CPE301 – SPRING 2024

Design Assignment 5

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Primary Github address: https://github.com/SON-Abe/submission_da.git
Directory: submission_da/Design_Assignments/DA5
Video Playlist: DA5

Submit the following for all Labs:

1. In the document, for each task submit the modified or included code (only) with highlights and justifications of the modifications. Also, include the comments.
2. Use the previously create a Github repository with a random name (no CPE/301, Lastname, Firstname). Place all labs under the root folder ESD301/DA, sub-folder named LABXX, with one document and one video link file for each lab, place modified asm/c files named as LabXX-TYY.asm/c.
3. If multiple asm/c files or other libraries are used, create a folder LabXX-TYY and place these files inside the folder.
4. The folder should have a) Word document (see template), b) source code file(s) and other include files, c) text file with youtube video links (see template).

1. **COMPONENTS LIST AND CONNECTION BLOCK DIAGRAM w/ PINS**

- Microchip Studio Debugger
- Microchip Studio Terminal Window
- Microchip Studio Simulator
- ATmega328PB Microcontroller
- SG90 Micro Servo
- mini breadboard
- usb
- Male to Male wires
- Female to Male wires

2. **INITIAL/MODIFIED/DEVELOPED CODE OF TASK 1/A**

ULTRASONIC:

```
/*
 * ATmega_UltrasonicHCSR05.c
 *
 * Created: 6/29/2021 11:48:54 PM
 * Author : VenkatesanMuthukumar
 */

#define F_CPU 16000000UL

#include <stdio.h>
#include <stdlib.h>
#include <avr/io.h>
#include <util/delay.h>
#include <avr/interrupt.h>
#include <string.h>

#define BAUDRATE 9600
#define BAUD_PRESCALLER (((F_CPU / (BAUDRATE * 16UL))) - 1)
char buffer[5];                 //Output of the itoa function

void USART_init(void){

    UBRR0H = (uint8_t)(BAUD_PRESCALLER>>8);
    UBRR0L = (uint8_t)(BAUD_PRESCALLER);
    UCSR0B = (1<<RXEN0)|(1<<TXEN0);
    UCSR0C = (3<<UCSZ00);
}
```

```
void USART_send( unsigned char data){

    while(!(UCSR0A & (1<<UDRE0)));
    UDR0 = data;

}

void USART_putstring(char* StringPtr){

    while(*StringPtr != 0x00){
        USART_send(*StringPtr);
    StringPtr++;}

}

#define  Trigger_pin    PB1 /* Trigger pin */

int TimerOverflow = 0;

ISR(TIMER1_OVF_vect)
{
    TimerOverflow++;        /* Increment Timer Overflow count */
}

int main(void)
{
    char string[10];
    long count;
    double distance;

    DDRB = 0x02;            /* Make trigger pin as output */
    /* PB0 is the Echo Pin & PB1 is the Trigger in */
    USART_init();

    sei();                  /* Enable global interrupt */
    TIMSK1 = (1 << TOIE1);  /* Enable Timer1 overflow interrupts */
    TCCR1A = 0;             /* Set all bit to zero Normal operation
*/
```

```
    while(1)
    {

        PORTB |= (1 << Trigger_pin);/* Give 10us trigger pulse on
trig. pin to HC-SR04 */
        _delay_us(10);
        PORTB &= (~(1 << Trigger_pin));

        TCNT1 = 0;          /* Clear Timer counter */
        TCCR1B = 0x41;      /* Setting for capture rising edge, No
pre-scaler*/
        TIFR1 = 1<<ICF1;        /* Clear ICP flag (Input Capture
flag) */
        TIFR1 = 1<<TOV1;        /* Clear Timer Overflow flag */

        /*Calculate width of Echo by Input Capture (ICP) on PortD
PD6 */

        while ((TIFR1 & (1 << ICF1)) == 0); /* Wait for rising edge
*/
        TCNT1 = 0;          /* Clear Timer counter */
        TCCR1B = 0x01;      /* Setting for capture falling edge, No
pre-scaler */
        TIFR1 = 1<<ICF1;        /* Clear ICP flag (Input Capture
flag) */
        TIFR1 = 1<<TOV1;        /* Clear Timer Overflow flag */
        TimerOverflow = 0;  /* Clear Timer overflow count */

        while ((TIFR1 & (1 << ICF1)) == 0); /* Wait for falling edge
*/
        count = ICR1 + (65535 * TimerOverflow); /* Take value of
capture register */
        /* 8MHz Timer freq, sound speed =343 m/s, calculation
mentioned in doc. */
        distance = (double)count / (58*16);

        dtostrf(distance, 2, 2, string);/* Convert distance into
string */
        strcat(string, " cm   ");
        USART_putstring("Dist = ");
```

```
        USART_putstring(string);    /* Print distance on Terminal */
        _delay_ms(200);
    }
}
```

