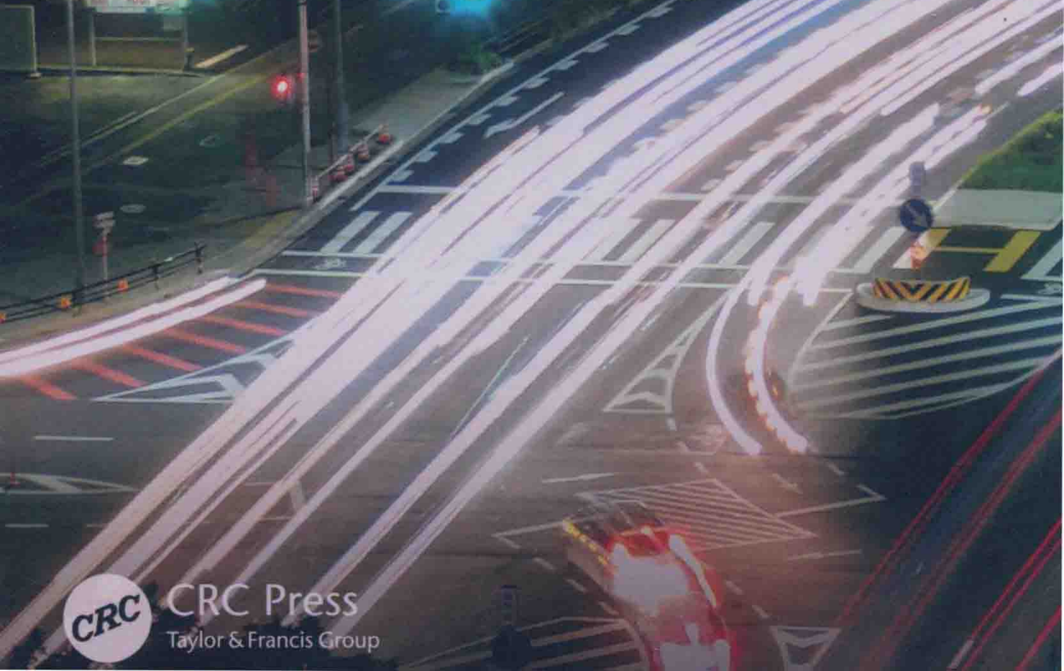
Predicting Vehicle Trajectory

Cesar Barrios • Yuichi Motai



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Predicting Vehicle Trajectory

This book concentrates on improving the prediction of a vehicle's future trajectory, particularly on non-straight paths. Having an accurate prediction of where a vehicle is heading is crucial for the system to reliably determine possible path intersections of more than one vehicle at the same time. The US DOT will be mandating that all vehicle manufacturers begin implementing V2V and V2I systems, so very soon collision avoidance systems will no longer rely on line of sight sensors, but instead will be able to take into account another vehicle's spatial movements to determine if the future trajectories of the vehicles will intersect at the same time. Furthermore, the book introduces the reader to some improvements when predicting the future trajectory of a vehicle and presents a novel temporary solution on how to speed up the implementation of such V2V collision avoidance systems. Additionally, it evaluates whether smartphones can be used for trajectory predictions, in an attempt to populate a V2V collision avoidance system faster than a vehicle manufacturer can.

Features

- MATLAB Code for proposed methods.
- Real Sensory Datasets (GPS, Accelerometer, ODBII, Scan-Tool) for download.
- Introduces the reader to some improvements when predicting the future trajectory of a vehicle, and presents a novel temporary solution on how to speed up the implementation of such V2V collision avoidance systems when only a small number of vehicles on the road will have this from the manufacturer.
- Discusses smartphone implementation.

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Predicting Vehicle Trajectory

Prediction is very difficult, especially if it's about the future.

—Niels Bohr, Nobel laureate in physics

This book is dedicated to the love of my life, Raquel,

for her unconditional encouragement.

—Cesar Barrios

I dedicate this book to my wife for her unlimited support.

—Yuichi Motai

Preface

Prediction of the trajectory path of a vehicle into the future is a difficult task, and even more so in non-straight paths, as observed in some of the research studied. Many times, the predicted future position of where the vehicle will be 3 s later in time falls outside of a physical road, making this prediction highly improbable. For the first part of this research, the assumption is made that the driven vehicle will remain on a road at all times, and any prediction that falls outside of a road will be considered incorrect. Through the use of a road-mapping technique, it will be shown that this error correction greatly reduces the prediction errors in non-straight paths.

Another problem observed when predicting a future position of a vehicle is that, when using multiple sensors, most of the time they are asynchronous. Some reviewed research describes a solution of running the system at the rate of its slowest sensor, and, therefore, solving the problem of asynchronous data. Other reviewed research uses previously estimated measurements to fill in the missing data from offline sensors. A vehicle is a large object that cannot change its spatial dynamics very quickly, but running a prediction system at a slow rate can slow down the detection of these spatial changes. For this research, the system is run at the rate of its fastest sensor, but missing measurements are calculated based on measurements obtained from online sensors using a dead-reckoning approach. A technique was developed to properly handle error accumulation from missing data from offline sensors, and that running the system at the fastest rate possible greatly reduces the prediction errors in non-straight paths.

The last part of this research looks into a possible solution to advance the usability of a vehicle-to-vehicle (V2V) system in its initial stages. The National Highway Safety Administration announced in 2014, its decision to begin taking the next steps toward implementing V2V technology in all new cars and trucks. Although all vehicle manufacturers are required to support this technology, it will still take many years until the V2V system is fully populated and most vehicles can participate. Until that point is reached, the benefits of the V2V technology will not be taken advantage of, unless a temporary solution is achieved to enable older vehicles to participate in the V2V system as well. Smartphones are readily available and already have many built-in sensors and good processing power, so in this part of the research, the possibility of using smartphones to predict the trajectory path of a vehicle will be used. It will be shown that some kinds of smartphones yield similar prediction errors as predictions calculated using vehicle-mounted sensors.

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Cesar Barrios received his BS (1999) and MS (2001) degrees in electrical engineering from the New Jersey Institute of Technology and his PhD (2014) in electrical engineering from the University of Vermont. After receiving his BS degree in 1999, he worked for IBM. Dr. Barrios has worked for Global Foundries since 2015. He first started in information technology, and then moved into semiconductor research and development.

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