

Round Exit Velocity Measurement Using Fiber Bragg Grating Sensors

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Introduction

Optical fiber Bragg grating sensors (FBGs) have been extensively used for strain sensing applications in harsh environments. The purpose of this research is to develop a system to measure the round exit velocity (REV) of a moving projectile in a medium caliber gun barrel through the use of surface mounted FBGs. Conventional REV measurement systems employ antenna arrays that measure the Doppler shift, foil strain gages or pressure transducers. Optical fiber sensors offer distinct advantages over all of them by way of their compactness and light weight, mechanical robustness and immunity to electromagnetic interference (EMI).

Operating principle and System design

- Accelerating round produces circumferential (hoop) strain which expands outer surface of barrel
- Strain is detected by the shift in reflected Bragg wavelength of two FBG sensors
- Spacing between FBG sensors is adjusted for a system resolution of 1%
- Effect of temperature rise is compensated by a FBG-based optical filter
- REV computation using a data acquisition and signal processing module

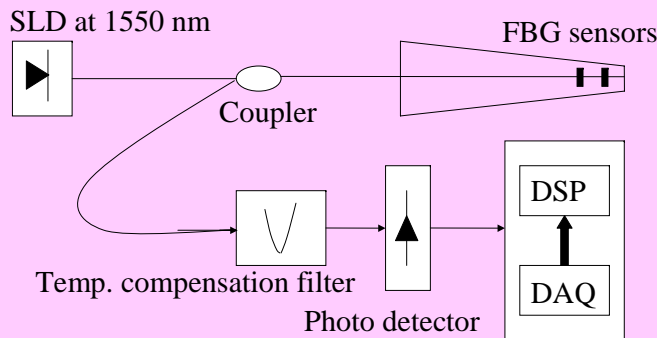


Figure 1 : REV system configuration



Fig. 2: Gun barrel with mounted sensors

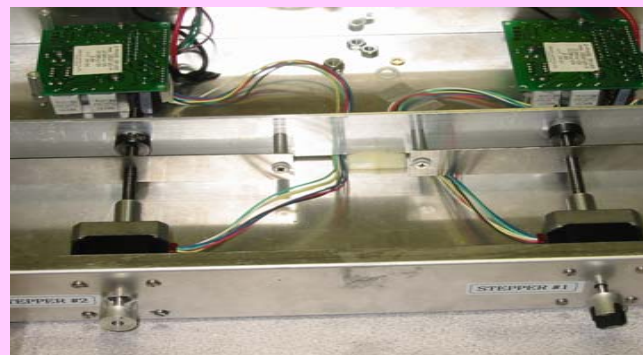


Fig. 3: Optical filter for Temperature compensation

Test results

The figures below depict data collected from live fire tests at Picatinny Arsenal under both single shot and burst shot modes. A Weibel radar system was used for the purpose of recording the reference muzzle velocity. The actual round exit velocity was computed using an efficient cross-correlation algorithm after appropriate noise filtering. The computed results compare well with the reference REV to within 1% error.

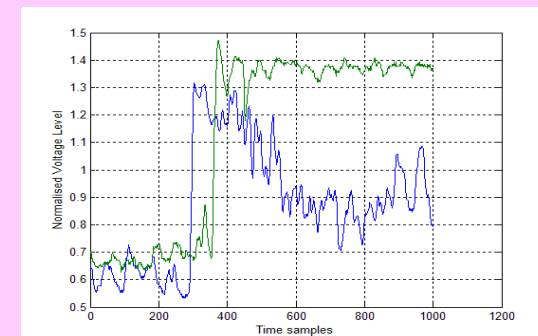
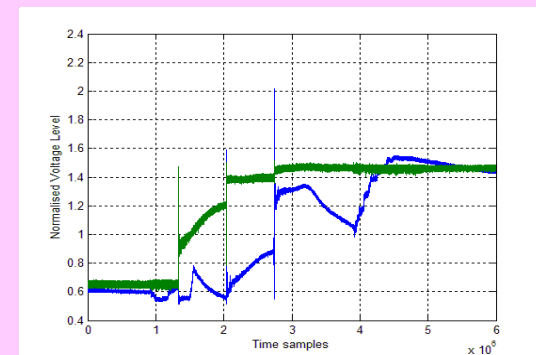


Fig. 4: Live fire data in burst and single shot mode