CPE301 – SPRING 2022

Midterm 2

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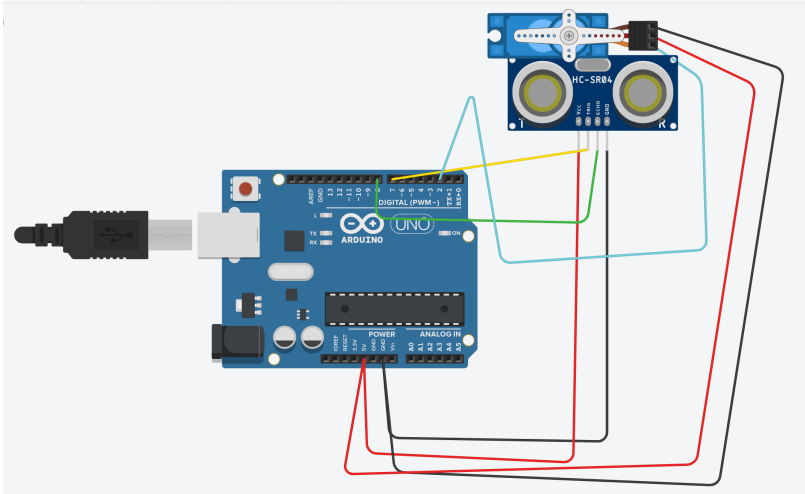
1. COMPONENTS LIST AND CONNECTION BLOCK DIAGRAM w/ PINS

List of Components used: ultra sonic sensor and servo motor
Block diagram with pins used in the Atmega328P:

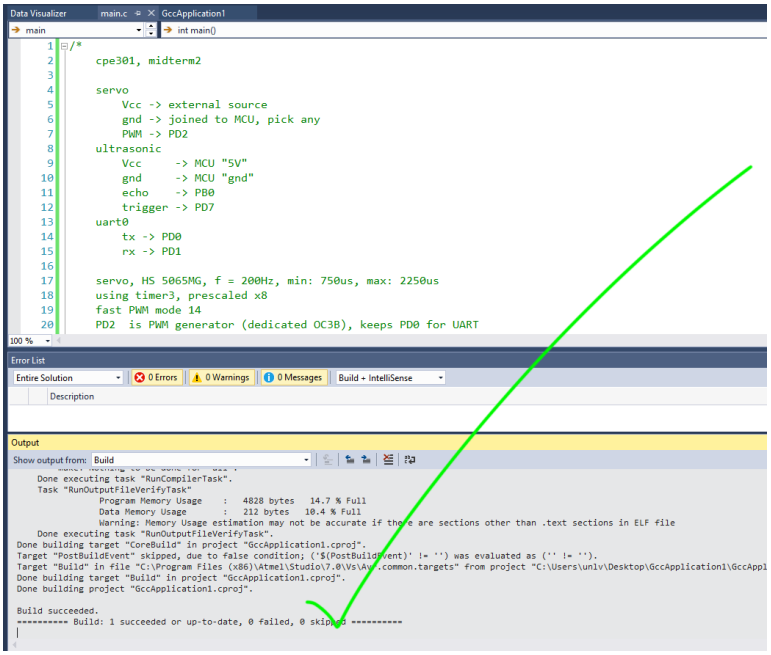


Servo uses ground, $V_{CC} = 5V$ and PWM on PD2

Ultrasonic sensor uses ground, $V_{CC} = 5V$, PB0 echo, PD7 trigger

2. INITIAL/MODIFIED/DEVELOPED CODE, all tasks

The code covers all tasks.
The code was successful:



