Interrupts On Firebird-V Robot

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Agenda for Discussion

1. Overview
   - What is an Interrupt
   - Sources of Interrupt
   - External Interrupt
   - Interrupt Pins
   - Position Encoder
   - Interrupt Calculation
2. Registers
   - SREG
   - EIMSK
   - EICRA
   - EICRB
   - ISR
   - C-Code

What is an Interrupt

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- Any signal that causes break in continuity of some ongoing process

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- Any signal that causes break in continuity of some ongoing process
- In microcontrollers interrupt signal halts the execution of main program and dedicates processor to another task

Main program exceution

```
while ( ) {
        Instruction 1
        Instruction 2
        Instruction 3
        Instruction 4
        Instruction 5
        Instruction 6
        }
```

What is an Interrupt

- While main program is running, if an interrupt occurs, execution of main program is stopped, and program counter goes to address of ISR

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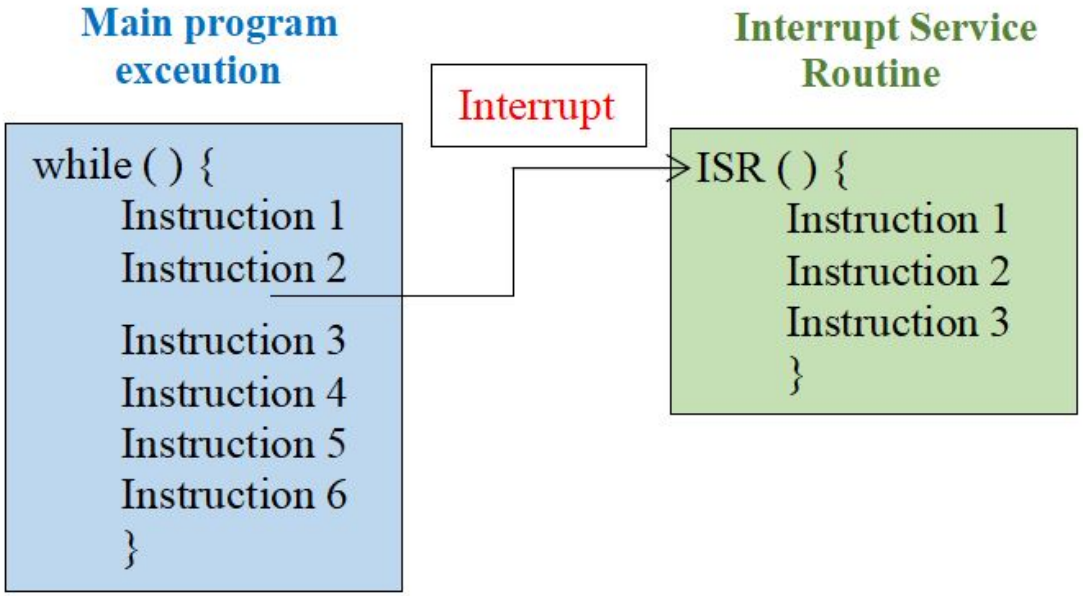
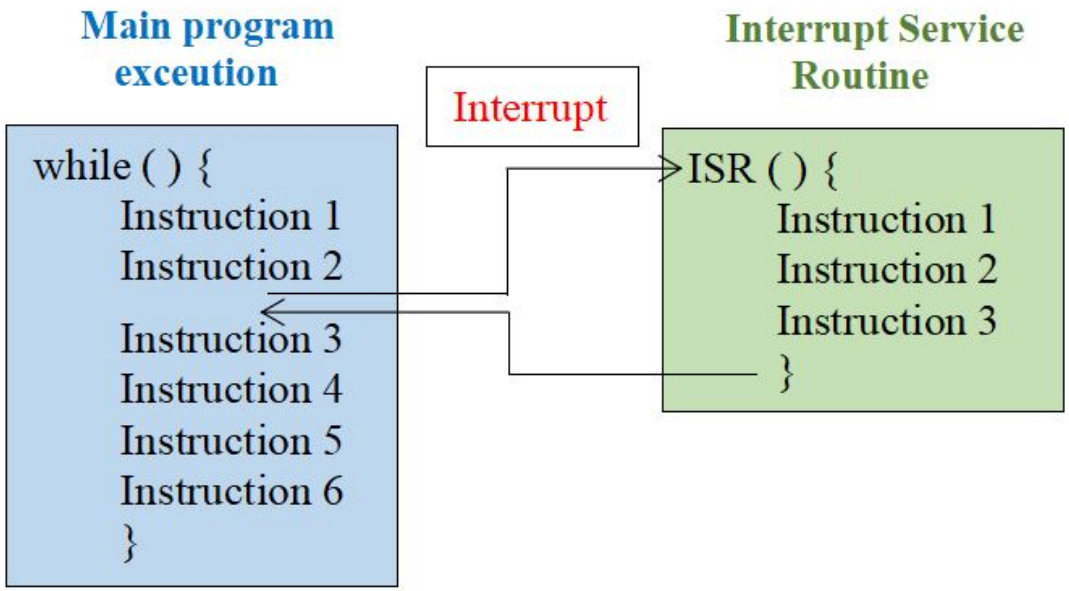
- While main program is running, if an interrupt occurs, execution of main program is stopped, and program counter goes to address of ISR
- Interrupt Service Routine: Program that needs to be executed when interrupt occurs



