

## Naturalistic Bicycling - Development of Data Collection and Analysis Tools

**Lucas Cruse, AICP<sup>\*</sup>, Achilles Kourtellis, PhD<sup>#</sup>, Pei-Sung Lin, PhD, PE, PTOE<sup>†</sup>**

<sup>\*</sup>City of St. Petersburg, Florida  
One 4th Street N, St. Petersburg, FL 33701  
email: lucas.cruse@stpete.org

<sup>#</sup>Center for Urban Transportation Research  
University of South Florida  
4202 E. Fowler Ave, CUT100, Tampa, FL 33620  
email: kourtellis@cutr.usf.edu

<sup>†</sup>Center for Urban Transportation Research  
University of South Florida  
4202 E. Fowler Ave, CUT100, Tampa, FL 33620  
email: lin@cutr.usf.edu

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### 1 INTRODUCTION

Riding a wave of health, environmental, and economic trends, bicycling has been making a comeback as a viable and popular mode of transportation. Unfortunately, bicyclists experience disproportionate rates of injuries and fatalities compared to other roadway vehicle types. The safety of bicyclists is of particular concern in Florida, where bicycle fatality rates were more than triple the national average in 2014 according to the Fatality Analysis Reporting System (FARS). According to the Florida Department of Highway Safety and Motor Vehicles (FLDHSMV), in 2014, 7,077 bicycle crashes resulted in 135 bicyclists killed and 6,680 injured, an increase from the previous year. Empirical study of bicycling behavior and interactions is necessary to identify the planning tools that will improve bicycling safety in the next century.

Many factors influence how and where bicyclists ride their bicycles, including experience level, facilities, environmental conditions, trip purpose, and interactions with other roadway users. The existing measures of bicycle route quality or suitability focus on either quantitative measures of the physical roadway attributes or subjective assessments of the level of traffic stress perceived by different categories of the bicycle riding population. What is missing from these existing models is empirical data that can shed light on the actual factors that most contribute to route selection for different segments of the bicycle riding population.

This paper introduces a naturalistic bicycle study, the Bicycle Data Acquisition System (BDAS) developed for the study, the data analysis tool developed, and preliminary results from applying the analysis tool to address the initial research objective: identify the factors that empirically have the greatest influence on bicycle route quality.

### 2 LITERATURE REVIEW

The use of a bicycle equipped with instruments to measure riding conditions is a new but growing field, with the first experiments occurring within the past decade. The studies have occurred in both urban and rural locations primarily in Europe, followed by Asia and Australia,

with the fewest studies having occurred in North America. A majority of the studies utilizing instrumented bicycles focus on using a limited set of devices to answer a specific question while preselecting the bicyclist behavior and route of interest. The most common research question is the issue of behaviors and separation provided by vehicles overtaking bicycles [1] [2] [3] [4]. Dozza and Werneke in 2014 [5] have shown that naturalistic bicycling data can identify and assess how specific location factors can predict the risk of critical events. This study in Sweden represents the most complete and sophisticated naturalistic bicycling study completed to date.

### **3 DATA COLLECTION**

Our study is engaging 100 participants for a minimum of 30 hours each, drawing from a wide cross section of the bicycling community, and covering an open geographic area provides a database that is both more rich and deep than any naturalistic bicycling study completed to date.

#### **3.1 Bicycle Data Acquisition System (BDAS)**

This study is attempting to observe bicyclists in the most natural conditions possible. Advances in computing power, video camera size, sensor performance and cost now enable the recording of bicyclist experiences with minimal intrusion on their natural behavior. The BDAS in this study will not require participants to interact with the instruments at all; instead relying on motion detection to turn the instruments on and off, enhanced battery and memory capacity, and use of wireless communication to continually and remotely monitor and communicate with the devices. The study adds the recording instruments to the participants' personal bicycles, thereby reducing the potential for modified behavior that could result from riding an unfamiliar bicycle. In addition to direct communication between the BDAS and the study server for diagnostics, a smartphone application also presents a brief post-ride survey to the participants. The survey documents trip purpose, any issues related to the BDAS, and a chance for participants to log any unique encounters experienced during the ride.

#### **3.2 Data Analysis Tool**

The analysis of the data requires the creation of a tool that accesses, combines, and views the multiple data sources. Inspired by the SHRP2 Naturalistic Driving Study, this study has created a dashboard for viewing a combined selection of the data. The dashboard provides the user with the participant data, bike data, trip summaries, and trip data from post-ride user surveys. The data analysis tool can be used to create a number of combinations of specific trip types, participant demographic variables, and background spatial data, to which multivariate statistical analysis will be applied.

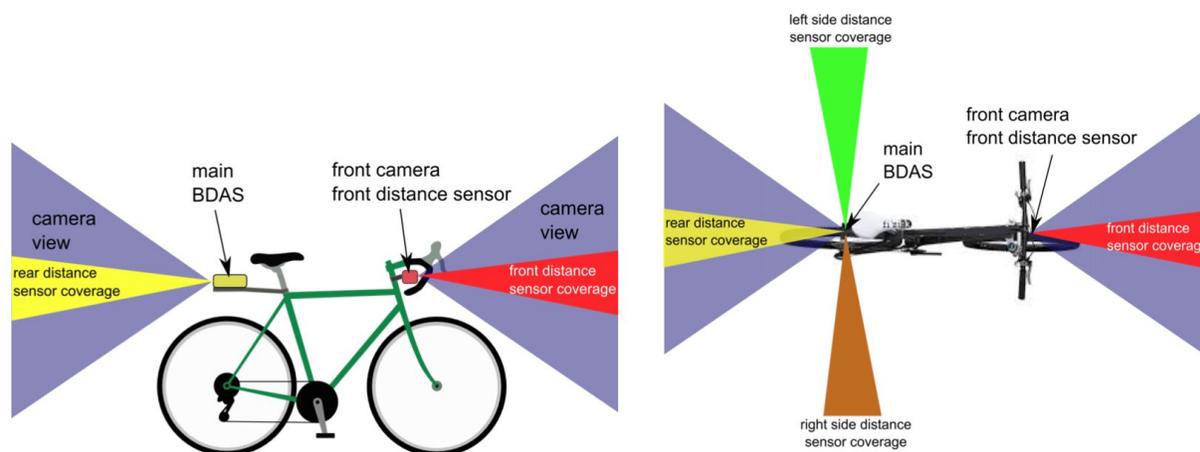


FIGURE 1. Bicycle side and top views with BDAS camera and sensor coverage.

#### 4 CONCLUSION

This naturalistic observation of bicyclists and their interactions with other roadway users enables analysis of the routes bicyclists of varying experience choose as well as the factors contributing to bicycle incidents (crashes and near misses). At a minimum, this analysis seeks to identify the factors and location types that result in close calls and crashes, the influence of trip purpose and bicyclist experience on route selection and behavior, and the efficacy of bicyclist training. That analysis points the way towards improved bicycling safety through an evaluation of the existing tools used in practice to measure bicycle routes, better bicycle facility planning and design, behaviors that need targeted law enforcement, and improved roadway user education.

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