C code:

```
/*
    cpe301, midterm2, all tasks are contained


    servo
        Vcc -> external source
        gnd -> joined to MCU, pick any
        PWM -> PD2
    ultrasonic
        Vcc     -> MCU "5V"
        gnd     -> MCU "gnd"
        echo    -> PB0
        trigger -> PD7
    uart0
        tx -> PD0
```

```
        rx -> PD1


    servo, HS 5065MG, f = 200Hz, min: 750us, max: 2250us
    using timer3, prescaled x8
    fast PWM mode 14
    PD2  is PWM generator (dedicated OC3B), keeps PD0 for UART
    share the common ground, but use external power just in case


    HC-SR04 ultra-sonic sensor
    PD7 for trigger
    PB0 for echo, must be use since timer1 has ICP1 on this pin
    sound will probably at 344 m/s where you use this
    for each tik, (1 / f_cpu) * prescale = T
    the sound travels to the target and back
    distance = (tiks / 2) * 344 meters, about    (1/16e6)*(344*100)/2 = 930  , the const for distance
in cm, must tune it
    "distance = rate * time ... m = m/s * s"


    statrt processing 4
    orcFont = loadFont("OCRAExtended-30.vlw"); is in the folder
    myPort = new Serial(this,"COM4", 9600); // starts the serial communication  check com port
    ...set the marco, processing uses different data types


    1500:33:4470 == 90 steps
    0:2:180 == 90 steps
 */
#define PROCESSING 11    // toggle here
#ifdef PROCESSING
    #define PROCESSING_STOP 180
    #define PROCESSING_START 0
    #define PROCESSING_STEP 2
#endif


#define F_CPU 16000000UL
#define BAUD 9600
```

```
#define BAUD_PRESCALE (((F_CPU / (BAUD * 16UL))) - 1)

#define SERVO_WIDTH 10000    // f_pwm  = 200 Hz,  200 = f_cpu / (N * (TOP+1)  -> TOP = 9999
#define SERVO_START 1500     // 750us min,  f = f_cpu / N = 2e6, T = 1/f = 0.5us  ->  750/0.5 =
1500...don't max out
#define SERVO_STOP 4470      // 2250us max, "                                      "  2250/0.5 =
4500...don't max out
#define SERVO_HANG 100       // ms, change based on step size, the wait time
#define SERVO_STEP 33        // change as needed, give resolution
#define SERVO_RETURN 500     // give it enough time to return from a sweep

#define TRIGGER_WIDTH_US 10    // duration of the trigger pulse in micro seconds
#define TIME_OUT 10            // overflows allowed to occur before continuing program
#define TUNER 1024             // should be around 930, see calculation above

#define PWM_PIN 2        // PD2 has OC3B
#define ECHO_PIN 0       // on PORTB, must be on PB0 for ICR1
#define TRIGGER_PIN 7    // on PORTD

#define HELP_BUF 128
#define TRUE 888
#define FALSE 999

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



uint16_t servo_counter;
volatile char helper[HELP_BUF];
volatile int timer_overflows;
```

```
volatile double distance;
volatile long tik_count;
int read_attempt;

void read_distance();
void usart_putc (char send_char);
void usart_puts (const char* send_str);


int main()
{
    #ifdef PROCESSING
        uint16_t temp_a;
        uint16_t temp_b;
        uint16_t process_step = 0;
        uint16_t process_distance;
    #endif
    DDRD |= (1 << TRIGGER_PIN);    // trigger signal as output
    PORTB |= (1 << ECHO_PIN);      // turn on pull up resistor for echo capture as input

    UCSR0B |= (1 << RXEN0) | (1 << TXEN0);      // turn on USART module, receive and transmit enabled
    UCSR0C |= (1 << UCSZ00) | (1 << UCSZ01);    // configure: asynchronous, 8-bit data, 1-bit stop
    UBRR0H |= (BAUD_PRESCALE >> 8);             // sets baud rate
    UBRR0L |= BAUD_PRESCALE;

    TIMSK1 |= (1 << TOIE1);    // enable timer1 overflow interrupt
    TCCR1A = 0;                // normal operation

    DDRD |= (1 << PWM_PIN);                                 // dedicated PWM pin for timer 3
    PORTD |= (1 << PWM_PIN);                                // this must be done to disable OC4B, the
pin is shared
    ICR3 = SERVO_WIDTH;                                     // the "TOP", makes the time period, OCR3A
makes duty cycle
    TCCR3A |= (1 << COM3B1) | (1 << WGM31);                 // non inverting, mode14
    TCCR3B |= (1 << WGM33) | (1 << WGM32) | (1 << CS31);    // mode 14, prescale 8
    servo_counter = SERVO_START;
```

```
usart_puts("\r\n");
usart_puts("initialized, program begins...\r\n");
sei();

while(1)
{
    while (servo_counter < SERVO_STOP)
    {
        read_attempt = 0;
        OCR3B = servo_counter;
        read_distance();
        _delay_ms(SERVO_HANG);
        while (distance == 0 && read_attempt < TIME_OUT)
        {
            read_distance();
            read_attempt ++;
            _delay_ms(SERVO_HANG);
        }
        #ifdef PROCESSING
        //
            process_step = process_step + PROCESSING_STEP;
            sprintf(helper, "%d", process_step);
            usart_puts(helper);
            usart_puts(",");
            sprintf(helper, "%d", (uint16_t)distance);
            usart_puts(helper);
            usart_puts(".");
            if(process_step > PROCESSING_STOP) {process_step = PROCESSING_START;}
            _delay_ms(SERVO_HANG);
        //
        #else
            usart_puts("\r\n");
            snprintf(helper, HELP_BUF-1, "tik#:  %d  ,  distance:  %0.3lf  cm",
            servo_counter, distance);
```