What is an Interrupt

- After program inside ISR is executed completely, program counter returns back to point where main program was interrupted



Sources of Interrupt in ATmega2560

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   - Timer/Counter0 - [3]
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   - USART3 - [3]
6. Others [7] such as Analog Comparator, ADC Conversion Complete and so on

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3. To use an external interrupt, the pin has to be configured as a standard IO input.
4. If pin is used as an input, external hardware device can be used to interrupt the controller.
5. Pin can also be used as an output, but in this case the interrupt is generated by the controller itself.

Interrupt pins

Interrupt pins

Sr. no	Interrupt	Pin	Firebird V Connection
1	INT0	PD0	-
2	INT1	PD1	-
3	INT2	PD2	-
4	INT3	PD3	-
5	INT4	PE4	Left encoder
6	INT5	PE5	Right encoder
7	INT6	PE6	-
8	INT7	PE7	Interrupt switch

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7	INT6	PE6	-
8	INT7	PE7	Interrupt switch

Position encoder

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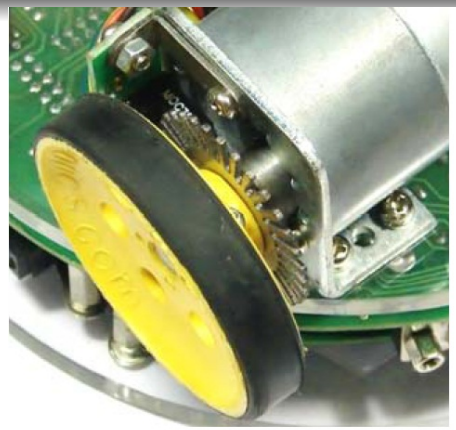

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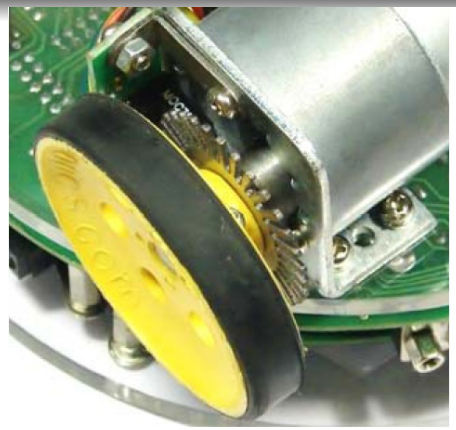

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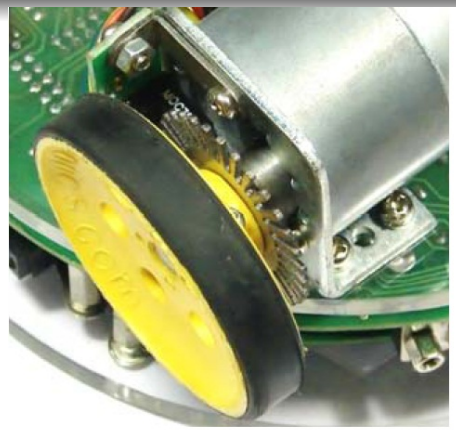
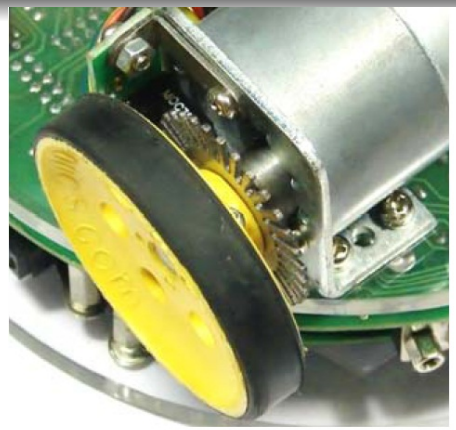


