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## Multiple Changepoint Detection on Speed Profile in Work Zones Using SHRP 2 Naturalistic Driving Study Data

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### Abstract

The presence of work zone increases disturbance to traffic flow and produce high cognitive work load for drivers which can increase the safety risks. There has been an increase of about 11% in work zone related fatality from 2010 to 2014 despite a small decrease in non-work zone related fatality in the U.S. Work zone safety is a major concern for construction workers, travelling publics, and transportation safety professionals. Work zone impacts on safety creates a strong need to protect road users and construction workers.

There are a large number of factors contributing to work zone safety but it is mainly believed that the major contributing factors are speeding, inattentive driving and other unsafe driver behaviors. Drivers react to the presence of work zone’s advanced warning sign, merge sign, lane closure sign, and other countermeasures such as DMS, flashing arrow, posted speed, speed feedback, and so on. These countermeasures tend to get drivers attention to reduce their speed and react to signage, which help them safely traverse the work zone area. It is essential to find how drivers react to various measures throughout the work zone in order to find countermeasures’ effectiveness. Due to the presence of multiple signage and countermeasures throughout the work zone, drivers may react differently to each measure which creates a changepoint in speed time series data. Changepoint analysis is a statistical tool

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aims to achieve homogeneity within time series data. This can be achieved by partitioning the time series data into a number of homogeneous segments. Multiple changepoints detection which is also known as time series segmentation, is basically finding a time instance when statistical properties of data change.

The speed trajectory time series data from SHRP2 work zones at a rate of 0.1 seconds (10 HZ) were used to develop changepoint models by utilizing Pruned Exact Linear Time (PELT) changepoint package (cpt) in R to accurately and efficiently estimate the location of changepoint in mean speed reacting to speed countermeasures such as DMS, posted speed sign, speed feedback sign, flashing arrow, merge sign, and so on. The model creates mean speed data partitioned into homogeneous regions in reaction to different signage and speed countermeasures.

The analysis reveals a promising results regarding driver's reaction to different measures in work zone by identifying prime changepoint locations in mean speed time series data. This method helps us to identify the effect of speed countermeasures on changing driver's speed behavior and subsequent modeling.

**Keywords: Work Zone Safety —Driver Behavior —Speed Countermeasure Effectiveness—  
Drivers' Reaction — Multiple Changepoints**