

Satellite Dish Positioning Control by DC Motor Using IR Remote Control

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Abstract- In this paper, PIC microcontroller was designed to develop a satellite dish positioning system which can be operated by using a remote control. The main point of using a dish is to receive signal from satellites and other broadcasting sources. In order to get the exact angle of position of the dish, it needs to be adjusted manually. In order to overcome the difficulty of adjusting manually, this paper helps in adjusting the position of the dish through a remote control. Remote control acts as a transmitter whose data is received by an IR receiver which is interfaced to a microcontroller of PIC 16F877A. The remote control sends coded data to the receiver whose output is then sent to the microcontroller. Basic pro language is also used to implement this system. The microcontroller sends the control signals to the motor through an interface known as relay driver.

Keywords – PIC 16F877A, Infrared(IR) Remote Control, DC Motor of the Satellite Dish

I. INTRODUCTION

There are many commercial communications satellites in the geosynchronous orbit. Geostationary satellites are located in orbit directly above the equator and stay in the same place in the sky since they go around the earth at the same angular speed as that of the earth as it rotates. Satellite locations may thus be defined by longitude only. **Geo Orbit position** is the longitude position around the geostationary orbit. The satellites are all approximately fixed in the sky above the equator. Negative orbit position numbers are degrees West from Greenwich meridian. Positive numbers are degrees East. The use of East and West longitudes is popular for public use since the numbers are smaller. Use of degrees East only (0 to +360deg, going East from Greenwich) however is my preference since the satellites go around this way and it makes sense for the numbers to keep increasing if the satellite moves forwards. Trying to do orbit calculations is bad enough without having numbers that keep switching forwards and backwards. Many satellite operators also use the 0 to +360 deg method, but may additionally provide the “deg West” notation for some output publications.

Imaginary lines, also called meridians, running vertically around the globe. Unlike latitude lines are not parallel. Meridians meet at the poles and are widest apart at the equator. Zero degrees longitude (0°) is called prime meridian. The degrees of longitude run 180° East and 180° West from the prime meridian in figure 1(a). In this paper, microcontroller is used to drive the DC motor of the satellite dish in terms of direction (East and West).

Microcontroller is used extensively where the precise position of the motor driving the system is required. Microcontroller is as important as computer control system. Remote control is used to command the signals to the microcontroller by the user to drive the DC motor of the satellite positioning dish. The main benefit of the microcontroller is also to control the position feedback. Microcontroller can be command to move exactly to a specific position. Satellite dish requires the accuracy. In this paper, PIC 16F877A microcontroller has been selected to control satellite dish for the system. The advantages of PIC 16F877A microcontroller are low cost high performance RISC (Reduce Instruction Set Computer) have many I/O ports, timer, memory and communication ports. So it is suitable for controlling actual position of the systems. The system can locate the satellite receiver dish at five different positions.

The most common issue anyone will come across when aligning the dish is aiming at the correct satellite for the broadcasts they require. Satellite receivers do have certain details on them regarding the satellites, but they cannot

determine whether you are aligned to the correct satellite. They rely on the user to align the dish in the correct direction. There are certain details we will require in order to successfully align the satellite dish accurately to the correct satellite for our requirements, these are listed below and as shown in figure 1(b).

Azimuth: This will be the heading required for the dish. The satellite that is broadcasting the signal will have a point of reference which the dish needs to be aligned to (for example, Astra 2A, B or D is set at 28.2° East of True South).

Elevation: This is the angle of the dish elevation required that is above the reference heading for the satellite that we have aligned the heading towards. As the Earth curves, we need to find the correct elevation for the area where the dish will be situated.

LNB Skew or Inclination: This is angle of the LNB on its axis. Much the same as the elevation, we are required to find the correct skew or inclination for the area where the dish will be situated.