SERVO:

```
#include <Servo.h>

//-----------------------------------
//servo setup
//Servo Pin must have PWM
const int servoPin = 8;
Servo myServo;
//-----------------------------------

//-----------------------------------
//ultrasonic sensor setup
const int trigPin = 10;
const int echoPin = 11;
long duration;
int distance;
//-----------------------------------

void setup() {

  Serial.begin(9600);

  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);

  myServo.attach(servoPin);
}

void loop() {

  //-------------------------------------------------------------
  //servo move forward
  for(int i=10;i<=170;i++) // servo position 10-170
  {
    myServo.write(i);
```

```
    delay(30);
    distance = measureDistance();
    Serial.print(i);
    Serial.print(",");
    Serial.print(distance );
    Serial.print(".");
  }
  //---------------------------------------------------------

  //---------------------------------------------------------
  //servo move backward
  for(int i=170;i>10;i--) // servo position 170-10
  {
    myServo.write(i);
    delay(40);
    distance = measureDistance();
    Serial.print(i);
    Serial.print(",");
    Serial.print(distance );
    Serial.print(".");
  }
  //---------------------------------------------------------
}

int measureDistance(){

  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);

  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance= duration*0.034/2;
  return distance;
}
```

3. **DEVELOPED/MODIFIED CODE OF TASK 3/A**

```
#define F_CPU 16000000UL                                    // 16MHz
clock
```

```
#define BAUDRATE 9600                                          //
baudrate
#define BAUD_PRESCALE (((F_CPU / (BAUDRATE * 16UL))) - 1)
//BAUD_PRESCALEFORMULA
#define  Trigger_pin    PINB1
//trigger pin
#include <stdio.h>
#include <stdlib.h>
#include <avr/io.h>
#include <util/delay.h>
#include <avr/interrupt.h>
#include <string.h>

int TimerOverflow = 0;
char string[20];
char angle_str[10];
char dist_str[10];
unsigned long count;
int distance;
int angle;

void usart_init(void)
{
    UBRR0H = (uint8_t) (BAUD_PRESCALE >> 8);    // LOAD UBRR0 HIGH 8
BITS
    UBRR0L = (uint8_t) (BAUD_PRESCALE);         // LOAD UBBR0 LOW
BITS
    UCSR0B = (1 << TXEN0);                      // USART TRANSMITTER
AND RECEIVER ENABLED
    UCSR0C = (1 << UCSZ01) | (1 << UCSZ00);     // 8 DATA BITS, 1
STOP BIT,NO PARITY
}

void usart_send (unsigned char ch)
{
    while (! (UCSR0A & (1<<UDRE0)));            // WAIT TILL UDR0 IS
EMPTY
    UDR0 = ch;                                  // TRANSMIT
CHARACTER
}
```

