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GETTING STARTED USING ROBOBASIC: CONTROLLING SERVOS

1. Introduction

In this document I show how to control the Hitec RoboNova's servos using RoboBASIC. The Hitec RoboNova's microcontroller board is the MR-C3024 shown below.

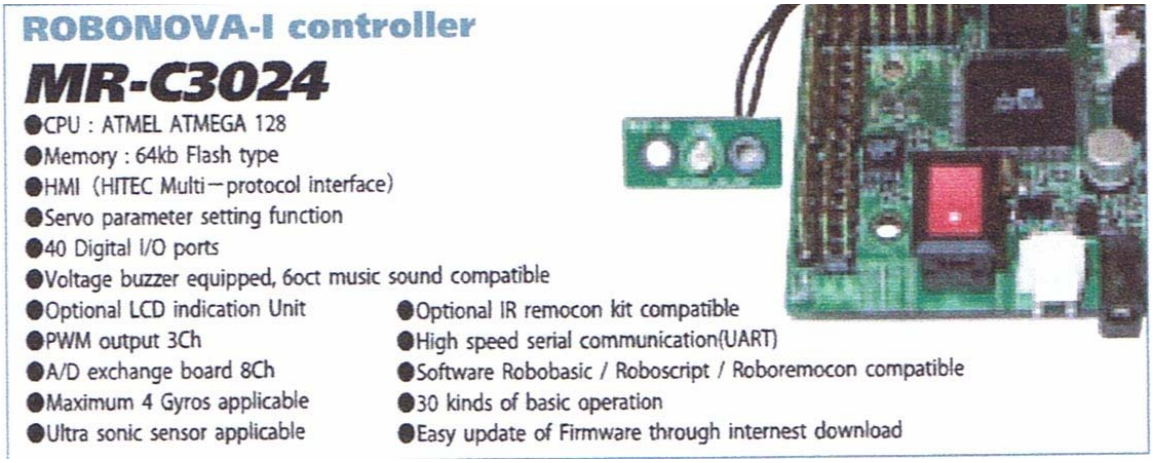

Figure 1. A description of the RoboNova-1 controller.
(source: http://us.st11.yimg.com/store1.yimg.com/I/e-clec-tech_1881_11517642)

2. Controlling RoboNova Servos

There are two ways to program RoboNova: RoboScript and RoboBASIC. In this document I show you how to use the more robust RoboBASIC to control RoboNova's servos. First, install all the files from the CD. It should be straightforward (refer to your RoboNova user's manual). Once the programs are installed, turn on RoboNova and connect it to your computer's serial port. Fire up RoboBASIC and click on the servo motion real-time control button as shown below.

Figure 2. Click on the Servo Motor Real-Time Control option in the top toolbar

Figure 3 should pop up after RoboBASIC interfaces to the robot servos.

