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Development and Evaluation of a Lightweight and Unobtrusive Bicycle-Based Data Acquisition System to Enable Real-World Safety Evaluations

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1 INTRODUCTION

Pedalcyclist safety is a significant concern for traffic safety researchers. Bicycling is a very desirable mode of transit from financial, environmental, recreational and fitness perspectives; however, in 2014, 726 cyclists were killed in the United States, and approximately 50,000 were injured [1]. To this point, there have been few viable research tools to obtain precise, comprehensive data concerning how cyclists behave in and with the built environment and how nearby road users interact with them.

This poster will present a novel research tool developed by the Virginia Tech Transportation Institute, a self-contained, modular, lightweight instrumented bicycle. This instrumented bicycle is based on existing technology modified for bicycle use, and will allow unprecedented insight into the interactions among cyclists, drivers, pedestrians, other road users, and infrastructure using experimental paradigms and during day-to-day riding. We will present an overview of the development of the instrumented bicycle, its data collection capabilities, and pilot data.

2 METHOD

Unobtrusive vehicle instrumentation pioneered by engineers at the Virginia Tech Transportation Institute (VTTI) for automobiles and heavy vehicles has allowed naturalistic driving research to develop into an extremely valuable tool for understanding everyday driving behavior on public roadways. These research capabilities have enabled a wide variety of research questions to be investigated, including the effects of driver distraction, fatigue, impairment, and other driver factors on driver performance, and the effects of driver experience and aging on driver behavior [e.g. 2-4]. However, bicycles present unique challenges for the implementation of data acquisition systems (DAS) with respect to weight, size, weatherization, security, and provision of electrical power.

The VTTI instrumented bicycle equipment is based on the most recent iteration of the VTTI DAS. The DAS was developed as a low-cost, self-contained instrumentation system for use in automobiles and on motorcycles, and has been adapted as the Bicycle DAS (or B-DAS) for non-powered bicycle use. Modifications include

weatherproofing, a flexible mounting solution, and the ability to run off a battery pack mounted inside a water bottle mounted in a standard cage on the downtube (Figure 1).

Figure 1. Bicycle instrumented with VTTI Mini-DAS.

The B-DAS consists of a single main unit measuring approximately 165mm x 133mm that contains two video cameras and numerous sensors that measure geographic location and bicycle dynamics. A mounting system was developed to allow flexibility of placement across different types of bicycles. The B-DAS is typically mounted to either the top or head tube allowing positioning of the unit forward of the head tube (**Error! Reference source not found.**A), which allows unobstructed forward view as well as views of the rider's face and hands, as well as approaching vehicles (**Error! Reference source not found.**B). During system development this location provided a significantly more stable platform than when mounted to the handlebars, which resulted in significant video sway and excess noise in kinematic data.

3 CONCLUSIONS

This instrumentation will provide data on how cyclists and other road users behave in the real world and the causal factors associated with cycle-related crashes, and is expected to pave the way for studies that will explore the interactions of cyclists, drivers, and infrastructure. A better understanding of real-world riding behavior has significant potential to improve rider safety, and consequently the desirability of bicycling. The poster will present additional visual and technical information about the B-DAS, along with demonstration data and video illustrating the novel data collection opportunities afforded by this instrumentation.

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