Spectral & Motion Sensing For Behavioral Discrimination In Grazing Animals

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Abstract

Forage intake of pastured animals is challenging to monitor. Equations to estimate forage intake and quality exist; however, they do not always represent individual behaviors well. The objective of this work was to explore multimodal sensing as a strategy for monitoring grazing behavior. Data were collected using a fly mask equipped with a TTGO-T-Beam microprocessor with GPS (right cheek) and LoRa radio linked to a SparkFun AS7265x spectral sensor (right ear), and ICM-20948, 9 degree of freedom inertial measurement unit (poll). The fly mask was used to collect data on 5 horses, each for a five-minute grazing and five-minute standing period as a proof-of-concept. Linear, mixed effect regression models with a fixed effect for horse behavior (standing vs grazing) and random effect for animal identified significant differences ($P<0.05$) in all measured wavelengths and in mean roll angle ($P<0.01$) and variability in pitch angle ($P=0.049$). These data suggest opportunity to leverage spectral and motion sensing to discriminate among grazing and standing behaviors.

Introduction

While horse owners can examine feed tags and regulate grain rations, forage intake in pastures are largely ambiguous due to the challenge of limited capacity to monitor animal behavior in real time and substantial variability in forage selection and quality. Since domestication of horses, part time grazing is recommended for horses due to their need for physical activity and social nature, and can also improve animal welfare and encourage positive, appropriate behavior (Molle et al., 2022). While individual technologies and studies shed light on key components of equine grazing, such as forage preference (Allen et al., 2012), calculating forage biomass yield (Martinson et al., 2017), determination of grazing vs. non-grazing behavior (Rue et al., 2020), forage chemical composition (Murphy et al., 2022), and mastication rate (Werner et al., 2018), there is no single unit of technology capable of measuring all of these characteristics concurrently to provide a precise measurement of the quantity and quality of forage being consumed in a grazing period.

Objective

The primary objective of this study was to validate the use of the ICM-20948,9 degree of freedom inertial measurement unit and and SparkFun AS7265x spectral sensor in determining grazing from non-grazing behavior in horses and potential for use of this technology in future equine grazing research and equine precision feeding techniques.

Materials & Methods

Five horses from the Virginia Tech Campbell Barn were used. During testing periods, horses were outfitted with the fly mask and affiliated sensors. Sensors included the ICM-20948,9 degree of freedom inertial measurement unit and and SparkFun AS7265x spectral sensor. Each horse participated in a five-minute grazing period outside the barn, followed by a five-minute standing period in the barn driveway. An observer recorded visual observations every 1-minute within each grazing or standing period for each horse for a total of 10 observations per horse, or five observations per horse per period (grazing or standing).