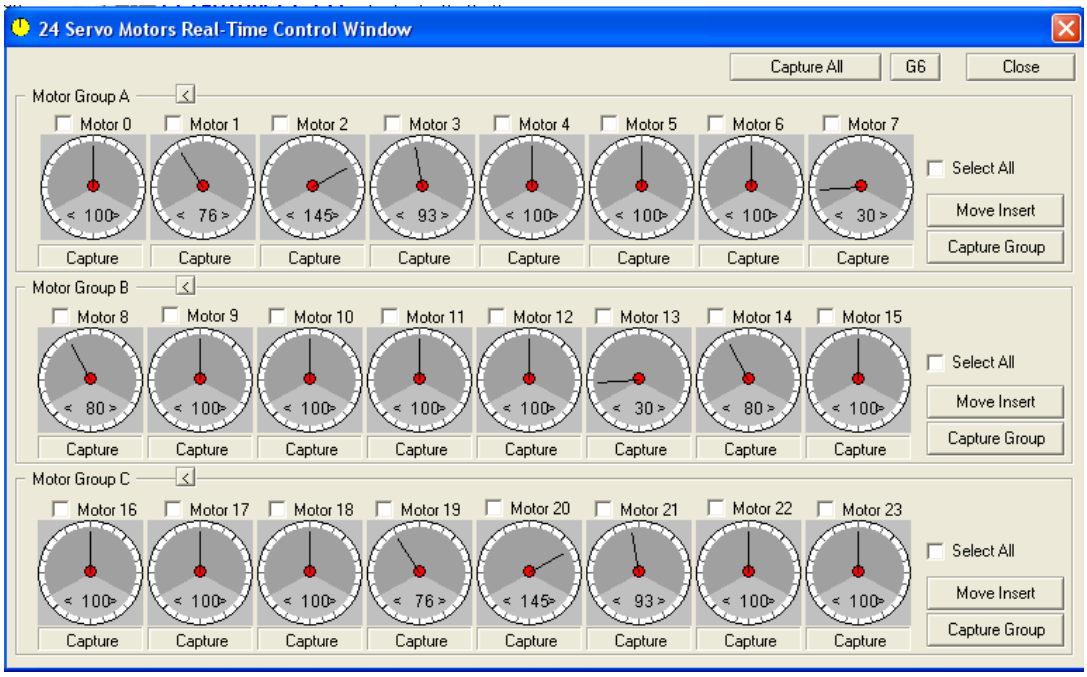

Figure 3. The default motor grouping of 8 motors in a group

It is however more intuitive to group the motors in 6 per group. To do this, click on the G6 button on the top. Figure 4 is the result

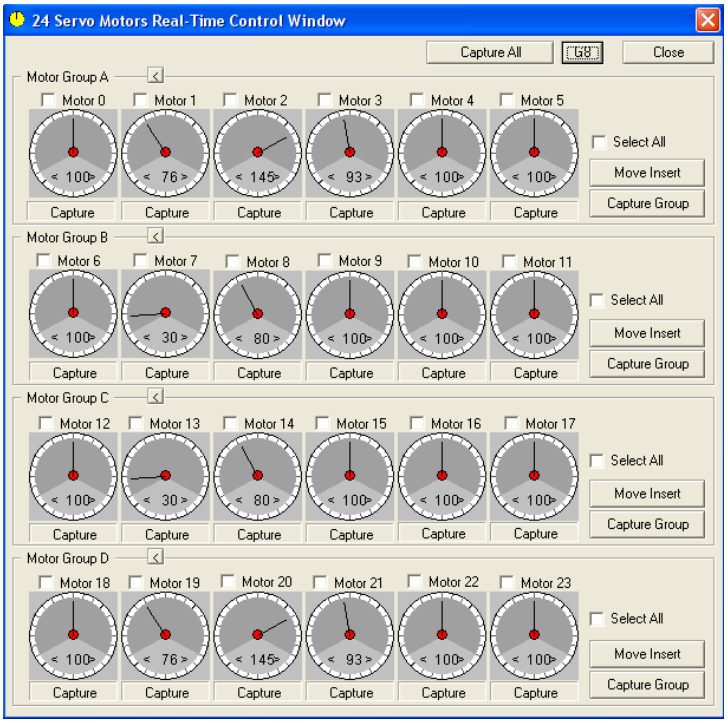

Figure 4. The more intuitive G6x (x = {A,B,C,D}) motor mapping

You can figure out the actual motor mapping by using the ROBONOVA icon  in the RoboBASIC toolbar. Figure 5 shows the servo numbers and default angles.

