Embedded Systems Laboratory

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Control LEDs

Introduction:

Now we are going to your C to program and control the LEDs. In order to use the predefined register names, delay functions, and interrupt vector names, you need to include the following header files:

```
#include <avr/io.h>
#define  F_CPU 4000000UL
#include <util/delay.h>
#include <avr/interrupt.h>
```

You may start your main function as follows:

```
int main(void)
{
    DDRD = 0xFF;
    //add your codes
}
```

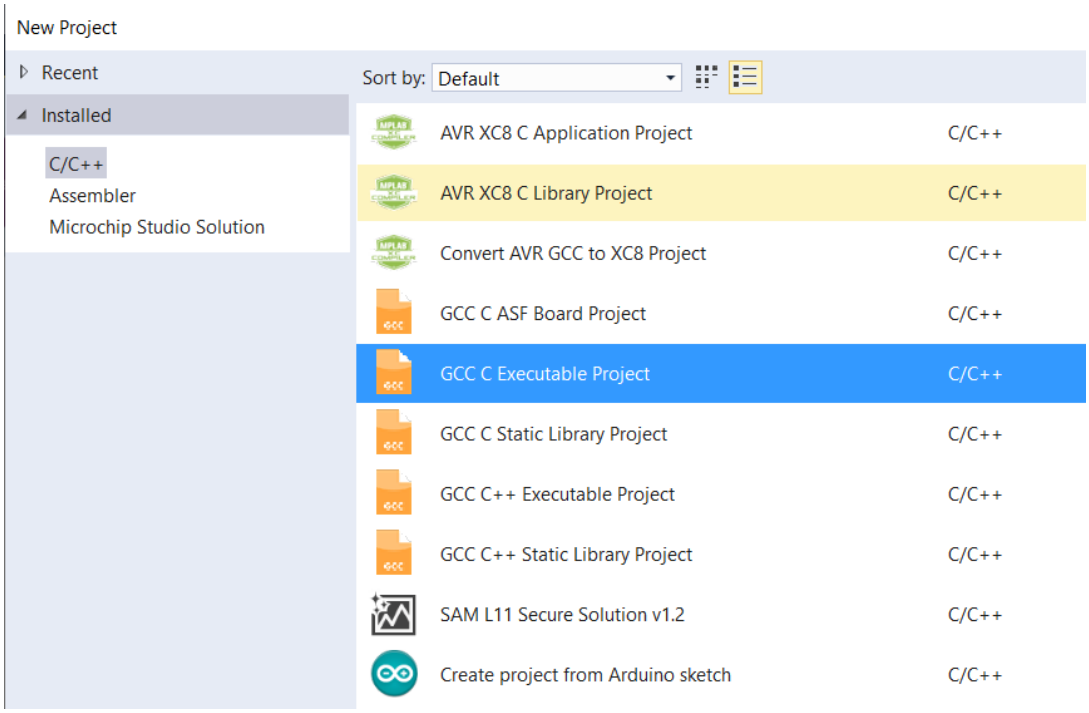
The interrupt service routine is written inside

```
ISR(XXX_vect)
{
     //your interrupt service routine

}
```

where XXX is the interrupt vector names defined in the datasheet. For example, for the external interrupt 0, one could use ISR(INT0_vect).

To create a new C project in Michochip Studio, please select GCC Executable Project shown as follows:



You need to select the Atmega328 as a target device!!

Pre Lab Tasks:

- Read the AVR C Programming Basic in my Introduction Document and get familiar with the logic operation such as <<, &, |, ~, ^, etc.
- Read the ATmega328 datasheet (Chapter I/O ports and Chapter External Interrupts) and understand the concept of DDRx, PORTx, PINx, INT0, EIMSK, EICRA. (If you already know it from the previous labs, you can skip this step).
- Read the content related to <avr/io.h> <util/delay.h><avr/interrupt.h> at the online document http://www.nongnu.org/avr-libc/user-manual/modules.html
- Find out the meaning of `#define F_CPU 4000000UL`
- Find the interrupt vector names in <avr/interrupt.h>.

Lab Assignments:

1. Connect 3 LEDs to PORTD and make them blink half second one after another continuously (you need to use the delay function to produce the half second delay).
2. Triggering an external interrupt by a pressing button, after pressing the button, all the 3 LEDs blink three times simultaneously.

3. Debug your code in Microchip Studio and you will see a Deassembly window. Please compare the assembly codes there with your own assembly codes. Which code is faster? Which code needs more memory space?

Lab Report: The requirements are the same as the previous lab.