Summary of UNLV Pedestrian Safety Program

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In 2002, the Federal Highway Administration (FHWA) awarded grants to the cities of Las Vegas, Miami and San Francisco, to examine and map out their pedestrian crashes and develop a plan for deploying and evaluating various pedestrian safety countermeasures in high crash “zones” and locations. University of Nevada Las Vegas - Transportation Research Center was the primary contractor for this study in the Las Vegas metropolitan area. UNLV-TRC partnered with City of Las Vegas, City of North Las Vegas, City of Henderson, Clark County Department of Public Works, and Regional Transportation Commission of Southern Nevada and successfully completed the project. The study was divided into two different phases.

UNLV’s Transportation Research Center (TRC) initiated the work on Phase 1 of the study in October of 2001. It is based on identifying high risk pedestrian incident target areas and populations, selecting and implementing safety engineering and ITS based countermeasures, and analyzing the effectiveness of treatments for various target groups and causal factors. Analysis of the geo-coded data for the intersections is done in order to determine the high crash rated intersections or corridors. Buffers were created along with the high crash locations to determine the high crash areas and corridors. For determining the high crash locations, the intersections / locations are arranged in the descending order of the number of the crashes at the intersection. This is used to locate intersections or locations with the highest number of crashes. The crash index of an intersection is determined using the data related to the population and the crashes in that study area. Using the crash index (CI) as the main criteria, the high crash locations were selected within the metropolitan area of the Las Vegas.

The focus of Phase 2 of the FHWA Pedestrian Safety Program is to implement engineering and Intelligent Transportation System (ITS) based countermeasures, to evaluate the effectiveness of these pedestrian safety countermeasures for various target groups and causal (risk) factors. Some of the countermeasures deployed in Phase 2 have been selected in consultation with Florida (Miami-Dade County) team and San Francisco team. This is to permit a comparative evaluation of countermeasures at three different locations in the country.

A Geographic Information Systems (GIS) based methodology was used to identify high pedestrian risk zones and areas in the study area. Initially 16 high risk zones comprising of 47 pedestrian high crash sites were identified in the Phase 1. However, due to limited financial resources to improve pedestrian safety at all the identified locations, eighteen (18) pedestrian high crash sites were identified in the Las Vegas metropolitan area. Of these 18 locations, countermeasures were deployed at 14 locations with the remaining 4 sites as control sites, where none of the countermeasures were deployed. Seventeen countermeasures were initially selected to evaluate in this program. Based on the risk associated at each site, multiple countermeasures were deployed at several sites. The deployment of these multiple countermeasures was done in phases to evaluate effectiveness of each individual countermea-
sure. Data were collected before and after each countermeasure deployment at sites. Statistical analyses were performed on the collected data to determine the significance of the changes in measures of effectiveness before and after deploying the countermeasure.

Although seventeen countermeasures were initially selected to be evaluated in this program, it was later reduced to fifteen, due to the unavailability of vendors to supply two of the countermeasures, “Enlarged Pedestrian Signal Heads” and “Advanced Warning Roving Eyes for Motorists.” However, a new countermeasure was added to the list and was installed at locations where “Enhancer LED Pedestrian Signals” were supposed to have been installed. Figure 1 shows “Median Refuge with Danish Offset” countermeasure installed at a high volume pedestrian crossing. This installation forces the pedestrian to have an eye to eye contact with the driver while using the crosswalk, thereby increasing the yielding behavior of the driver.

Figure 1: Median Refuge with Danish Offset

Figure 2 shows a special In-Roadway Knockdown Sign that was designed for mid-block locations with high pedestrian volume without a crosswalk. This sign is not specified in the Manual of Uniform Traffic Control Devices (MUTCD). However the research team came up with its own idea of alerting the driver about the possible presence of a pedestrian at a non-crosswalk location.

Figure 2: In-Roadway Knockdown Signs

Figure 3 shows “High Visibility Crosswalk Treatment” at a study location. This installation was intended to help reduce the problem of inconspicuous crosswalks at the location. The objective of this countermeasure is to enhance visibility and minimize inappropriate perceptions between the pedestrians and the motorists. This countermeasure is also expected to encourage greater number of pedestrians to use crosswalks.

Figure 3: High Visibility Crosswalk Treatment

These results from the study indicate that while most of the countermeasures helped to enhance the safety, some others were not that effective in improving safety. In this study, several countermeasures were implemented together during same stage. Even though they showed significant safety improvements, since they were implemented as a group, the effects of individual countermeasures could not be evaluated. However, several of these countermeasures in the combination are relatively inexpensive. Therefore, if these were to be deployed at any other locations, it would be economically feasible.
Aim of an isolated ramp metering is to maximize the flow on the mainline by controlling the inflow of the vehicles coming in. We can design a “traffic-responsive” feedback ramp controller to achieve this task. In order to do this, we need to obtain a mathematical model of the system. We use a nominal model which needs to emulate the essential dynamics of the system, but should not be so complicated as to render the control design impossible. The feedback loop itself takes care of the uncertainties of the system. As a very simple example, consider the following model of the system.

\[
\frac{d\rho(t)}{dt} = q_{in}(t) - q_{out}(t) + r_{in}(t)
\]

Here, \( \rho \) is the traffic density in the mainline section connected to the input ramp, \( q_{in}(t) \) is the input/upstream flow, \( q_{out}(t) \) is the downstream flow, and \( r_{in}(t) \) is the input flow from the ramp going into the mainline. We make \( r_{in}(t) \) the control variable, which we implement using the ramp lights. Traffic flow is the product of density and speed. Traffic speed, in turn, can be obtained as a function of traffic density using “fundamental” relationships, e.g. by using the Greenshield formula. This gives

\[
q_{out}(t) = \rho v_f \left( 1 - \frac{\rho}{\rho_m} \right)
\]

Here, \( v_f \) is the free-flow speed, and \( \rho_m \) is the jam density. We can design the input ramp flow to depend on the actual real-time traffic density of the traffic. We do that so that we can make the traffic density stay as close as possible to a flow maximizing density, \( \rho_{cr} \). This can be accomplished by using

\[
r_{in}(t) = -q_{in}(t) + \rho v_f \left( 1 - \frac{\rho}{\rho_m} \right) + k(\rho(t) - \rho_{cr})
\]

Using this control design, we can show by substituting in the dynamics that the difference between the actual density and the desired flow-maximizing density goes to zero in time. Of course, this happens only if the real-time conditions allow it. As an example, if the traffic is low on the mainline, and there are enough vehicles in the queue, then this would be possible. If there are no vehicles on the ramp, then obviously the system has no way of affecting the density. Notice also that this control design depends on the upstream flow rate and the traffic density, both of which are to be supplied by the sensors on the system.
News from the Center

UNLV-TRC completed FHWA sponsored pedestrian safety project. Las Vegas was selected as one of the three cities to do this pilot study to evaluate effectiveness of various countermeasures to enhance pedestrian safety.

UNLV-TRC along with ASCE, ITE, and ITS Nevada hosted 2008 annual Fall Transportation Conference in October. About 200 professionals and vendors attended this two day conference.

Ms. Vidhya Kumaresan, a graduate student from UNLV/TRC received the best students paper competition award for her paper on Development of A Safety Analysis System”.

UNLV/TRC received a grant from Nevada Office of Traffic Safety to develop guidelines for nighttime seat belt usage surveys.

Vinod Vasudevan completed his Ph.D. program in Fall 2008. His research was on examining the issues associated with the gasoline-based highway financing system and identifying alternative funding mechanisms.