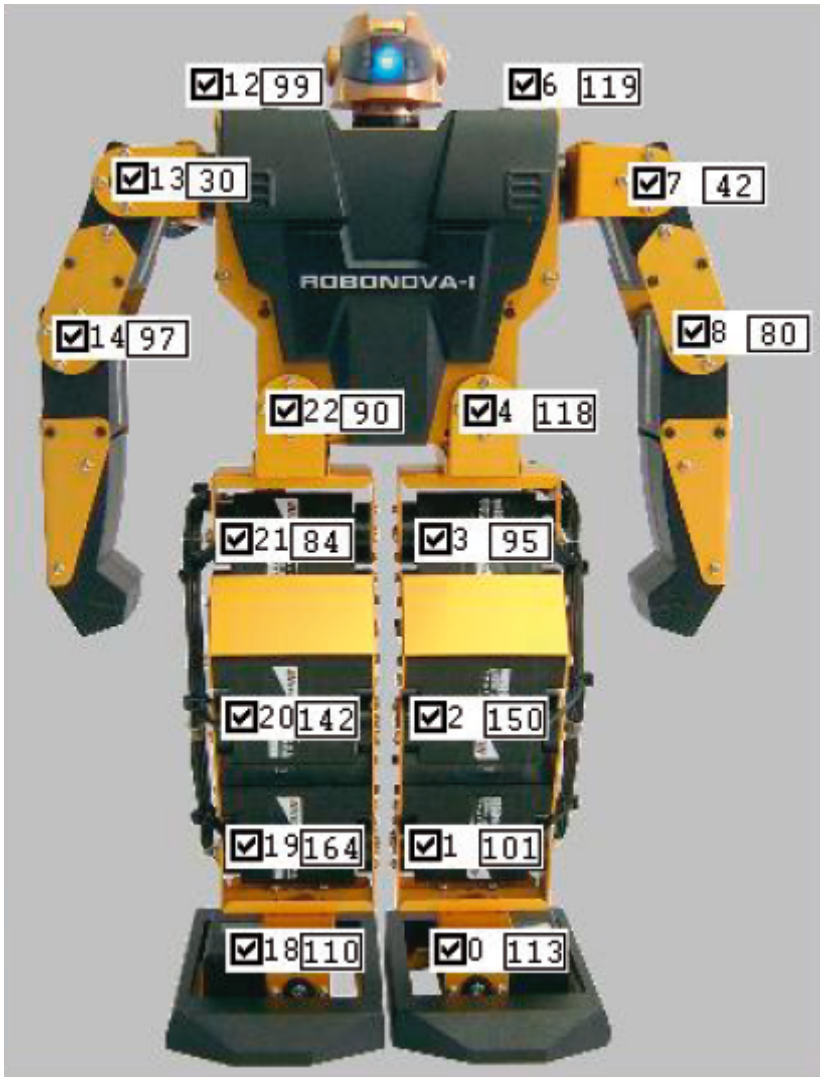

Figure 5. Servo numbers and default servo angles on the RoboNova. You can access this menu by clicking on the ROBONOVA icon  in the RoboBASIC toolbar.

Notice that using figures 4 and 5 you can pretty much map out the desired servo positions. A modified version of the default program for moving the robot's hands up is shown below. The comments should explain how the program works. You can use this template as a starting point for more advanced programs.

```
'== MODIFIED VERSION OF THE DEFAULT HANDS UP PROGRAM
'== Bharathwaj Muthuswamy (mbharat@eecs)
'== February 5th 2006

PTP SETON       ' Point-to-Point control for smooth motion
PTP ALLON       ' Refer to pages pp.88-90 of the RoboBASIC
                ' manual for details
```

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```
'== motor diretion setting ======================
DIR G6A,1,0,0,1,0,0             'Set motor directions
DIR G6B,1,1,1,1,1,1             '0-counterclockwise
DIR G6C,0,0,0,0,0,0             '1-clockwise
DIR G6D,0,1,1,0,1,0             'Refer to pages pp.86-87 of the RoboBASIC
                                'manual for details
'== motor start position read ==================
GETMOTORSET G6A,1,1,1,1,1,0  'You can tell the MR-C3024 controller
GETMOTORSET G6B,1,1,1,0,0,0  'to move the servos to the zero degrees
GETMOTORSET G6C,1,1,1,0,0,0  'position (0) or maintain the present
GETMOTORSET G6D,1,1,1,1,1,0  'position (1).  It is a good idea
                                'to do this to avoid servo damage.
                                'Refer to p.105 of the RoboBASIC
                                'manual for details.