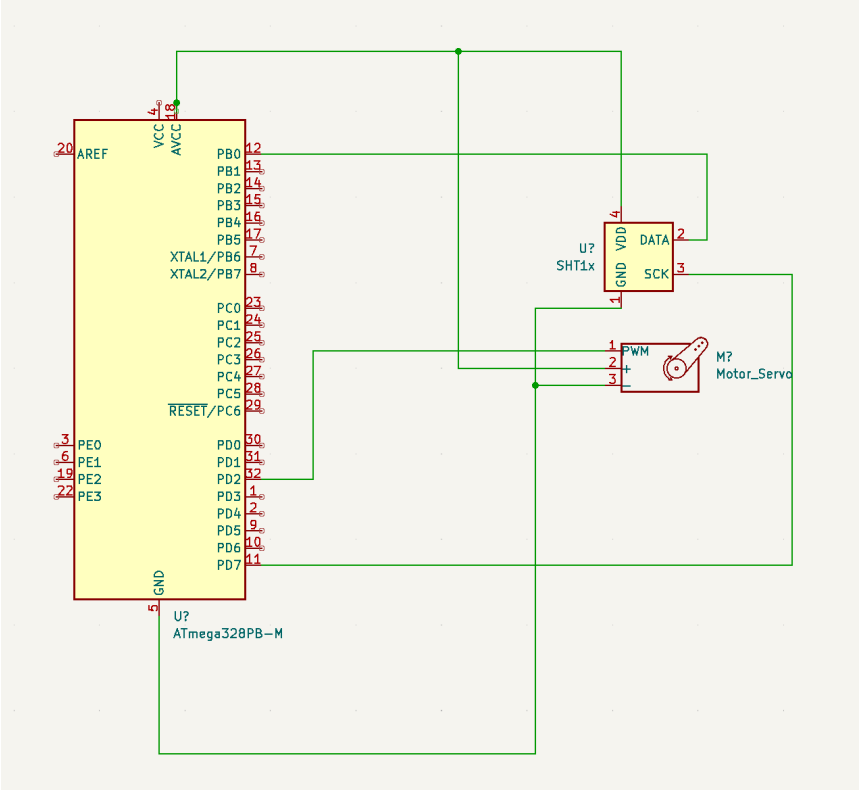
```
            usart_puts(helper);
            usart_puts("\r\n");
            _delay_ms(SERVO_HANG);
        #endif
        servo_counter = servo_counter + SERVO_STEP;
    }
    while (servo_counter > SERVO_START)
    {
        read_attempt = 0;
        OCR3B = servo_counter;
        read_distance();
        _delay_ms(SERVO_HANG);
        while (distance == 0 && read_attempt < TIME_OUT)
        {
            read_distance();
            read_attempt ++;
            _delay_ms(SERVO_HANG);
        }
        #ifdef PROCESSING
        //
            process_step = process_step - PROCESSING_STEP;
            sprintf(helper, "%d", process_step);
            usart_puts(helper);
            usart_puts(",");
            sprintf(helper, "%d", (uint16_t)distance);
            usart_puts(helper);
            usart_puts(".");
            if(process_step > PROCESSING_STOP) {process_step = PROCESSING_START;}
            _delay_ms(SERVO_HANG);
        //
        #else
            usart_puts("\r\n");
            snprintf(helper, HELP_BUF-1, "tik#:  %d  ,  distance:  %0.3lf  cm",
            servo_counter, distance);
            usart_puts(helper);
```

```
                usart_puts("\r\n");
            #endif
            servo_counter = servo_counter - SERVO_STEP;
        }
        if (servo_counter < SERVO_START-5 ||
            servo_counter > SERVO_STOP+5   )
        {
            servo_counter = SERVO_START;
            _delay_ms(SERVO_RETURN);
        }
    }
    return EXIT_FAILURE;
}


////~~~~


void read_distance()
{
    memset(helper, '\0', HELP_BUF);
    timer_overflows = 0;
    distance = 0;
    tik_count = 0;
    PORTD |= (1 << TRIGGER_PIN);                        // pulse begin
    _delay_ms(TRIGGER_WIDTH_US);                        // pulse high, duration in us
    PORTD &= ~(1 << TRIGGER_PIN);                       // pulse end
    TCNT1 = 0;                                          // clear timer1 counter
    TCCR1B = (1 << ICES1) | (1 << CS10);                // capture rising edge, no prescaling
    if (TIFR1 & (1 << ICF1)) {TIFR1 |= (1 << ICF1);}    // clear input capture flag
    timer_overflows = 0;                                // overflows reset
    while ((TIFR1 & (1 << ICF1)) == 0)                  // echo begins -> wait for rising edge
    {
        if (timer_overflows > TIME_OUT) {break;}        // time out causes break
    }
    timer_overflows = 0;                                // echo high, timer_overflows must reset
```

```
    TCNT1 = 0;                                          // clear timer1 counter
    TCCR1B = (1 << CS10);                               // falling edge capture, no prescaling
    if (TIFR1 & (1 << ICF1)) {TIFR1 |= (1 << ICF1);}    // clear input capture flag
    while ((TIFR1 & (1 << ICF1)) == 0)                  // echo ends -> wait for falling edge
    {
        if (timer_overflows > TIME_OUT) {break;}        // time out causes break
    }
    if (timer_overflows < TIME_OUT)                     // a valid measurement occurred
    {
        tik_count = ICR1 + 65535 * timer_overflows;
        distance =  (double)tik_count / TUNER;
    }
}


////~~~~


void usart_putc (char send_char)
{
    while ((UCSR0A & (1 << UDRE0)) == 0) {}
    UDR0 = send_char;
}


////~~~~


void usart_puts (const char* send_str)
{
    while (*send_str)
    {
        usart_putc(*send_str++);
    }
}
```