1. Encoder consists of IR LED and photo transistor placed opposite of each other

Position encoder



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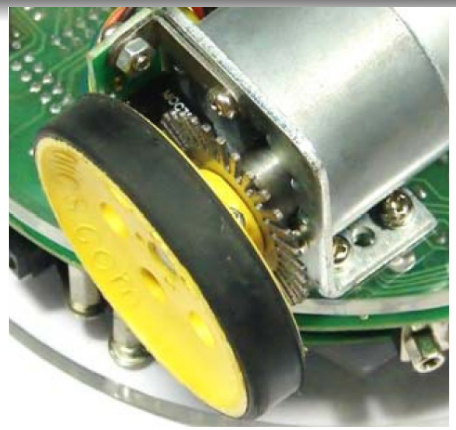

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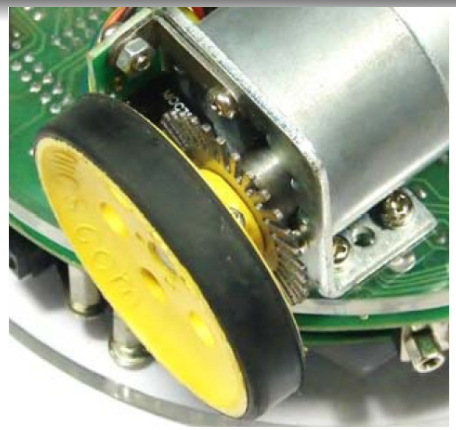

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4. Left encoder is connected to INT4 and Right encoder is connected to INT5

Some Mathematics...

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1. Number of slots in disc = 30

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$$= (\pi * d)/30 = 5.44$$

Some Mathematics...

1. Number of slots in disc $= 30$
2. Number of Pulse/rotation $= 30$
3. Diameter of wheel $= 52mm$
4. Resolution of position encoder
   $= (\pi * d)/30 = 5.44$
5. Pulse count
   $= distance/5.44$

SREG- AVR Status Register

This register is used to Globally Enable all Interrupt

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Bit	Symbol	Description	Bit Value
7	I	Global Interrupt Enable bit	1
6	T	Bit Copy Storage bit	0
5	H	Half Carry Flag	0
4	S	Sign Bit	0
3	V	Two's Complement Overflow Flag	0
2	N	Negative Flag	0
1	Z	Zero Flag	0
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(defined in <avr/interrupt.h> header file)

EIMSK- External Interrupt Mask Register

This register is Used to enable Individual External Interrupt

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Bit	Symbol	Description	Bit Value
7	INT7	External Interrupt Request 7	0
6	INT6	External Interrupt Request 6	0
5	INT5	External Interrupt Request 5	**1**
4	INT4	External Interrupt Request 4	**1**
3	INT3	External Interrupt Request 3	0
2	INT2	External Interrupt Request 2	0
1	INT1	External Interrupt Request 1	0
0	INT0	External Interrupt Request 0	0

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6	INT6	External Interrupt Request 6	0
5	INT5	External Interrupt Request 5	**1**
4	INT4	External Interrupt Request 4	**1**
3	INT3	External Interrupt Request 3	0
2	INT2	External Interrupt Request 2	0
1	INT1	External Interrupt Request 1	0
0	INT0	External Interrupt Request 0	0

EIMSK = 0x30

Interrupt Sense Control Bits

Interrupt Sense Control Bits

ISCn1	ISCn0	Description
0	0	The low level of INTn generates an Interrupt request
0	1	Any edge of INTn generates asynchronously an interrupt request
1	0	The falling edge of INTn generates asynchronously an interrupt request
1	1	The rising edge of INTn generates asynchronously an interrupt request

where n = External Interrupt Number (For Atmega2560: n = 0-7)

For External Interrupt = 0
Interrupt Sense Control Bit = ISC01 and ISC00

EICRA- External Interrupt Control Register A

This register is Used to generate Interrupt Signal

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Bit	Symbol	Description	Bit Value
7	ISC31	Interrupt Sense control bit for Ext. Interrupt 3	0
6	ISC30	Interrupt Sense control bit for Ext. Interrupt 3	0
5	ISC21	Interrupt Sense control bit for Ext. Interrupt 2	0
4	ISC20	Interrupt Sense control bit for Ext. Interrupt 2	0
3	ISC11	Interrupt Sense control bit for Ext. Interrupt 1	0
2	ISC10	Interrupt Sense control bit for Ext. Interrupt 1	0
1	ISC01	Interrupt Sense control bit for Ext. Interrupt 0	0
0	ISC00	Interrupt Sense control bit for Ext. Interrupt 0	0

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4	ISC20	Interrupt Sense control bit for Ext. Interrupt 2	0
3	ISC11	Interrupt Sense control bit for Ext. Interrupt 1	0
2	ISC10	Interrupt Sense control bit for Ext. Interrupt 1	0
1	ISC01	Interrupt Sense control bit for Ext. Interrupt 0	0
0	ISC00	Interrupt Sense control bit for Ext. Interrupt 0	0