SPEED 5                         'Motor speed, refer to p.84 of the RoboBASIC
                                'manual for details.
'== motor power on  ============================
MOTOR G24                               'Power on all motors, refer to pp.79-80 of
                                        'the RoboBASIC manual for details.
GOSUB standard_pose
'================================================
MAIN:
        DELAY 10000             ‘Wait for 10 seconds before starting program
        GOSUB hands_up
        DELAY 500               'Delay for 0.5 seconds (measured in 1 ms)      '
        GOSUB standard_pose     'Refer to p.41 of the RoboBASIC manual for details
        END                     'MAKE SURE YOU USE THE END STATEMENT.  IF NOT
                                ‘YOUR PROGRAM WILL "FALL THROUGH" TO THE
                                ‘HANDS_UP SUBROUTINE (IN THIS CASE)!
                                'Refer to p.36 of the RoboBASIC manual for details
'================================================
hands_up:
        SPEED 5
        MOVE G6A,100,76,145,93,100
        MOVE G6D,100,76,145,93,100
        MOVE G6B,100,168,150
        MOVE G6C,100,168,150
        WAIT

        RETURN
'================================================
standard_pose:

        MOVE G6A,100,76,145,93,100,100 'move motors in group A (left leg) to desired angles.
        MOVE G6D,100,76,145,93,100,100 'Refer to pp.82-83 of the RoboBASIC manual for details.
        MOVE G6B,100,30,80,100,100,100
        MOVE G6C,100,30,80,100,100,100
        WAIT                            'wait till current program is finished before executing
                                        'the next program.  Check p.39 of the RoboBASIC manual
                                        'for details.

        RETURN
'================================================
```

3. A more complicated example: sinusoidal motion

On page 76 of the RoboBASIC user's manual, it shows the following for the servo's range of motion:

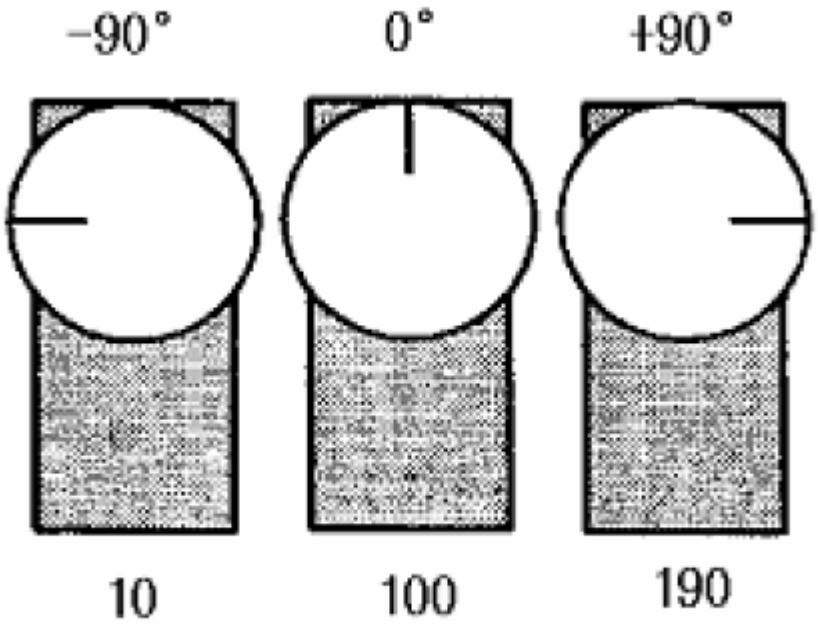

Figure 6. Servo range of motion and integer mapping
(source: RoboBASIC English Command Instructional Manual)

Lets have a sine wave that goes from 55 to 145 (-45^o to +45^o servo motion). Here is the MATLAB code to generate the points[1]:

```
>> t = linspace(0,1,100);
>> y = 45*sin(2*pi*t) + 100;
>> plot(t,y)
>> xlabel('time (seconds)');
>> ylabel('Servo values');
```

Figure 7 shows the result. The curve looks smooth enough so the motion should not be jerky.

[1] We need to generate the points offline since the controller does not have a FPU (Floating Point Unit)

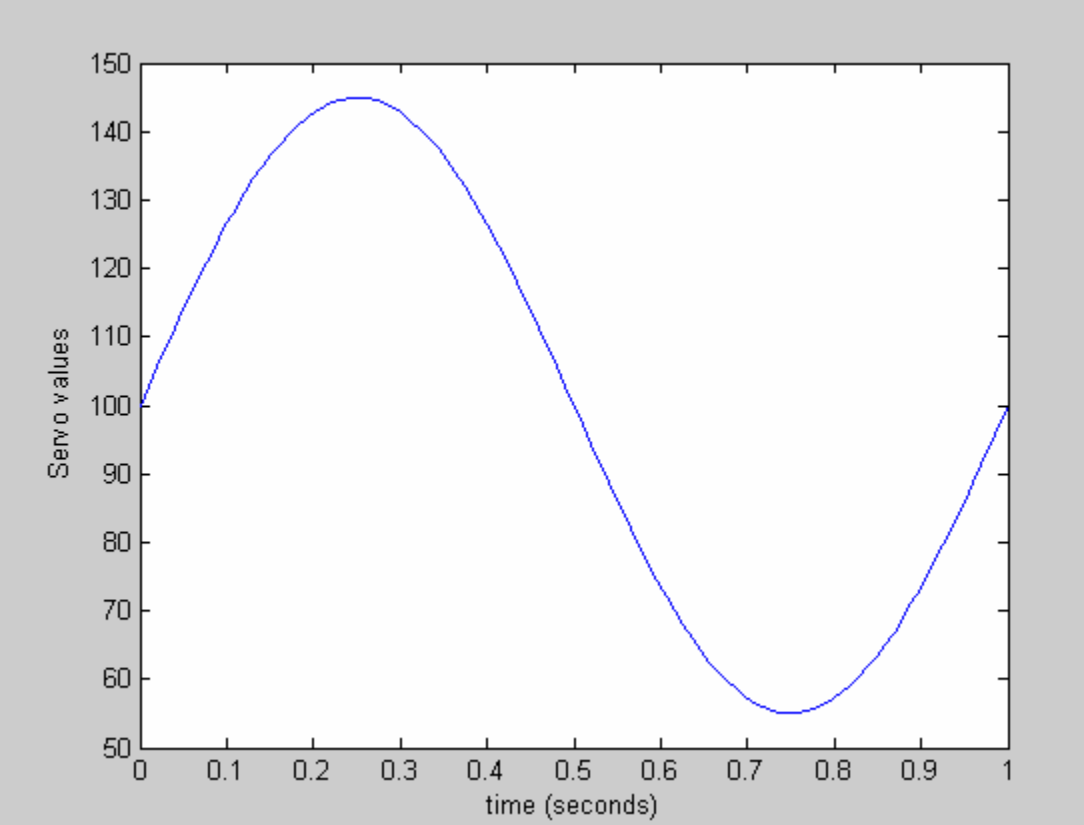

Figure 7. Servo values for the sine wave

The program below moves the left shoulder of the robot in a sinusoidal motion

```
'== Sinusoidal motion of the left shoulder servo
'== Bharathwaj Muthuswamy (mbharat@eecs)
'== March 9th 2006

PTP SETON       ' Point-to-Point control for smooth motion
PTP ALLON       ' Refer to pages pp.88-90 of the RoboBASIC
                        ' manual for details

