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Efficient electronic speed controller algorithm for multirotor flying vehicles

Abstract. *The majority of multirotor UAV's (unmanned aerial vehicles) platforms consist of a BLDC (brushless direct current) motors, because of their robustness and high rotation speed capabilities. The ESC's (electronic speed controllers) driving the motors are produced as cost/component efficient inverters. They are motor ambiguous, meaning they should work correctly with any BLDC machine connected to the ESC without any complex tuning procedures. In the paper, a sensorless BLDC driving algorithm is presented, utilizing low cost hardware used in mainstream ESC controllers, thus improving the performance over the typical open-loop control scheme.*

Keywords: ESC, BLDC, driver, sensorless

Introduction

The most common sensorless driving algorithm used commercially for high speed BLDC motor commutation sector detection is the back EMF (Electromotive force) integrating method [1] (Figure 1). It utilizes the inverter's MCU (microcontroller) high clocking frequency and advanced ADC (Analog to digital converter) peripheral features. In a low cost devices, such as UAV ESC controller, cheap and slow MCU's are used, not capable of full back EMF integrating algorithm execution. An alternative method for rotor position tracking using the back EMF signals was developed for this purpose.

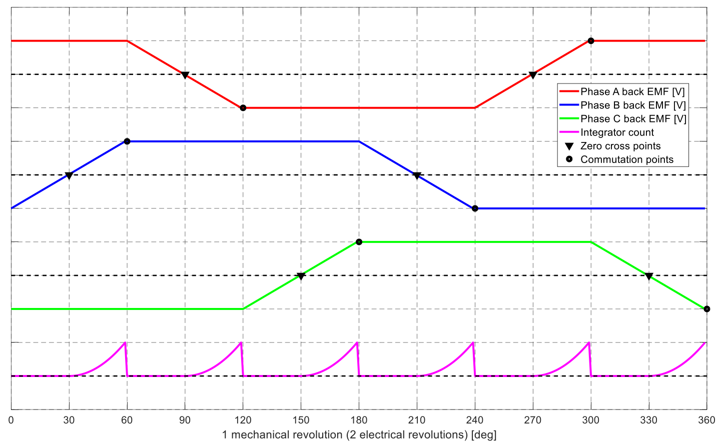

Fig.1. A 3 phase BLDC motor back EMF signals with integrator counter and zero crossing and commutation points marked.

Theory of operation

Instead of time consuming integration, the algorithm is measuring the time between each back EMF zero cross (using integrated comparators) from the past, in order to calculate the "ahead" commutation moment (Figure 2).

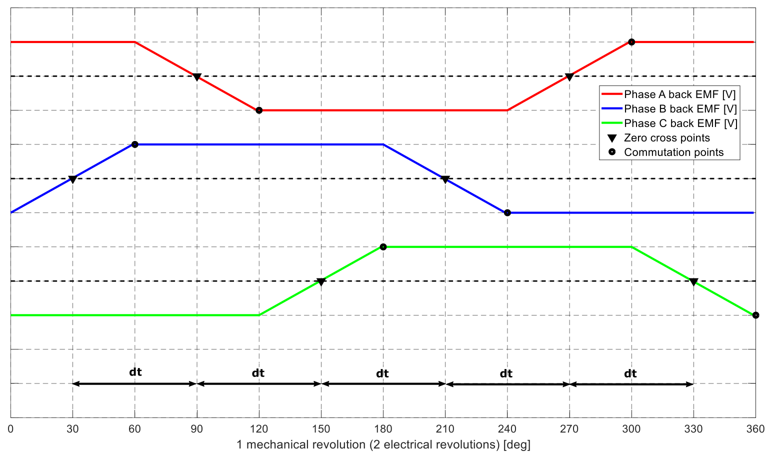

Fig.2. A 3 phase BLDC motor back EMF signals with time measurement quanta's (dt) marked.

A look-up table has been precompiled for the MCU's 16 bit timer periods and prescallers using GA (genetic algorithm) in order to set the timer interrupt routine for the changing commutation frequency (changed rotor speed).

Summary

A Matlab/ Simulink program has been prepared for the algorithm simulation in advance to hardware implementation. The work presents the results of that simulation, as well as extended theory of operation. This method was designed in order to reduce the BLDC motor torque ripple as well as current consumption, by using tailored closed loop control rather than the open loop one.

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