EICRA = 0x00

EICRB- External Interrupt Control Register B

This register is Used to generate Interrupt Signal

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Bit	Symbol	Description	Bit Value
7	ISC71	Interrupt Sense control bit for Ext. Interrupt 7	0
6	ISC70	Interrupt Sense control bit for Ext. Interrupt 7	0
5	ISC61	Interrupt Sense control bit for Ext. Interrupt 6	0
4	ISC60	Interrupt Sense control bit for Ext. Interrupt 6	0
3	ISC51	Interrupt Sense control bit for Ext. Interrupt 5	**1**
2	ISC50	Interrupt Sense control bit for Ext. Interrupt 5	0
1	ISC41	Interrupt Sense control bit for Ext. Interrupt 4	**1**
0	ISC40	Interrupt Sense control bit for Ext. Interrupt 4	0

EICRB- External Interrupt Control Register B

This register is Used to generate Interrupt Signal

Bit	Symbol	Description	Bit Value
7	ISC71	Interrupt Sense control bit for Ext. Interrupt 7	0
6	ISC70	Interrupt Sense control bit for Ext. Interrupt 7	0
5	ISC61	Interrupt Sense control bit for Ext. Interrupt 6	0
4	ISC60	Interrupt Sense control bit for Ext. Interrupt 6	0
3	ISC51	Interrupt Sense control bit for Ext. Interrupt 5	**1**
2	ISC50	Interrupt Sense control bit for Ext. Interrupt 5	0
1	ISC41	Interrupt Sense control bit for Ext. Interrupt 4	**1**
0	ISC40	Interrupt Sense control bit for Ext. Interrupt 4	0

EICRB = 0x0A

ISR-Interrupt Service Routine

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ISR(INTn_vect)
{
    code
}
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Where n = External Interrupt Number (For Atmega2560: n=0-7)

Syntax for C-Program

Port Initialization

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Left Encoder Port Initialization

Syntax for C-Program

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Left Encoder Port Initialization

```
void left_encoder_pin_config (void) //Configure Interrupt 4
{

 DDRE  = DDRE & 0xEF; //Set the direction of the PORTE 4 pin as input
 PORTE = PORTE | 0x10; //Enable internal pull-up for PORTE 4 pin

}
```

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Right Encoder Port Initialization

Syntax for C-Program

Port Initialization

Left Encoder Port Initialization

```
void left_encoder_pin_config (void) //Configure Interrupt 4
{

 DDRE  = DDRE & 0xEF; //Set the direction of the PORTE 4 pin as input
 PORTE = PORTE | 0x10; //Enable internal pull-up for PORTE 4 pin

}
```

Right Encoder Port Initialization

```
void right_encoder_pin_config (void) //Configure Interrupt 5
{

 DDRE  = DDRE & 0xDF; //Set the direction of the PORTE 5 pin as input
 PORTE = PORTE | 0x20; //Enable internal pull-up for PORTE 5 pin

}
```

Syntax for C-Program

Interrupt Initialization

Syntax for C-Program

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Left-Encoder Interrupt Initialization

Syntax for C-Program

Interrupt Initialization

Left-Encoder Interrupt Initialization

```
void left_position_encoder_interrupt_init (void) //Interrupt 4 enable
{
 cli();                 //Clears the global interrupt
 EICRB = EICRB | 0x02; // INT4 is set to trigger with falling edge
 EIMSK = EIMSK | 0x10; // Enable Interrupt INT4 for left position encoder
 sei();                 // Enables the global interrupt
}
```

Syntax for C-Program

Interrupt Initialization

Left-Encoder Interrupt Initialization

```
void left_position_encoder_interrupt_init (void) //Interrupt 4 enable
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 cli();                 //Clears the global interrupt
 EICRB = EICRB | 0x02; // INT4 is set to trigger with falling edge
 EIMSK = EIMSK | 0x10; // Enable Interrupt INT4 for left position encoder
 sei();                 // Enables the global interrupt
}
```

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Left-Encoder Interrupt Initialization

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{
 cli();                 //Clears the global interrupt
 EICRB = EICRB | 0x02; // INT4 is set to trigger with falling edge
 EIMSK = EIMSK | 0x10; // Enable Interrupt INT4 for left position encoder
 sei();                 // Enables the global interrupt
}
```

Right-Encoder Interrupt Initialization

```
void right_position_encoder_interrupt_init (void) //Interrupt 5 enable
{
 cli();                 //Clears the global interrupt
 EICRB = EICRB | 0x08; // INT5 is set to trigger with falling edge
 EIMSK = EIMSK | 0x20; // Enable Interrupt INT5 for left position encoder
 sei();                 // Enables the global interrupt
}
```

Thank You!

Post your queries on: support@e-yantra.org