'== motor diretion setting ======================
DIR G6A,1,0,0,1,0,0             'Set motor directions
DIR G6B,1,1,1,1,1,1             '0-counterclockwise
DIR G6C,0,0,0,0,0,0             '1-clockwise
DIR G6D,0,1,1,0,1,0             'Refer to pages pp.86-87 of the RoboBASIC
                                'manual for details
'== motor start position read ===================
GETMOTORSET G6A,1,1,1,1,1,0  'You can tell the MR-C3024 controller
GETMOTORSET G6B,1,1,1,0,0,0  'to move the servos to the zero degrees
GETMOTORSET G6C,1,1,1,0,0,0  'position (0) or maintain the present
GETMOTORSET G6D,1,1,1,1,1,0  'position (1).  It is a good idea
                             'to do this to avoid servo damage.
                             'Refer to p.105 of the RoboBASIC manual for details.
SPEED 5                      'Motor speed, refer to p.84 of the RoboBASIC manual for details.
```

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```
'== motor power on  ============================
MOTOR G24                       'Power on all motors, refer to pp.79-80 of
                                 'the RoboBASIC manual for details.
GOSUB standard_pose
'================================================
MAIN:
        DELAY 10000             ‘Wait for 10 seconds before starting program
        GOSUB sinusoid
        DELAY 500               'Delay for 0.5 seconds (measured in 1 ms)
        GOSUB standard_pose     'Refer to p.41 of the RoboBASIC manual for details
        END                     'MAKE SURE YOU USE THE END STATEMENT.  IF NOT
                                'YOUR PROGRAM WILL "FALL THROUGH" TO THE
                                'HANDS_UP SUBROUTINE (IN THIS CASE)!
                                'Refer to p.36 of the RoboBASIC manual for details
'================================================
sinusoid:
        SERVO 6,100
        DELAY 5
        SERVO 6,103
        DELAY 5
        SERVO 6,106
        DELAY 5
        SERVO 6,109
        DELAY 5
        SERVO 6,111
        DELAY 5
        SERVO 6,114
        DELAY 5
        SERVO 6,117
        DELAY 5
        SERVO 6,119
        DELAY 5
        SERVO 6,122
        DELAY 5
        SERVO 6,124
        DELAY 5
        SERVO 6,127
        DELAY 5
        SERVO 6,129
        DELAY 5
        SERVO 6,131
        DELAY 5
        SERVO 6,133
        DELAY 5
        SERVO 6,135
        DELAY 5
        SERVO 6,137
        DELAY 5
        SERVO 6,138
        DELAY 5
        SERVO 6,140
        DELAY 5
        SERVO 6,141
        DELAY 5
        SERVO 6,142
        DELAY 5
```

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SERVO 6,143
DELAY 5
SERVO 6,144
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DELAY 5
SERVO 6,126
DELAY 5
SERVO 6,123
DELAY 5
SERVO 6,121
DELAY 5
SERVO 6,118
DELAY 5
SERVO 6,115
DELAY 5
SERVO 6,113
DELAY 5
SERVO 6,110
DELAY 5
SERVO 6,107
DELAY 5
```

```
SERVO 6,104
DELAY 5
SERVO 6,101
DELAY 5
SERVO 6,99
DELAY 5
SERVO 6,96
DELAY 5
SERVO 6,93
DELAY 5
SERVO 6,90
DELAY 5
SERVO 6,87
DELAY 5
SERVO 6,85
DELAY 5
SERVO 6,82
DELAY 5
SERVO 6,79
DELAY 5
SERVO 6,77
DELAY 5
SERVO 6,74
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SERVO 6,66
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```

```
        SERVO 6,55
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        DELAY 5
        SERVO 6,76
        DELAY 5
        SERVO 6,78
        DELAY 5
        SERVO 6,81
        DELAY 5
        SERVO 6,83
        DELAY 5
        SERVO 6,86
        DELAY 5
        SERVO 6,89
        DELAY 5
        SERVO 6,91
        DELAY 5
        SERVO 6,94
        DELAY 5
        SERVO 6,97
        DELAY 5
        SERVO 6,100
        DELAY 5
        SPEED 5
        RETURN
'================================================
standard_pose:
        MOVE G6A,100,76,145,93,100,100 'move motors in group A (left leg) to desired angles.
        MOVE G6D,100,76,145,93,100,100 'Refer to pp.82-83 of the RoboBASIC manual for details.
        MOVE G6B,100,30,80,100,100,100
        MOVE G6C,100,30,80,100,100,100
```

```
        WAIT                    'wait till current program is finished before executing
                                'the next program.  Check p.39 of the RoboBASIC
                                ‘manual for details.
        RETURN
'=============================================
```

In the program above, I have used a MATLAB script to automatically output the servo commands. Servo #6 is the left-shoulder servo (if you used the G6 mapping shown in figure 5). I wait for 5 ms after each servo movement because I calculated that it takes 3.3 ms for a servo to move 1 degree (ROBONOVA User’s manual, p. 11).