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Evaluation of Portable Automated Data Collection Technologies: Interim Report, Work Accomplished During Fiscal Year 2005-2006

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ABSTRACT

This report documents work accomplished during Fiscal Year 2005-2006 as a part of a research project entitled “Evaluation of Portable Automated Data Collection Technologies.” Major activities during this period included a literature survey, surveys of potential users and vendors, preliminary evaluation of portable data collection technologies to select candidate systems for demonstration, and development of demonstration plans. There is demand for portable automated data collection systems for uses related to planning, traffic operations, traffic census, and traffic surveillance functions. Potential users are interested in volume count, speed, occupancy, travel time, vehicle-length classification, and axle-based vehicle classification data. Potential uses require systems to remain installed from a few hours up to several years. Potential users want systems that minimize traffic disruption and exposure of crews to traffic, are “plug-and-play,” have IP-addressable communications capability, can provide data in a variety of formats, and have flexible power supplies. Candidate systems for demonstration are expected to consist of combinations of different sensors with different power supply and mounting system options. Current plans call for nine separate demonstrations. These demonstrations include tests of systems based on EIS microwave radar sensors that are currently underway in Caltrans District 11, demonstrations of other systems based on EIS and Wavetronix microwave radar sensors to be designed by the study team and carried out by District 11, and a demonstration of The Infra-Red Traffic Logger (TIRTL) that is planned by District 7.

EXECUTIVE SUMMARY

This report documents work accomplished during Fiscal Year 2005-2006 as a part of a research project entitled “Evaluation of Portable Automated Data Collection Technologies.” Major activities during this period included a literature survey, surveys of potential users and vendors, preliminary evaluation of portable data collection technologies to select candidate systems for demonstration, and development of demonstration plans.

In the past, Caltrans has relied on manual traffic data collection in many situations; however, manual data collection is labor-intensive and expensive. An alternative is use of portable automatic data collection systems combining state-of-the-art non-intrusive sensors, mounting systems, portable power sources, and flexible data transmission systems. The overall goals of the project are to identify portable data collection systems, demonstrate them in the field under realistic conditions, and evaluate them to determine whether they can serve as substitutes for manual traffic data collection for three specific data collection tasks: multilane traffic counts and speed data, vehicle classification counts, and turning movement counts. The project is limited to systems that currently exist or can be easily assembled from existing components.

Literature related to portable automated data collection systems was surveyed and found to be primarily focused on documentation, comparison, and evaluation of non-intrusive sensors. Because of the rapid evolution of sensor technology, most to this literature is out-of-date and of comparatively little value.

Surveys of potential users of portable automated data collection systems included a survey of Caltrans personnel and a survey of personnel of other state departments of transportation and the Federal Highway Administration. These surveys showed that there is demand for portable automated data collection systems for a variety of uses related to planning, traffic operations, traffic census, and traffic surveillance functions. The most commonly-requested type of data is volume counts, but respondents also expressed interest in speed, occupancy, travel time, vehicle-length classification, and axle-based vehicle classification data. Potential system uses imply durations of field deployment ranging from a few hours up to several years. Potential users are looking for systems that minimize traffic disruption and exposure of crews to traffic, are “plug-and-play,” have IP-addressable communications capability, can provide data in a variety of formats, and have flexible power supplies. Some respondents also suggested that global positioning satellite (GPS) units be included.

Firms believed to be active in manufacturing or selling portable traffic data collection systems or components were also surveyed to determine the availability of equipment and the willingness of specific firms to participate in the demonstrations. Unfortunately, response to this survey was disappointing; as a result, manufacturers and vendors of products that are being seriously considered for demonstration are being contacted directly.

The preliminary evaluation of technologies was intended to provide a basis for selecting systems to demonstrate. It involved consideration of functional requirements, definition of general types of candidate systems, and a preliminary assessment of the advantages and disadvantages of potential components. Candidate systems for demonstration are expected consist of combinations of different sensors with different power supply and mounting system options. Sensors to be demonstrated include two different brands of microwave radar sensor and a low-mounted infrared sensor system known as The Infra-Red Traffic Logger (TIRTL). Microwave radar sensors will be used for volume counts, speeds, occupancy, and length-based vehicle classification; TIRTL will be used for axle-based vehicle classification. Three different combinations of power supplies and mounting system type have been identified in an attempt to cover the full range of deployment duration suggested by potential users. These include short-run systems utilizing portable poles and storage batteries, intermediate systems utilizing portable poles and solar collectors, and long-run systems utilizing fixed objects in the right of way (e. g., light standards) and either AC current or solar collectors. Different options are under consideration for portable poles for use with short-run and intermediate systems and fixed objects for use with long-run systems.

