**Topic:** PWM velocity control

**Pre-requisite:** Basic motion control of motors

**Components required**: Firebird V with 8051 adapter board

**Basic Concept:**

* **What is PWM?**

PWM (Pulse Width Modulation) is a process in which duty cycle of square wave is modulated to control motor velocity.

* **Duty Cycle** is the ratio of ‘T-ON/T’, where ‘T-ON’ is ON time and ‘T’ is the period of the wave.
* Now, Power delivered to load(here, motor) is directly proportional to ‘T-ON’ time and,

T-ON time = duty cycle x T (Time period of wave)

Thus by modulating duty cycle or by increasing or decreasing T-ON time, we can change power delivered to motor which ultimately changes its velocity.



**Figure 1: Pulse Width Modulation (PWM) for velocity control**

**In case A, ON time is 90% of time period and in case B ON time is just 10% of total time hence motor will run faster in case A than in case B.**

To implement PWM students must have knowledge of **PCA (Programmable Counter Array).**

**PCA:**  It has an array of 5 counter/capture modules. They can be programmed in any of the following 4 modes:

* Rising or falling edge timer
* Software timer
* High speed output
* PWM(pulse width modulation)

Now the pins of the microcontroller which are used for PWM control are CEX0/P1.3 for left motor and CEX1/SS/P1.4 for right motor.

**The following registers have to be programmed in order to use the PCA for PWM generation –**

CMOD=0X80; PCA Counter Mode Register

CCON=0X40; PCA Counter Control Register

CCAPM1 = 0x42; PCA modules compare/capture register

CCAPM0 = 0x42; PCA modules compare/capture register

To set the velocity of the left motor:

CCAP0L=0x00;

CCAP0H=0xFF; Left motor duty cycle. 0 to 0xFF gives 0 to 100% duty cycle i.e. velocity from 0 to maximum speed. Any value in between 0x00 and 0xFF will give intermediate velocity.

To set the velocity of the right motor:

CCAP1L=0x00;

CCAP1H=0xFF; Right motor duty cycle. 0 to 0xFF gives 0 to 100% duty cycle i.e. velocity from 0 to maximum speed. Any value in between 0x00 and 0xFF will give intermediate velocity.

**Algorithm to generate PWM signal** –

1. Initialize all the required registers in PCA with the values stated above.
2. Set the values for compare velocity by setting the values of CCAP0H for left motor and CCAP1H for right motor.
3. Now by comparing this value with the counter value it changes the velocity
4. When we load CCAPnH=0xFF; (where n = 0 for left motor and n = 1 for right motor) output is 0% duty cycle and motors will not run and when value is 0x00 output will be of 100% duty cycle. I.E. motors will run at the full speed.
5. Speed of the motors is more at lower values of CCAPnH than at higher values, for e.g. Motor will run faster at 0x0F than at 0x5F.
6. Move forward
7. End

* **Code for the above is given in the experiments folder.**

**Exercise:**

* Observe change in velocity by passing values 0x0F, 0x1F and 0x5F and take left and right turns by varying the velocity of left and right motors.