Grazing & Standing Behavior Data

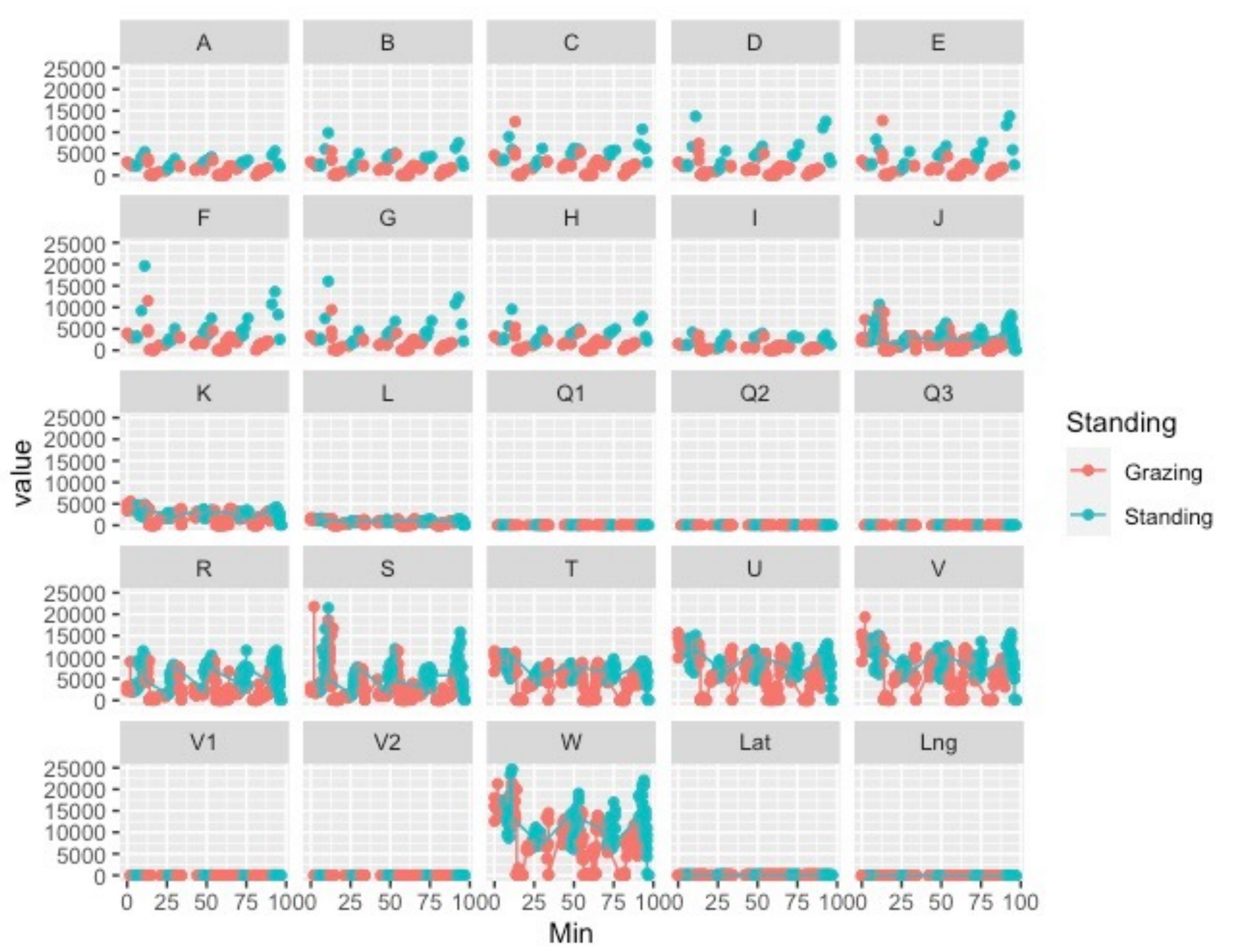

Figure 1. RStudio ggplot. This plot depicts the contrast in spectrophotometer data readings between standing and grazing periods.

IMU Data Accuracy

Confusion Matrix

	Grazing	Standing	Error
Grazing	22	0	0.00000
Standing	2	10	0.16667

Table 1. For twenty-two of twenty-two grazing observations, the data was correctly classified as grazing. For ten of twelve standing observations, the data was correctly classified as standing; however, two of twelve standing observations were incorrectly classified as grazing instead of standing.

VT IACUC

Use of animals for the trial was approved by Virginia Tech's Institute of Animal Care and Use Committee under protocol number 22-137 (APSC).

Results

Linear, mixed effect regression models with a fixed effect for horse behavior (standing vs. grazing) and random effect for animal identified significant differences ($P<0.05$) in all measured wavelengths. In addition, visual contrast in wavelengths between grazing and standing periods can be seen in Figure 1. Overall, this demonstrates the potential use for head-mounted spectral sensors for the collection of grazing behavior in horses. Ten of twelve standing observations were correctly correlated with standing IMU data; however, two of twelve standing observations were classified as grazing rather than standing, producing a 16.67% error.

Discussion

Automated behavior-monitoring systems that can be controlled remotely, are low-cost, durable, and reliable offer opportunities to improve grain ration assignment and ultimately, grain costs. This study demonstrated that a spectrophotometer and an IMU have abilities to accurately record grazing vs. non-grazing behavior, showing low error precents between observations and data. An extended observation and data collection period of a horse exhibiting natural behavior in the field would offer more data points of grazing and non-grazing behavior, further proving the efficacy (or lack thereof) of the devices.

Contact

If you have further questions regarding this project, please contact me at charleezs@vt.edu.

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