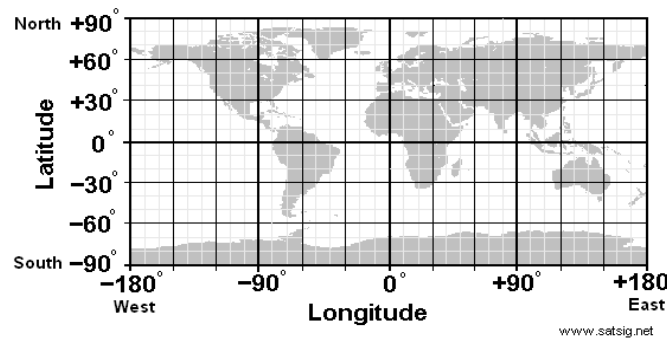


Figure 1(a). Latitude and Longitude are how our site location is defined on the surface of the earth

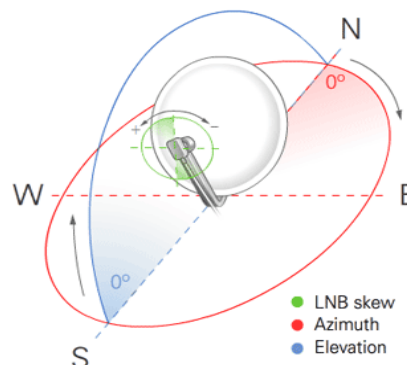


Figure 1(b). Aligning the dish

II. DISH POSITION CONTROL SYSTEM

The control system of a satellite dish consists of the hardware within the dish used to move it and the software written to control this movement. This system was consisted of hardware components which remote controller, PIC microcontroller, relay driver and DC motor based servo mechanism. A user will enter in a command such as position of the satellite dish; a position will be generated, and then the control software will be called. The software of the controller will determine a desired position of the dish and send the command to the motor through the microcontroller. Remote control sends the command 12 bits of information.

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III. BLOCKDIAGRAM OF THE SYSTEM

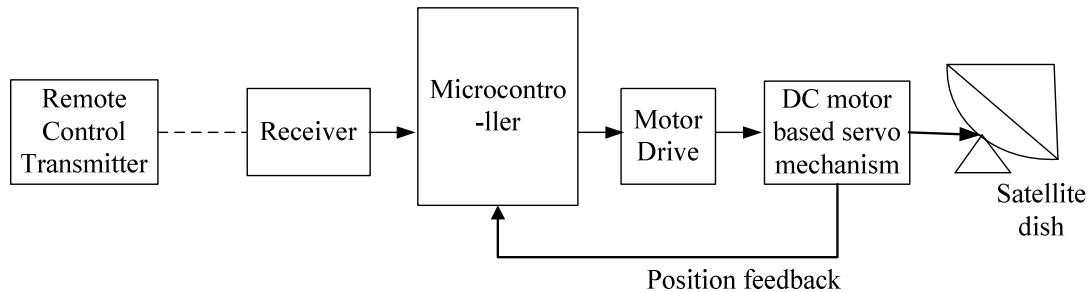


Figure.2. Block Diagram of the system

IV. OPERATION OF THE SYSTEM

Firstly, the motor is reaching in something degree when the power supply on. This degree is called the last degree. If the setting switch is pressed to save degree and count of the motor of the satellite dish, motor will go to the lowest limit from current degree. After reaching to the lowest limit, the motor will stop. We get zero degree and zero count. Then the motor will go to the highest limit. After reaching the highest limit, the motor will stop. And then, the maximum degree is saved in the microcontroller. So the maximum degree and maximum count are got. Microcontroller calculated resolution and saved the degrees and pulses in EEPROM. When command degree from remote control fed to the PIC microcontroller, the motor is driven. The motor is driving with the counts. These counts are being sensed by reed sensor. Reed sensor feedback counts of driving motor to the microcontroller. Microcontroller makes increasing the counts if the command degree is greater than the last degree. While increasing the counts, the motor will be stopped by microcontroller when the command degree is equal to the last degree. Similarity, microcontroller makes decreasing the counts if the command degree is less than the last degree. While decreasing the counts, the motor will be stopped by microcontroller when the command degree is equal to the last degree.

