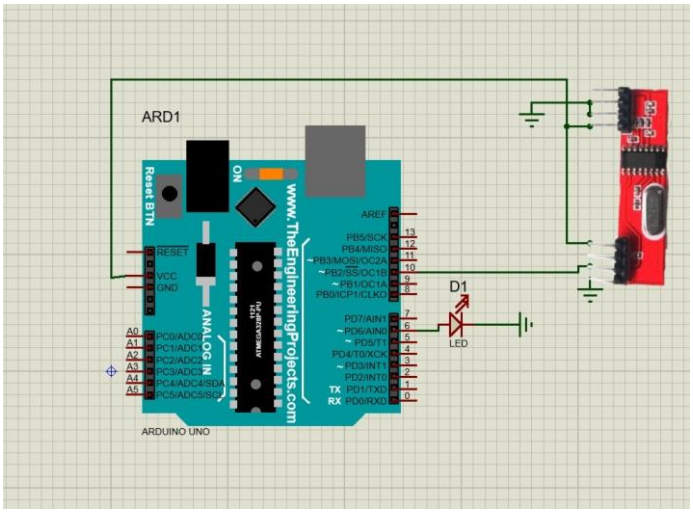


Fig. 6. re433 module

2) Receiver: This module consists separate transmitter and receiver module. It is as simple as the transmitter module ,size of receiver os bigger than transmitter. It consists of anRF tuned circuit and a couple of operational amplifiers (OP Amps) that amplify the received signal . The amplified signal is then fed into a PLL (Phase Lock Loop), which allows the decoder to "lock" onto a stream of digital bits, resulting in improved decoded output and noise immunity.



IV. RESULT AND DISCUSSION

This chapter will discuss about the testing method and the preliminary design of the antenna rotator design and control. The most important aspect that needs to be understood and tested is motor for position control. The desired commandof input antenna is the azimuth position of the antenna. The signal of error will drives the motor to move the antenna and will be stopped when the position feedback stated the antenna in a right desired azimuth.

The basic idea for antenna rotator is using micro-controller Arduino, AC power supply, motor, gearbox for gear step up and step down, rotator and position display.

The motor has been tested using Arduino for checking the basic principle of clockwise and anti-clockwise motor.In order to control the rotation direction of the motor, a pair of push button switch has been used. The switches have being labelled as SW1 for clockwise rotation and SW2 for anti- clockwise rotation. Therefore, the position of the antenna can be controlled by pushing the SW1 of SW2 and stop when the motor have positioned in the right position.

V. CONCLUSION

The antenna rotator is the automation and control system project. It is required hardware and software knowledge in Arduino board and DC motor as well as rotator. The designof the rotator effects on the azimuth angle and position of the antenna. The outcome of the project need to fulfil the workingprototype for antenna rotator complete with rotating device, circuit interface and controller. The objectives that need to be achieved are the project needs to be done to design suitable rotation device with two depth of field (DOF) for azimuthand elevation control, design the interfacing circuit between the motor and the micro-controller. The project also needsto program and implement micro-controller based control strategy for motion control.

For recommendation, it is better to use wireless connection between the rotator and controller. It is also more applicable to use the higher motor rating to run the rotator with larger antenna. The antenna rotator can be upgrade to detect thesignal and stop at the position where the desired signal been detected.

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