Lecture 04.01 Pulse-width modulation[1]

Pulse-width modulation (PWM) is a technique used to deliver an effectively variable signal to a load (in our case a motor) without a truly variable power source. A pulse of full source amplitude is repeated at a high frequency (e.g. 20 kHz), delivering a signal that is effectively averaged by the load dynamics such that its effects on the load are nearly continuous. The fraction of the period T that the signal is high (on) is called the *duty cycle* δ. Figure 04.1 shows a PWM signal $v(t)$ and its average $\bar{v}(t)$ with a few parameter definitions.

The mean of any periodic signal with period T can be computed with the integral

$$\bar{v}(t) = \frac{1}{T}\int_0^T v(t),$$

which is easily evaluated for a PWM signal:

$$\bar{v}(t) = \frac{Aw}{T} = A\delta.$$

This result shows that if a PWM signal is delivered to a load, such as a DC motor, that is relatively unaffected by high-frequency signals, the effective signal will be simply the product of the source amplitude A and the duty cycle δ. The duty cycle can have values from 0 to 1, so the effective DC signal produced varies linearly with δ from 0 to A.

[1]This lecture appears also in the *Mechatronics Laboratory Manual*.

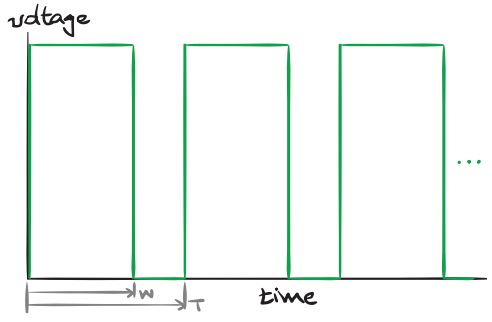

Figure 04.1: a pulse-width modulation (PWM) signal.