V. HARDWARE COMPONENT OF THE SYSTEM

A. Infrared Remote Control Device

The infrared remote controller was composed of infrared remote control transmitter and infrared remote control receiver, shown in Figure 3. Structure of remote transmitter circuit was made up of specific integrated circuit IC1 as the core element; matrix circuits for transmitter keyboard were composed of matrix switches, which could constituted input circuit of keyboard commands with pulse generator in the IC1 and signal encoder in the keyboard. Remote receiver was composed by specific integrated circuit IC2 installed with photodiode. When infrared light from remote control was received by photosensitive tube of receiver, the light signal will be transformed as the electrical signal by photosensitive tube.

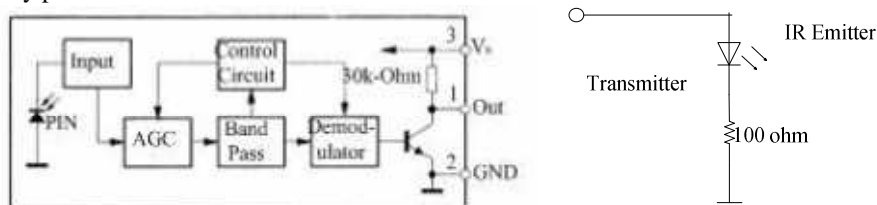


Figure.3. Transmitter circuit and Receiver circuit

B. Description of Signals Of The IR Transmitter And Receiver

IR sensor module receives the IR pulses sent from remote and converts it to corresponding electric pulses. These electric pulses are given to microcontroller that decodes it to corresponding data byte using zero crossing detector and on chip timer and interrupt. These data bytes are used to take further control decisions. The control output signals are given to driver circuit, which drives the DC motor of the satellite dish.

A Sony remote control transmitter is used in this paper. The Sony remote control is based on the Pulse-Width signal coding scheme. The code exists of 12 bits sent on a 40 kHz carrier wave. The code starts with a header of 2.4milli second (ms) or 4 times T, where T is 600 micro second (μ s). The header is followed by 7 command bits and 5 address bits as shown in Figure.4. The address and commands exists of logical ones and zeros. A logical one is formed by a space of 600 μ s or 1 T and a pulse of 1200 μ s or 2T. A logical zero is formed by a space of 600 μ s and pulse of 600 μ s. The space between 2 transmitted codes when a button is being pressed is 40 ms. The bits are transmitted least significant bits first. The total length of a bit-stream is always 45 ms.

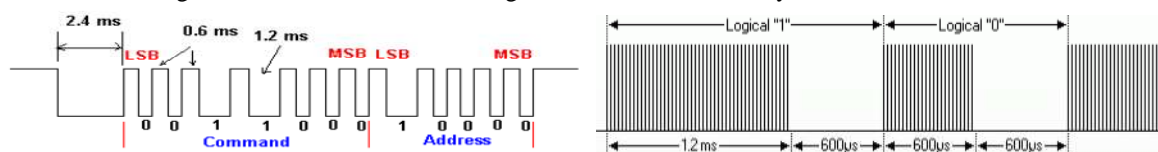


Figure.4. IR transmitter protocol

C. PIC Microcontroller

There are many different varieties of PICs. Some are OTP (One Time Programmable) type devices and some are Flash type devices. OTP devices are not well suited for electronics hobbyists because their software code cannot be changed when have been programmed. Flash type devices are repeatedly reprogrammed in-circuit. There are generally three types of Flash type device microcontroller .They are PIC 16F84A, 18 pin microcontroller, PIC 16F628A, 18 pin microcontroller and PIC 16F877A, 40 pin microcontroller. PIC 16F877A microcontroller has built-in ADC (analog to digital converter), USART (universal synchronous and asynchronous receiver transmitter), PWM (pulse width modulation), more I/O ports and more program memory space. Because of its capability, it has been chosen in this paper.

