Arduino based Antenna Positioning System

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Video Introduction
Presentation Overview

1. Mechanical Assembly
2. RC Servo Basics
3. Arduino Pro Mini Microcontroller
4. Programming The Arduino
5. Position Control Program
6. Hands On Demonstration
Close-up View
Mechanical Assembly

a) Azimuth Rotator
   - Housing for Servo
   - Mounts to tripod or mast
   - Rotates Elevation Rotor thru 180 degrees

b) Elevation Rotator
   - Housing for Servo
   - Mounts on top of Azimuth Rotor
   - Provides mounting for antenna etc.
   - Rotates antenna thru 180 degrees
RC Servo Overview

A Closed Loop Positioning System
RC Servo Specifications (typical)

- Rotation Angle – 180 degrees ***
- High Speed – 60 deg in 0.25 seconds
- Excellent Torque – 7.1 kg/cm
- Pulse Width – 1 to 2 microseconds
- Pulse Rate – 20 milliseconds
- Simple Power Requirements – 4.5 V, 1.2 A

Precision Angle Control by PWM signal
Small & Easy-to-use Package
360° Azimuth using Flip Mode

FLIP

Elevation 180 to 90

NORMAL

Elevation 0 to 90

Umesh Ghodke, K6VUG, SBARA
Arduin Microcontroller

- Popular & Easy to use Microcontroller Boards
- Efficient Interrupt-driven Architecture
- Pulse Width Modulation Feature Built-in ***

- Web Site www.arduino.cc
- Jump Start Instructions & Samples
- Free IDE Software for Development and Test
Arduino Specifications (typical)

- ATmega32x 16 MHz Microcontroller
- 32 KB Flash Memory (program storage)
- 2 KB SRAM (program execution)
- 1 KB EEPROM (data storage)
- 14 Digital I/O Pins (6 PWM outputs) ***
- 6 Analog Input Pins
- Operating Voltage 5V, 50mA
- USB or Serial Interface
- Includes Boot Loader (0.5 KB)
Arduino Uno & Pro Mini

Arduino Pro Mini – Embeds easily into a project
Writing A Software Program

1. Structure – The Solution
   a. Defines the Sequence of steps (Algorithm)
   b. Independent of Programming Language
   c. Provides Clarity to the Solution

2. Syntax – The Code
   a. Encodes Solution into Micro-Actions
   b. Completely Language Specific
   c. May provide ways to be Efficient
Arduino Program Structure

// Run Once After Reset
void setup () {
    initialization statements;
}

// Run Continuously Until Next Reset
void loop () {
    data processing statements;
}
#define pin 13; // specify the LED pin
void setup () {
    pinMode (pin, OUTPUT); // set the ‘pin’ as output
}
void loop () {
    digitalWrite (pin, HIGH); // turn LED pin on
    delay (1000); // pause for one second
    digitalWrite (pin, LOW); // turn LED pin off
    delay (1000); // pause for one second
}
More Sample Statements

// Using the Serial Port
Serial.begin(BAUDRATE); // initialize COM Port
inByte = Serial.read();   // read a byte

// Using the PWM Output
Servo AzServo;            // initialize AZ pin
AzServo.attach(pin9, minPW, maxPW);
AzServo.write(curAzimuth); // turn the servo
Position Control Program Specs.

- Handle EasyComm II commands
- Generate PWM signals to accurately position Azimuth & Elevation Servos
- Provide full sweep using Flip Mode
- Provide a wide range speeds (1 to 50 rpm)
Control Program Structure

Initialize → Wait for Cmd

- AZ Cmd?
  - Y: Set New AZ Position *
  - N: System Cmd?
    - Y: Process Sys Cmd
    - N: EL Cmd?
      - Y: Set New EL Position *
      - N: System Cmd?
## Commands Implemented

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VE</td>
<td>(display version)</td>
</tr>
<tr>
<td>AZ[nnn.n]</td>
<td>(0 – 360 degrees)</td>
</tr>
<tr>
<td>EL[nn.n]</td>
<td>(0 – 90 degrees)</td>
</tr>
<tr>
<td>HELP</td>
<td>(display this page)</td>
</tr>
<tr>
<td>SET</td>
<td>(display settings)</td>
</tr>
<tr>
<td>SET AZPW</td>
<td>ELPW [nnn nnnn]</td>
</tr>
<tr>
<td>SET SPEED [nn]</td>
<td>(1 - 50 rpm)</td>
</tr>
<tr>
<td>SET DEFAULTS</td>
<td>(load defaults)</td>
</tr>
</tbody>
</table>

( Audience Participation Demo !!! )
Summary

- High Utility & Fun DIY Project using Arduino
- Programming Complexity – ‘Intermediate’
- Works with any Software that supports EasyComm II - HRD Satellite, PC-Sat, etc.
- Simple Mechanical Parts
- Easily Portable & Quickly Setup
- Perfect for Light-weight Satellite Antennas!
Project Cost

- Arduino Pro Mini ~ $20
- RS232 Level Converter ~ $15
- Servos (x2) ~ $60
- Power Adapter 5V 1.5A DC ~ $15
- Plastic Sheets 8x10 inch (x2) ~ $2
- Hardware - Nuts and Bolts ~ $3
- DB9 Adapters & Phone Cable ~ $9
- Elbow Grease ~ Priceless!
References

- Arduino Web Site www.arduino.cc
- Arduino Project Ideas www.arduino.cc/playground/Projects/Ideas
- How RC Servos Work www.pcbheaven.com
- RC Store sheldonshobbies.com
- Tap Plastics Store www.tapplastics.com
Thank you!

Wishing you a fun time building Arduino & Amateur Radio projects!

Email Questions or Comments to k6vug@arrl.net
The End
Arduino Boot Loader

- Activated by Reset
- Completes basic checks
- Transfers control to the custom uploaded program

- Makes it very easy to upload & run new programs
EasyComm II Protocol

- Specifies Commands to Control Rotator, Radio, etc.
- Simple Text Command Format
  - Example: AZ123.0 EL45.0
- Commands can be spaced out in one line
- New commands override previous commands – helps rapid change in movement
Pulse Width Modulation

Pulse Width: 1mS

Pulse Width: 3mS

Pulse Width: 8mS

Pulse Rate: 20mS
PWM Drive in RC Servos

- Smart way to transmit analog signals over long distances
- Excellent tolerance to electrical noise and attenuation
- Simple algorithm converts a range of analog values to a range of pulse widths
- Simple electronics at the receiving end reconstructs the analog signal