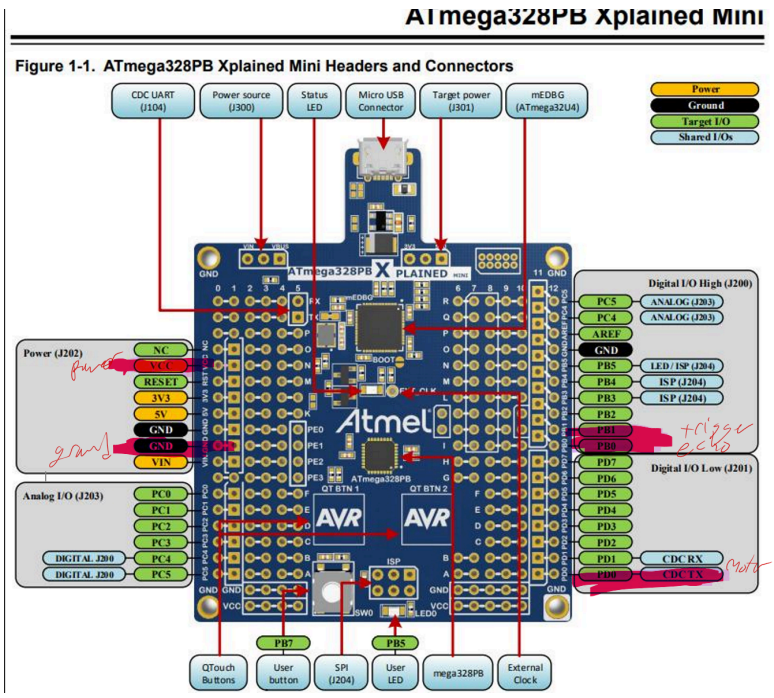
```
void usart_print(char* ChArrPtr)
{
    while ((*ChArrPtr) != '\0')                    // WHILE CHAR ARRAY
ISNT EMPTY
    {
        while (! (UCSR0A & (1 << UDRE0)));         // WAIT TILL UDR0 IS
EMPTY
        UDR0 = *ChArrPtr;                          // TRANSMIT CHAR
        ChArrPtr++;                                // MOVE TO NEXT CHAR
IN ARRAY
    }
}

//COUNTER FOR ULTRASONIC
ISR(TIMER1_OVF_vect)
{
    TimerOverflow++;                               // Increment Timer
Overflow count
}

//ULTRASONIC FUNCTION
void ultrasonic()
{

    PORTB |= (1 << Trigger_pin);                   // 10us TRIGGER
PULSE
    _delay_us(10);                                 // DELAY
    PORTB &= (~(1 << Trigger_pin));                // FALLING EDGE

    TCNT1 = 0;                                     // CLEAR TIMER1
COUNTER
    TCCR1B = 0x41;                                 // CAPTURE AT RISING
EDGE SETUP
    TIFR1 = 1<<ICF1;                               // CLEAR INPUT
CAPTURE FLAG FOR TIMER1
    TIFR1 = 1<<TOV1;                               // CLEAR TIMER1
OVERFLOW
```