D. DC Motor Based Servomechanism

Nowadays, the most popular motor is a servo motor that is used to control and drive for heavy load application. On the other hand, the servo motor cost is extensively high for this application. So, YURI 518R servomechanism is chosen for this system. The general view of the YURI 518R servomechanism is shown in Figure.5. It is supported to drive over 250 kg loads, when only driven by 36V DC motor. In figure 5.4(b), the mechanism consists of upper and lower limit switch. This limit switch are protected not to damage the mechanism for extremely drive and internal magnetic on the main axis and the feedback reed switch. The reed switch feedback 7 pulses per rotation and totally 873 pulses for the whole movement of the inner rod.



Figure.5. YURI 518R servomechanism

VI. MAGNETIC REED SWITCH SENSOR

A reed sensor is a device that built using a reed switch with additional functionality like ability to withstand higher shock, easier mounting, additional intelligent circuitry, etc. When a magnetic force is generated parallel to the reed

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switch, the reeds become flux carriers in the magnetic poles, which attract each other. If the magnetic force between the poles is strong enough to overcome the restoring force of the reeds, the reeds will be drawn together. The reeds switch is in a sealed glass capsule usually with a special insert gas that prevents the switch contacts from oxidizing (rusting). When a magnet is brought within a specific distance, the reed blades become opposite magnetic poles which attract. This closes the circuit and allows current to flow. When the magnet is taken away, the reed blades lose their induced magnetic and separate thereby opening the circuit. Because the switch is sealed it can be used in harsh environments. Reed switches respond to both magnetic poles (North and South).

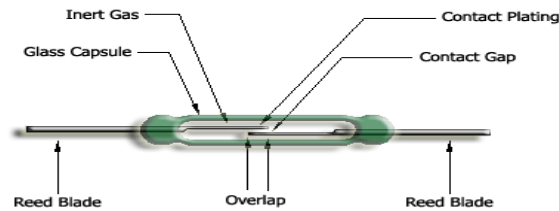


Figure.6. Reed Switch Sensor

VII. SOFTWARE IMPLEMENTATION OF THE SYSTEM

This system used remote control for input device and LCD module for output device for user interfacing. Moreover other two different LEDs are used to indicate for motor direction movement. The DC motor is driven by two electromagnetic relays with the amplification of transistors. The position feedback is acquired by the usage of reed switch interface with the help of the Opto-coupler.

A. Operation of The Motor

Microcontroller is used to drive the motor to the clockwise direction when the command degree is greater than the last degree and counterclockwise direction when the command degree is less than the last degrees in Figure.7. And it is used to drive the motor with the desired degree by calculating the command degree from remote and feedback degree from the reed sensor.

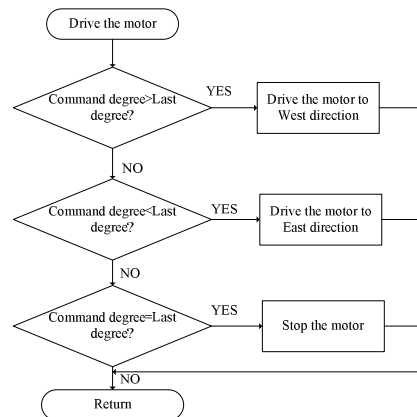


Figure.7. Flow chart for the motor operation

Microcontroller is used to drive the motor to the clockwise direction when the command degree is greater than the last degree and counterclockwise direction when the command degree is less than the last degrees in figure 4(A). And it is used to drive the motor with the desired degree by calculating the command degree from remote and feedback degree from the reed sensor.

