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State of the Art Evaluation of Traffic Detection and Monitoring Systems

Volume I – Phases A & B: Design

INTRODUCTION

Accurate, complete, and timely traffic data is critical to the effective management of Arizona's highway system. Limitations in current traffic monitoring abilities are an ongoing challenge for the Arizona Department of Transportation (ADOT) and for its customers as well in both urban and rural areas. Many technologies exist for detecting vehicles and determining traffic volume, speed, and lane occupancy.

This research project included a state-of-the-practice review, intended to assist ADOT and other Arizona transportation agencies in identifying the most appropriate detection technologies to meet local needs. The scope of this project also required the development of a design for a detector testbed facility, which ADOT proposes to develop in the near future, in the Phoenix area.

CURRENT PHOENIX AREA DETECTION SYSTEMS

Embedded inductive loops and pole-mounted passive acoustic detectors (PADs) are currently the primary detectors used on the roughly 250 centerline miles of freeways in the Phoenix metro area. Inductive loops are a mature and accurate technology but lane closures for their installation and maintenance have become less feasible in recent years due to traffic volumes, safety issues, and costs.

PADs have not been as accurate as originally anticipated, so viable alternative detectors are needed. ADOT's preference, due to the historical problems noted with embedded roadway sensor designs, was to focus the study initially on new non-intrusive detection concepts.

LITERATURE & INTERNET SEARCH

A thorough literature and Internet search produced a number of useful documents on the topic of vehicle detection on freeways.

Due to the dynamic nature of this topic and the ever changing nature of the detector market, the most useful information was developed recently – from the late 1990s until the present day.

None of the newer non-intrusive detectors appear to be as accurate in vehicle presence detection as loops under all environmental conditions, but many agencies have determined that other positive features outweigh the modest reduction in accuracy.

Close scrutiny of literature and Internet sources reveals that comparing each research project's findings is difficult at best due to the use of different metrics, different traffic conditions, different models of the same detector (or at least different firmware), and different positioning of detectors.

In general, however, a few of the newer detectors can count traffic consistently within 5 percent of true counts. Speed estimates from these devices indicate similar accuracy, and in limited cases exceed the speed estimates of standard inductive loops (e.g. Doppler radar).

The non-intrusive technologies that have withstood the scrutiny of several installations and have the most promise for replacing inductive loops are microwave radar, video imaging, and magnetic detectors. Of the two prominent magnetic detectors, one is intrusive but is still deemed worthy of consideration.

VEHICLE DETECTOR TESTBEDS

Existing field test facilities in California, Minnesota, and Texas make use of components that were already in place along existing freeways such as overhead structures, poles, and conduit. For example, the Caltrans facility on I-405 in Irvine, California utilizes a unique camera system to establish ground truth, substantially reducing the need for manual viewing of recorded video. It also has inductive loops in the pavement to be used as needed.

The Minnesota test facility on I-394 near downtown Minneapolis used standard inductive loops for ground truth and mounted test systems either on an overhead bridge, on movable telescoping poles (sidefire), or underneath the pavement.

The Texas facility on I-35 near downtown Austin used an upscale vehicle classifier, the Peek ADR-6000, for ground truth, existing luminaire poles and conduit, and an overhead sign bridge. Most of the test detectors were mounted on the luminaire pole. Lessons learned from these vehicle detector testbeds could provide useful information as this project moves forward.

STATE CONTACTS

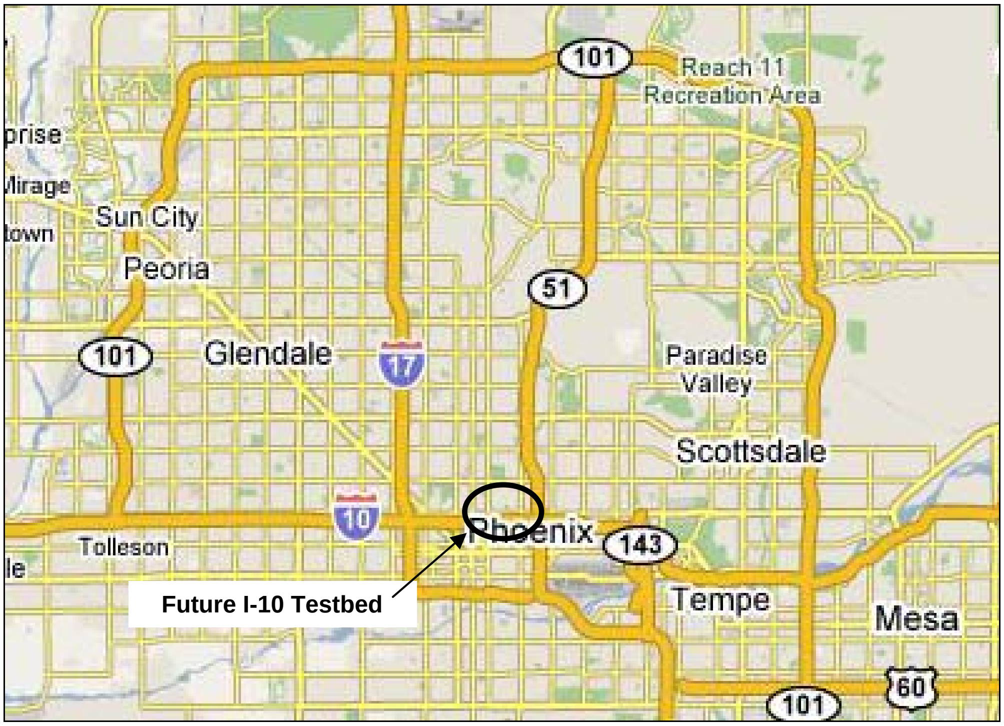
The information gathered in this section complements the other sections. The literature and Internet search helped identify states that had tested and installed new technology detectors, and the state contacts brought some of the information up to date.