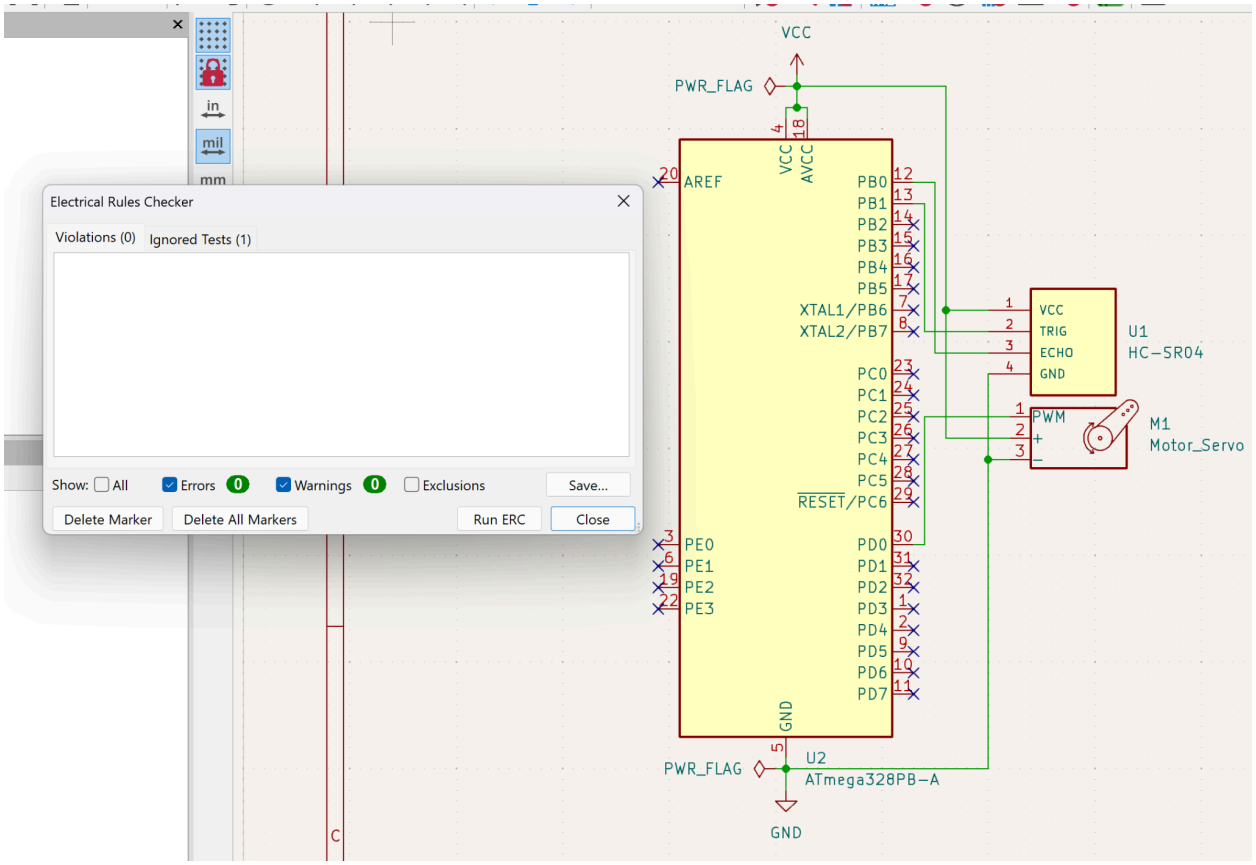
```
    while ((TIFR1 & (1 << ICF1)) == 0);          //  WAITS FOR RISING
EDGE
    TCNT1 = 0;                                   // CLEAR TIMER1
COUNTER
    TCCR1B = 0x01;                               // SET TO CAPTURE
FALLING EDGE
    TIFR1 = 1<<ICF1;                             // CLEAR INPUT
CAPTURE FLAG FOR TIMER1
    TIFR1 = 1<<TOV1;                             // CLEAR TIMER1
OVERFLOW
    TimerOverflow = 0;                           // CLEARS TIMER
OVERFLOW COUNTER

    while ((TIFR1 & (1 << ICF1)) == 0);          // WAITS TILL
FALLING EDGE
    count = ICR1 + (65535 * TimerOverflow);      // COUNT FORMULA
    distance = (unsigned long)count / (58*16);   // DISTANCE FORMULA

    if(angle <= 9)                               // IF THE ANGLE IS
<= 9
        dtostrf(angle, 1, 0, angle_str);         // CONVERT ANGLE TO
STRING WITH 1 DIGIT RESERVED FOR INTEGER PART AND 0 DIGITS FOR THE
DECIMAL PART
    else if(angle <= 99)                         // ELSE IF THE ANGLE
IS <= 99
        dtostrf(angle, 2, 0, angle_str);         // CONVERT ANGLE TO
STRING WITH 2 DIGIT RESERVED FOR INTEGER PART AND 0 DIGITS FOR THE
DECIMAL PART
    else                                         // ELSE
        dtostrf(angle, 3, 0, angle_str);         // CONVERT ANGLE TO
STRING WITH 3 DIGIT RESERVED FOR INTEGER PART AND 0 DIGITS FOR THE
DECIMAL PART

    strcat(angle_str, ",");                      // APPEND "," TO
ANGLE_STR CHAR ARRAY

    if(distance <= 9)                            // IF THE ANGLE IS
<= 9
```

```
        dtostrf(distance, 1, 0, dist_str);      // CONVERT DISTANCE
TO STRING WITH 1 DIGIT RESERVED FOR INTEGER PART AND 0 DIGITS FOR
THE DECIMAL PART
    else                                        // ELSE
        dtostrf(distance, 2, 0, dist_str);      // CONVERT DISTANCE
TO STRING WITH 2 DIGITS RESERVED FOR INTEGER PART AND 0 DIGITS FOR
THE DECIMAL PART

    strcat(angle_str, dist_str);                // APPEND DIST_STR
    strcat(angle_str, ".");                     // APPEND "."
    usart_print(angle_str);                     // SEND THE CHAR
ARRAY TO USART

}

//Servo Motor
void motor()
{
    angle = 0;                                  // START ANGLE AT 0
DEGEREES
    //servo move forward 0-180
    for(OCR3A = 1000; OCR3A<=5200; OCR3A+=23)
    {
        angle++;                                // INCREASE ANGLE
        ultrasonic();                           // SEND PWM
        _delay_ms(5);                           // DELAY
    }

    angle = 180;                                // START ANGLE AT
180 DEGREES
    //servo move backward 180-0
    for(OCR3A=5200;OCR3A>1000;OCR3A-=23)
    {
        angle--;                                // DECREASE ANGLE
        ultrasonic();                           // SEND PWM
        _delay_ms(5);                           // DLEAY
    }
}

int main ( )
```