Current plans call for nine separate demonstrations to test different combinations of sensors, power supply and mounting options, and data collection tasks. These demonstrations include tests of short-run systems based on EIS microwave radar sensors that are currently underway in Caltrans District 11, demonstrations of other systems incorporating EIS and Wavetronix microwave radar sensors to be designed by the study team and carried out by District 11, and a demonstration of TIRTL that is planned by District 7. Other demonstrations may be conducted (or some of the ones currently planned deleted or revised) depending on the outcome of prior demonstrations and/or technological developments.

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1. INTRODUCTION

This report documents work accomplished during Fiscal Year 2005-2006 as part of a research project entitled "Evaluation of Portable Automated Data Collection Technologies." Major activities during this period included (*a*) a literature survey, (*b*) a survey of Caltrans personnel to determine needs for portable data collection systems, (*c*) a survey personnel of other state departments of transportation and the Federal Highway Administration (FHWA) to determine whether there is interest in such systems outside California and whether any systems have been developed or tested elsewhere, (*d*) a survey of vendors to determine their interest in participating in the project, (*e*) preliminary evaluation of portable data collection technologies to select technologies for demonstration, and (*f*) development of plans for demonstrating candidate systems. This report documents results of the surveys, candidate systems for demonstration, and current demonstration plans.

2. BACKGROUND

In the past, Caltrans has relied on manual traffic data collection in many situations. Examples include locations without operable loop detectors, intersections where turning movement counts are needed, and construction work zones. Manual data collection is labor-intensive and expensive; consequently, in times of restricted budgets and personnel resources it may not be possible to collect traffic data needed to make good decisions about the operation of the highway system. An alternative is to use portable automated data collection systems that combine state-of-the-art non-intrusive sensors, mounting systems, portable power sources, and flexible data transmission systems. The overall goals of this project are to identify portable data collection systems, demonstrate them in the field under realistic conditions, and evaluate them to determine whether they can serve as effective, practical, and economical substitutes for manual traffic data collection.

Due to time and resource limitations the scope of the project is limited to identification, demonstration, evaluation, and documentation of systems that currently exist or can be easily assembled from existing components. The project is focused on three specific data collection tasks. These are: (*a*) multilane traffic counts and speed data for locations (including mainlines, ramps, and connectors) for which loop detectors are not installed or not operable; (*b*) vehicle classification counts; and (*c*) turning movement counts at intersections. In order to ensure realism in demonstrations planned for the San Diego area, equipment will be installed in the field by crews furnished by the Traffic Census unit of Caltrans District 11, with the study team observing, documenting, and evaluating the results. Since the inception of the project, the study team has become aware of planned demonstrations of portable data collection systems in other Caltrans districts. In these cases, the study team will participate as appropriate to observe the demonstrations and document their results.

Project activities during 2005-2006 have focused on identification of requirements for portable data collection systems, preliminary evaluation of available technologies, and identification of systems to be demonstrated.

3. LITERATURE SURVEY

Most past literature related to this project consists of reports evaluating or summarizing information about non-intrusive traffic sensors. A major source of information about traffic sensors is the Vehicle Detector Clearinghouse (no date a) sponsored by the Southwest Technology Development Institute at New Mexico State University. The clearinghouse maintains a summary of product information relating to different types of non-intrusive sensors (Vehicle Detector Clearinghouse no date b), and also sponsors reports summarizing and comparing the characteristics of different types of sensors (Mimbela and Klein 2003). In addition, there are a number of reports available that provide evaluations of different sensor technologies. These include reports by the Minnesota Guidestar project (Minnesota Department of Transportation 1997, Minnesota Department of Transportation 2002), the Texas Transportation Institute (Middleton and Parker 2002), the California Department of Transportation (Wald 2004a) and others (Martin 2003, Skszek 2001). Also, California has recently issued a set of microwave detection system (MVDS) guidelines (Wald 2004b) that apply primarily to permanent MVDS installations. Unfortunately, pace of development of technology in this field is so rapid that almost all of the information in these sources is out of date.

In addition, there has been some research related to the use of automatically-collected traffic data for specific data collection tasks. In this category, studies related to automated collection of turning movement counts (Hauer 1981, Virkler and Kumar 1998, Tian 2004) are of particular importance.

4. SURVEYS

Three surveys were conducted by e-mail and telephone. These were intended to determine the range of potential uses for portable automated data collection systems, user requirements for such systems, and the availability of such systems.