In summary, all three states - California, Minnesota, and Texas – have conducted research on some of the same detectors but there are differences in how the research is being implemented. The various districts in California and Texas are installing a wide variety of non-intrusive detectors to replace failing loops, but Minnesota continues to install and rely almost exclusively on loops.

TESTBED SITE SELECTION AND CONCEPTUAL DESIGN

The site selected for the future ADOT testbed consists of a mainline element, which is on I-10 at 13th Street (see map page 3), and an entrance ramp element, which will be at the nearby 16th Street interchange.

Some strengths of this site include its central location, high traffic volume (including trucks), number of lanes, proximity to the downtown Phoenix I-10 tunnel (related to lane closures), space availability for testbed equipment and parking, and unobstructed view of approaching traffic.



Proposed ADOT Testbed Location – Interstate 10 and 13th Street, Phoenix

The conceptual testbed design utilizes many of the existing FMS facilities and elements at the site, as well as the numerous proposed new components required for the testbed including equipment cabinets, underground boring, pull boxes, ground truth devices, and safety barriers.

The offset sign bridges offer locations for mounting detectors and surveillance cameras overhead, and proposed new poles could be used for mounting sidefire detectors and surveillance cameras. Horizontal 3-inch bores spaced 18 feet apart can accommodate microloops by Global Traffic Technologies (GTT, previously a unit of 3M).

Inductive loops on the upstream side of each structure are intended to be used for ground truth using a Peek ADR-6000. It is anticipated that if the testbed is built in two stages that initial equipment installation will emphasize the westbound direction of traffic flow and the north side of the freeway.

DETAILED DESIGN AND TESTING PROGRAM DEVELOPMENT

Building on what had already been accomplished in the conceptual design and the site selection process, the detailed design provided more accurate information on quantities and sizes of components.

Given the uncertainties of installing shallow inductive loops in the rubberized asphalt pavement layer, there was also an investigation of the Inductive Signature Technologies (IST) system as an alternative baseline system instead of the Peek ADR-6000. The Technical Advisory Committee (TAC) decided that the IST system did not have the maturity needed, electing to stay with the Peek unit.

Components in the Detailed Design that changed from the Conceptual Design included use of more ADOT-furnished components such as pull boxes, poles, and cabinets. The poles (two on the north side of I-10) will now be standard ADOT poles without mast arms. Also, the existing on-site camera will provide surveillance coverage, supplemented by two proposed Autoscope video imaging systems, one per direction of traffic flow.

The overall detector evaluation process is currently envisioned as a seven-step process, and it is anticipated that the Transportation Technology Group (TTG) of ADOT will be primarily responsible for selecting detectors for testing, and for the exact procedures which are to be used.

The total cost of the ADOT testbed facility is estimated to be approximately $566,000. Some standard facility components will be provided by ADOT at no cost to the project; however, all of the proposed traffic detector systems to be evaluated are included in the budget estimate.

Other major site elements in the above total figure are infrastructure, communications, multiple detector system mounts and a node building, as well as the costs of the final design package, construction management, and contingency.

The full report: *State of the Art Evaluation of Traffic Detection and Monitoring Systems, Volume I – Phases A & B: Design*, by Dan Middleton, Ryan Longmire, and Shawn Turner of the Texas Transportation Institute (Arizona Department of Transportation, report no. FHWA-AZ-07-627, published October 2007) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; Fax 602-712-3400. Businesses may order copies from ADOT's Engineering Records Section.