B. Flowchart of the System

The overview of Satellite Dish Positioning System is shown in Figure8. After ports and registers initialization the program will check whether the setting switch is pressed or not. This means that if the setting switch press, the program will enter into the set mode and displays the set menu. On the other hand if not pressed the setting switch, the program will enter into the search mode to get the desired degree. The setting mode is used to save the degrees and counts of the motor. So, the user can choose one of the two modes set mode and search mode. The actual position of the satellite dish is saved to the EEPROM to reduce system errors while power supply failure is taken.

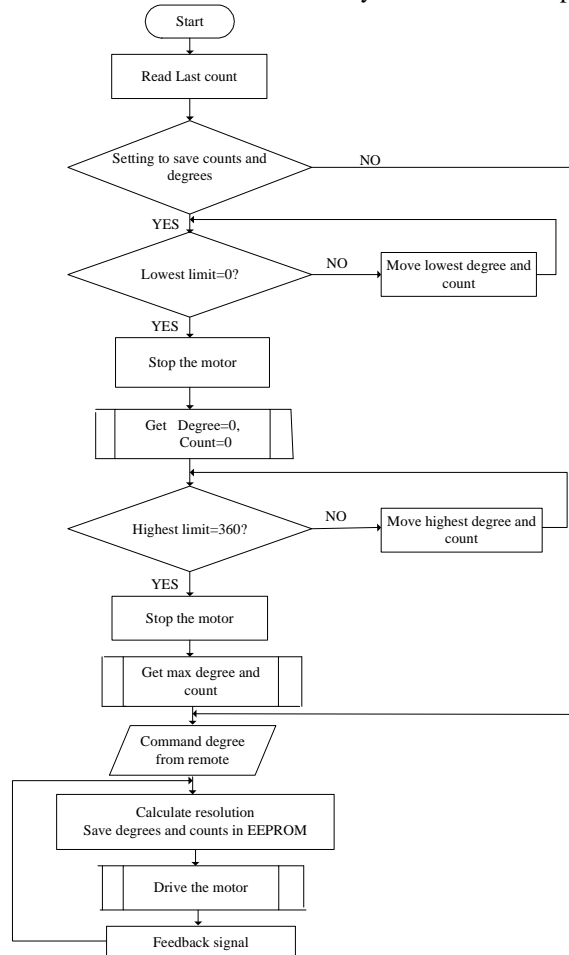


Figure.8. System flow chart

VII. RESULT FOR THE SYSTEM

A. Result of the Motor Rotating East Direction

This circuit consists of IR remote control, DC motor and LCD display for motor operation. DC motor is used to control the satellite dish. Microcontroller is used to drive the DC motor. LCD module is used to display the degrees and East direction of DC motor of the dish. And IR receiver is used to receive the signals from the remote control.

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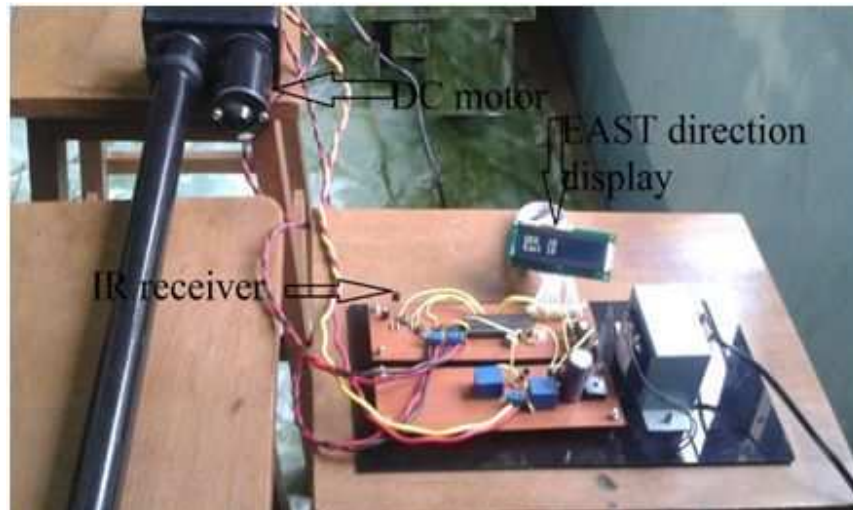


Figure.9. Test Photo 1

B. Result of the Motor Rotating West direction

Devices consisted of this circuit operate instructions of the program according to the command of the user. In this circuit, LCD module displays the degree and West direction of the DC motor of the satellite dish.

