Abstract

The project consists of designing a microcontroller system that sweeps a photo sensor mounted on servo motor through 180 degrees. The photo sensor outputs the intensity of the light continuously swept during the rotation. An LCD indicates the angle of the brightest light and the angle of the dimmest light**.**

This project is implemented using a 16-bit PWM created using module 0 of the PCA in software timer mode.

Components:

(1) HD44780U HITACHI Dot Matrix Liquid Crystal Display

(1) 8-bit flash microcontroller ATMEL AT89C51RD2
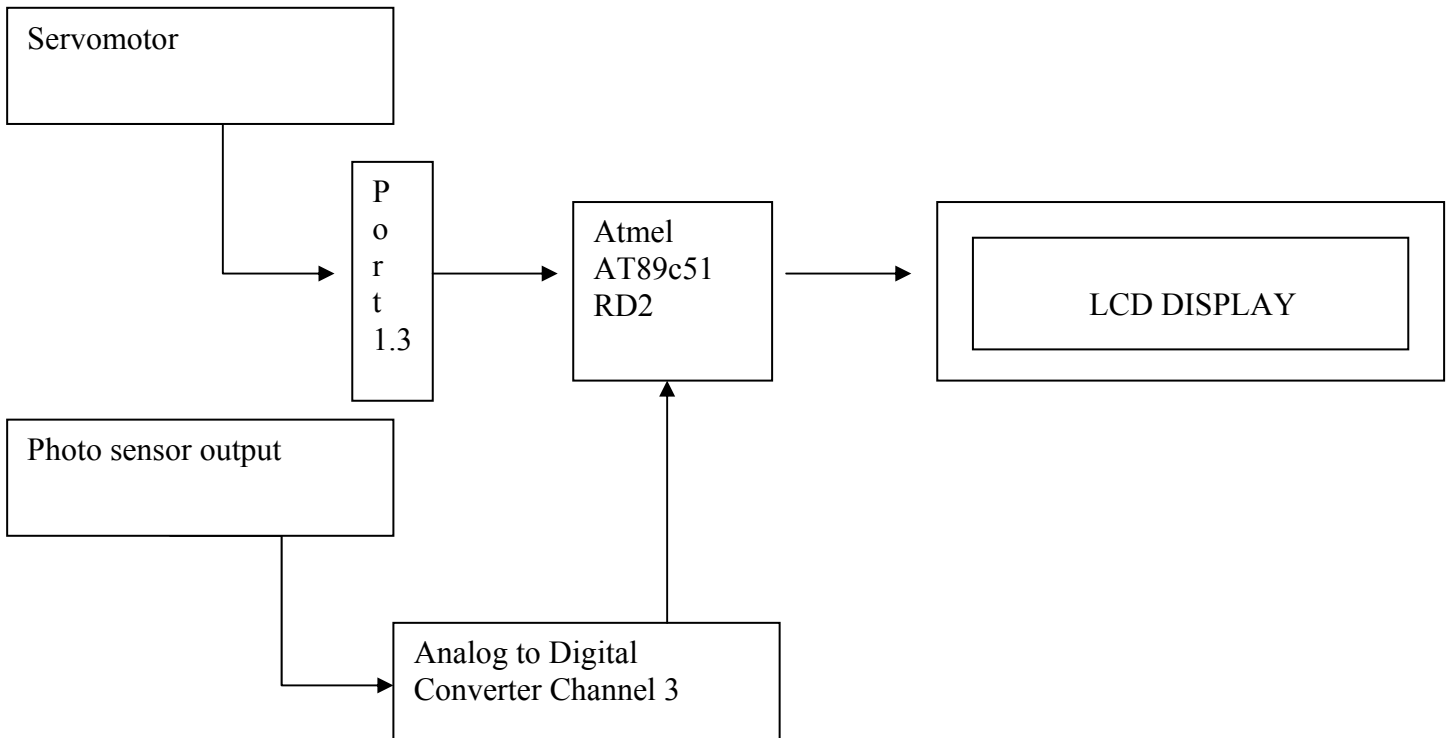
(1) Photo sensor

(1) Servomotor

(1) 10kΩ resistor

Figure 1: Connection Diagram

Description:

The program keeps tracks of the position of the servomotor in the main code routine. An angle is associated to every position of the servomotor. The photo sensor attached transmits an output voltage to the channel 3 of the Analog to Digital converter, according the intensity of the light applied.

Calculations:

After testing the servomotor connected to the port P1.3, a 180 degrees rotation starts at 1000 counts and stops at 5000 counts.

Number of counts for 180 deg = 5000 counts – 1000 counts = 4000 counts

For gradual 20 increments of the servomotor position:

$$\text{counts per increment} = \frac{5000}{20} = 200 \; counts \; per \; increments$$

$$\text{angle per increment} = \frac{180}{20} = 9 \; degrees \; per \; increments$$
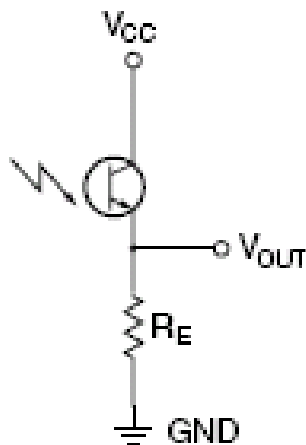
- Photo sensor:

Figure 2. Common-Collector Amplifier

VCC = 5V

V_{OUT} varies according to the light intensity

R_E:
The value of R_E has been adjusted to give best results for the photo sensor light tracking.
Using the Analog to Digital test routine and the LCD, I was able to test the voltage coming out of the photo sensor to the AD channel 4 for different values of R_E. The best value obtained for R_E is 10kΩ.

