Mouthguard-based wireless high-bandwidth helmet-mounted inertial measurement system

John Lund, Anthony Paris, Jennifer Brock

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Authors: John Lund[a], Anthony Paris[b], Jennifer Brock[b]

Affiliations:

[a]Western Washington University, 516 High Street, Bellingham, WA 98225, USA (corresponding author)

[b]University of Alaska Anchorage, 3211 Providence Drive, Anchorage, AK 99508, USA

Contact email: John.Lund@wwu.edu

Abstract: Characterizing head impacts in athletic and occupational settings requires the evaluation of accelerations of the head. Often athletic and occupational scenarios with a heightened risk of head injury or impact already utilize helmet and/or mouthguard hardware. We present a device which relies on existing safety equipment to implement a mouthguard-based inertial measurement device. This device uses high-bandwidth spatially-separated single axis accelerometers and a helmet-mounted data collection and transmission system to record and report accelerations of the head with a measurement bandwidth and resolution that exceeds existing mouthguard-based inertial measurement systems. The device is capable of recording data for the duration of an athletic event (~3 hours) and transmitting impact events wirelessly to a receiver unit outside of the field of play, allowing for the real-time monitoring and recording of head impact events.

Keywords: accelerometer; mouthguard; instrument; PCB; head; concussion; brain; inertial; characterization

Specifications table

Hardware name	*Helmet-Mounted Instrumented Mouthguard*
Subject area	Engineering and Material Science
Hardware type	Inertial Sensing
Open Source License	*MIT License*
Cost of Hardware	$660.82
Source File Repository	https://osf.io/4x8z9/

1. Hardware in context

The need for instrumentation to measure and characterize impacts to the head during athletic and occupational activities has expanded in recent years. While older generation devices characterizing head accelerations were bulky and limited to laboratory investigation[1–5], a new generation of MEMS-based accelerometers and gyroscopes has enabled the development of inertial measurement systems mounted to mouthguards[6–8], helmets[9,10], ears[11], and other head-mounted devices[12]. One downside to these modern MEMS devices is often they are restricted to sensing bandwidths below 1