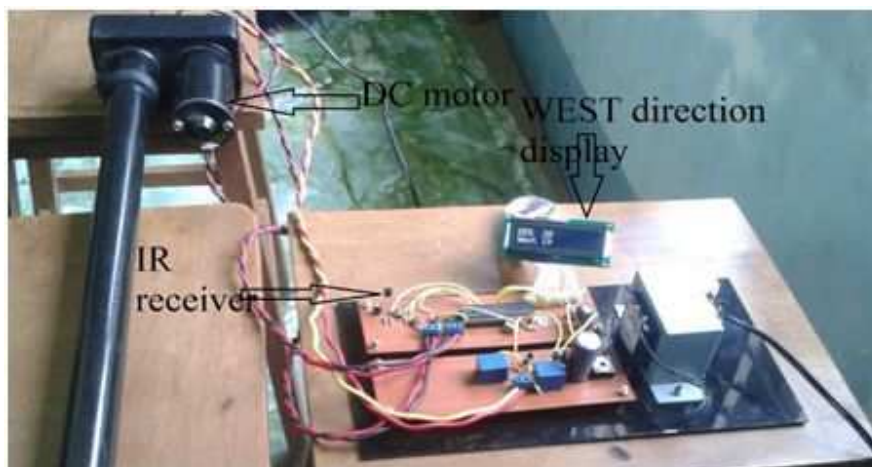


Figure.10. Test Photo 2

C. Result of the Motor Rotating For Stop Position

DC motor is intended to control the satellite dish for receive the signals from the communications satellites. Microcontroller calculates the signals between the command degree from IR remote control and last degree in EEPROM. LCD module displays the stop position of the motor in this circuit.



Figure.11. Test Photo 3

IV.CONCLUSION

This paper is intended to drive the satellite dish to the select channel's position. At first the system displays the satellite dish positioning menu and waits for the user input desired channel via remote control. When the desired channel is selected, the program first calculated which direction is needed to drive. And the load current from EEPROM displays on the LCD. The dish is driven by the searching subroutine and feed backed and calculated by check feedback signal subroutine. The direction movement of the dish is indicated by two LED. If the forward direction is taken the green LED will indicate and for opposite direction the red LED will indicate. As soon as, the driven position is reached the program will stop the motor and two LEDs will off. In this paper, reed sensor is used to send the feedback signal to the microcontroller that the satellite dish is in the desired position or not. If the sensor is not connected, the system will hang and the user must reset the system. And microcontroller cannot connect a motor directly because it cannot give sufficient current to drive the motor. So, in this system, motor driver circuit is designed with two relays as switches which it is used to drive the motor with clockwise and counterclockwise direction. Satellite dish positioning system can be provided with computer system without microcontroller. But microcontroller is a single chip it is low cost, small size and high performance. So, microcontroller is most suitable for auto positioning system. In this system, a satellite positioning system has been developed. A satellite dish control system is critical to its tracking capability. Satellites are controlled by a ground station antenna on earth that sends commands and receives information from the satellites. This system is used remote control to start the motor moving in the desired direction. PIC microcontrollers are widely used all over the world and it is based on the latest technologies. Using the remote control improves the advanced technology. And using the microcontroller develops the motor to maintain the desired position. Although this is the first approaching step to the control system, automation system and robotics systems, these can greatly serve to the industrial control.

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