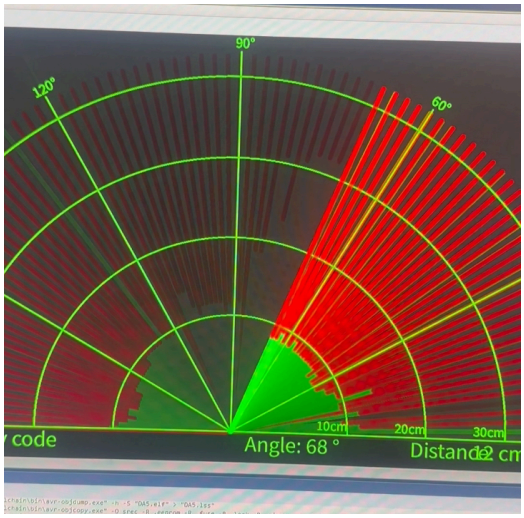
```
{
    /*MOTOR*/
    TCCR3A |= (1 << COM3A1) | (1 << COM3B1) | (1 << WGM31); //
Compare Output Mode, Fast PWM: Clear OC1A/OC1B on Compare Match, set
OC1A/OC1B at BOTTOM (non-inverting mode)
    TCCR3B |= (1 << WGM33) | (1 << WGM32) | (1 << CS31);    //FAST
PWM & PRESCALE 8
    DDRD |= (1 << PIND0);                                    //PWM
PINS AS OUT
    ICR3 = 39999;                                            //FWPM =
50 HZ, T = 20ms. 40k-1

    /*ULTRASONIC*/
    DDRB = (1<<DDB1);                                        // PB0
is the Echo Pin & PB1 is the Trigger in
    usart_init();                                            //
INITIALIZE USART

    sei();                                                   //
ENABLE GLOBAL INTERRUPTS
    TIMSK1 = (1 << TOIE1);                                   //
ENABLE TIMER1 OVERFLOW INTERRUPTS
    TCCR1A = 0;                                              // SET
TCCR1A 0

    while(1)
        motor();                                             // RUN
THE MOTOR FUNCTION
}
```

4. **SCHEMATICS**

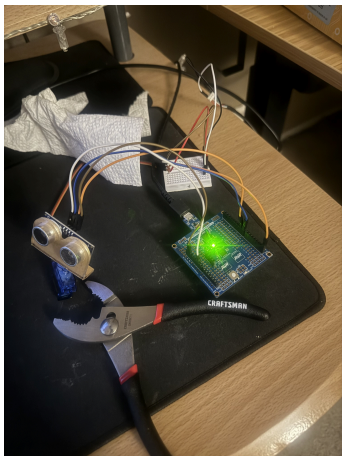




5. SCREENSHOTS OF EACH TASK OUTPUT (ATMEL STUDIO OUTPUT)



6. **SCREENSHOT OF EACH DEMO (BOARD SETUP)**



7. **VIDEO LINKS OF EACH DEMO**

DA5

8. **GITHUB LINK OF THIS DA**

DA5

Student Academic Misconduct Policy

http://studentconduct.unlv.edu/misconduct/policy.html

"*This assignment submission is my own, original work*".

Abraham Garcia