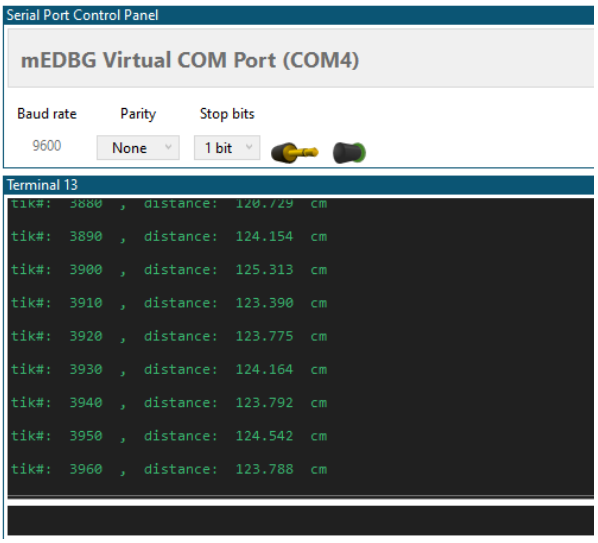
```
////~~~~



ISR(TIMER1_OVF_vect)

{

    timer_overflows++;

    if (timer_overflows > TIME_OUT*TIME_OUT ||

    timer_overflows < 0                    )

    {

        timer_overflows = 0;

    }

}



////////~~~~~~~~END>  main.c
```