Source Code Documentation:

The software makes use of 1 module

- **Initialize routine design**
 1- Initialize the display
  2- Initialize the PCA

- **Main program design**
  1- Call the Initialize() routine
  2 – While loop
      2.1- Reset the servo to initial position and reset variables to zero
      2.2- 'for' loop from 0 to 20
          2.2.1- Increment the angle by 9
          2.2.2- Increment the servomotor position by 200
          2.2.3- Get the A to D converter input voltage
          2.2.4- Update the lowest and highest voltage and their corresponding angles
          2.2.5- Wait on a time delay
      2.3- Display the angle of the brightest and the dimmest light on the LCD

- **Display routine design**
  1- LCD Delay module
  2- LCD Driver module
  3- Display text module
  4- Display number module

- **Analog routine design**
  1- Set the address at 0X7000
  2- Get the requested channel number and convert analog value
  3- Wait until operation is done
  4- Return the value digital value

- **Interrupt routine design:**
  1- Set the PCA time
  2- Invert P1.3
  3 – If P1.3 is high
      3.1- Reload capture register with the current PCA time
  4- Otherwise
      4.1 -Reload capture register with the current PCA time and the PWM period
  5- Clear CCF0

Hardware design:
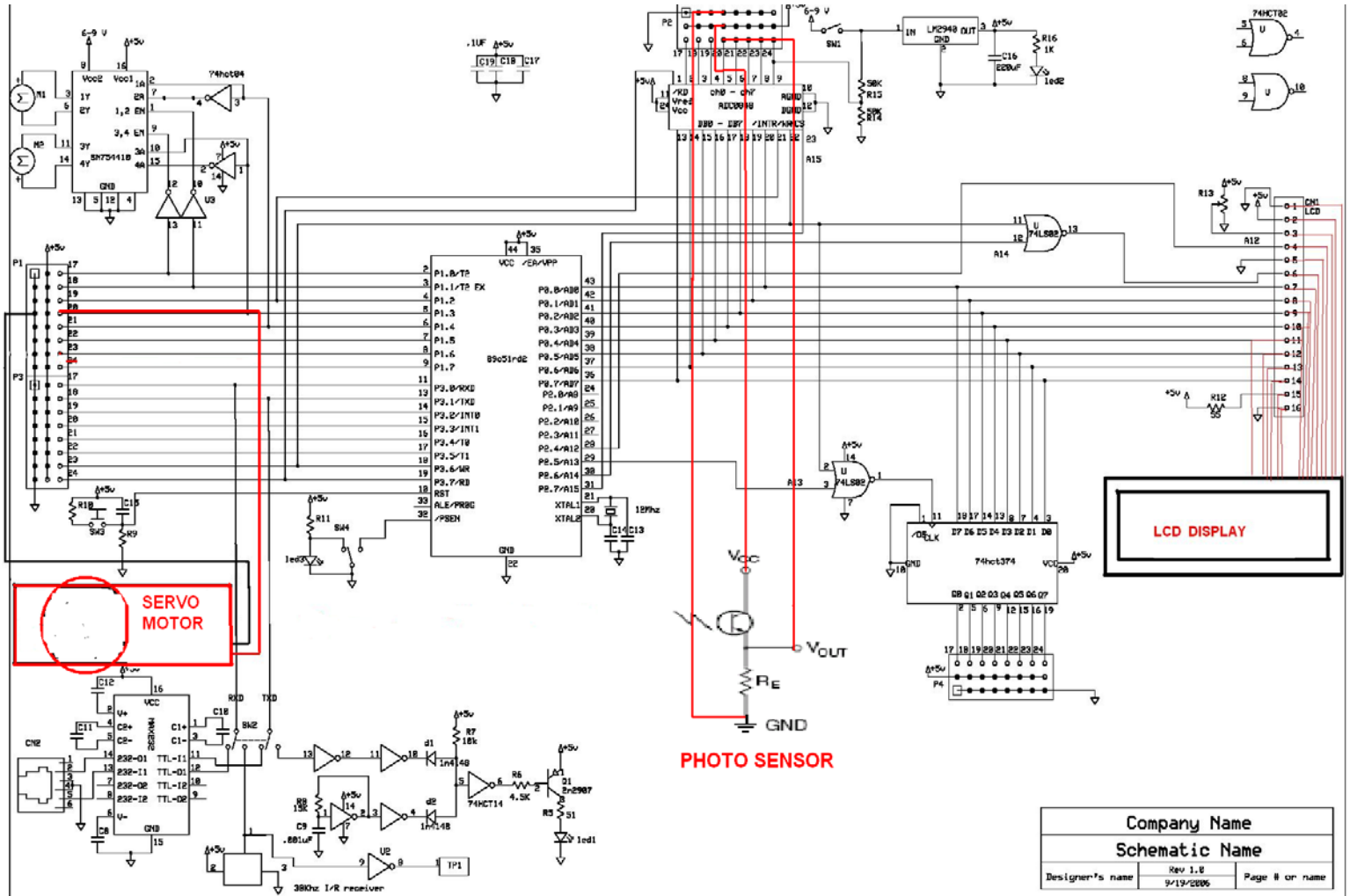
Schematic

The servomotor is connected to the port P1.3 and the photo sensor is connected to the channel 3 of the Analog to Digital converter.

Extra features

- The LCD also shows the highest and lowest voltages outputted by the photo sensor

Conclusion

The device has been tested successfully and operates using a flash-light as a light source.