3. SCHEMATICS

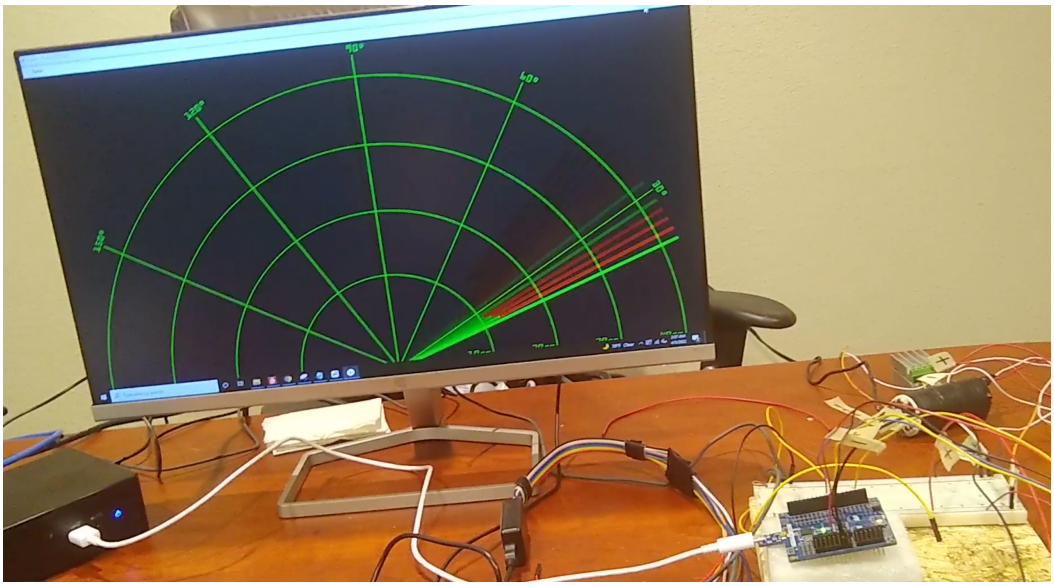


4. SCREENSHOTS OF EACH TASK OUTPUT (ATMEL STUDIO OUTPUT)

task 1, raw data:

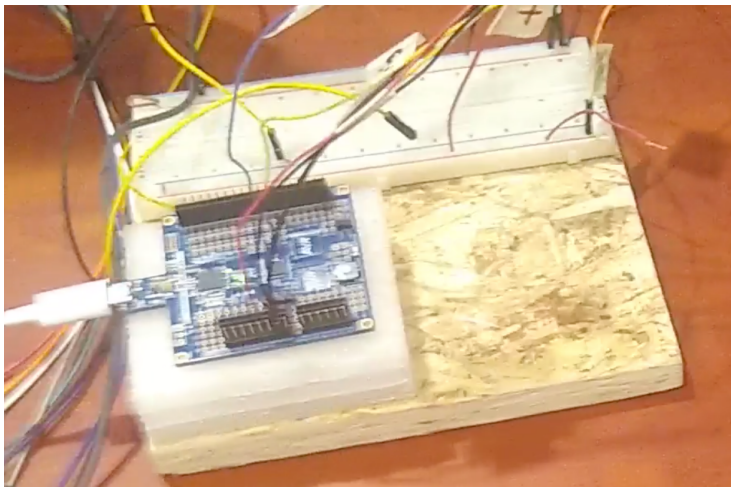


task 2, radar:

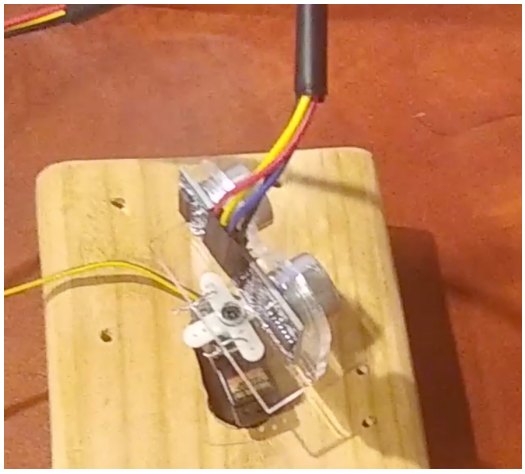


5. SCREENSHOT OF EACH DEMO (BOARD SETUP)

The board, for both tasks:



The module:



6. VIDEO LINKS OF EACH DEMO

task1, raw demonstration https://youtu.be/j68XFYX07bM
task2, using "processing" https://youtu.be/Ds2jTorLmts

7. GITHUB LINK OF THIS DA

https://github.com/davenakasone/cpe301_David_Nakasone/tree/main/Midtermz/Midterm2

Student Academic Misconduct Policy
http://studentconduct.unlv.edu/misconduct/policy.html

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