4.1 Caltrans

Caltrans personnel identified by the Caltrans project monitors were surveyed to determine their views on potential uses of and requirements for portable automated data collection systems. Personnel included headquarters and district personnel working in the areas of new technology development and assessment, traffic census, traffic operations, and transportation planning. A copy of the survey instrument is included in the Appendix. This survey instrument was sent by e-mail to a total of 50 individuals. In a number of cases, however, these individuals forwarded the survey to other Caltrans personnel, so that the total number contacted directly or indirectly was somewhat larger. Substantive responses were received from 16 individuals. Where appropriate, respondents were later contacted by e-mail or telephone to clarify their responses.

4.1.1 Potential Uses

Potential uses mentioned by respondents may be grouped in several broad areas. These include data collection for planning studies, traffic operations, and traffic census, and use as substitutes for loop detectors in various traffic surveillance roles.

In the case of *planning studies*, the data collected would normally be traffic counts taken over one to two days at each location.

Suggested uses related to *traffic operations* include collection of traffic counts, turning movement counts, and travel times. Specific traffic operations activities requiring these data include demonstration projects, timing of fixed-time ramp meters, simulation and optimization of signal systems, traffic management studies, incident management, and before-and-after studies for traffic operations improvements or intelligent transportation systems (ITS) projects. The duration of data gathering is expected to vary depending on the application but in most cases should range from a few hours to a day or two. One respondent suggested use of portable global positioning satellite (GPS) devices as waypoint markers for travel time studies using probe vehicles. This is a somewhat different type of portable data collection system than envisioned in the project proposal, but it may deserve consideration.

Suggested uses related to collection of *traffic census* data include volume counts, turning movement counts, and vehicle classification counts. Most respondents working in traffic census units expressed interest in systems that would classify vehicles by length, but several others expressed a need for portable systems that could classify vehicles by the number of axles, since this information is needed to fully meet the federal traffic monitoring guidelines (Federal Highway Administration 2001). Some respondents suggested that data collection at sites used for updating classification counts could accomplished by one-day counts; however, the federal guidelines recommend 48-hour counts.

Suggested uses in which portable data collection systems would substitute for loop detectors in *traffic surveillance* systems include replacements for malfunctioning loops; temporary data collection at locations where permanent detectors have not yet been installed; and data collection for construction zones, seasonal routes, and special events. Although counts related to special events might be needed for only a few days, most of these uses imply some sort of “semi-permanent” installation in which units would be deployed for as much as several years.

4.1.2 System Requirements

For the most part, responses to the survey confirmed the system requirements that had been envisioned in the project proposal. Points emphasized by the respondents include the following:

- Systems should minimize the traffic disruption and safety risks associated with in-pavement or on-pavement sensors, such as road tubes, taped-down induction loops, magnetometers, and piezoelectric detectors. This confirms the decision to limit demonstrations to systems incorporating side-mounted non-intrusive sensors.

- Respondents want "plug-and-play" systems that can be installed in the field with a minimum of effort and expertise. This confirms the decision to limit demonstrations to systems whose electronic components are already fully integrated and which require no more assembly than the minimum required for field installation.

- Systems should have the ability to upload settings and download data through wireless, IP-addressable communications systems.

- Systems should have the capability to provide data in a variety of formats to be specified by the user.

- One respondent stated that for uses involving traffic surveillance, systems should provide for seamless interface into existing data collection systems without need for an external server.

- Some respondents stated that systems should include GPS units so that they can be located automatically.

- One respondent wants portable data collection systems to be installed on changeable message sign (CMS) trailers.

- Another respondent states that it would be desirable if systems were skid-mounted.

- Systems should have the capability of being powered by batteries, solar collectors, or AC current.

4.2 Other State Departments of Transportation and FHWA

This survey was sent to personnel associated with the FHWA or departments of transportation in states other than California whom the study team believed to be possibly interested in portable automated data collection. Potential respondents were identified by consulting the membership roster of the American Association of State Highway and Transportation Officials (AASHTO) Traffic Operations committee and the web sites of the applicable agencies. A copy of the survey instrument is included in the Appendix. This survey instrument was sent by e-mail to a total of 70 individuals. In a number of cases, however, these individuals forwarded the survey to other individuals, so that (as in the case of the Caltrans survey) the total number contacted directly or indirectly was somewhat larger. Substantive responses were received from 9 individuals. Where

appropriate, respondents were later contacted by e-mail or telephone to clarify their responses.

The results of this survey did not add much to what had been learned from the Caltrans survey about potential uses and system requirements. It did make the study team aware that the Minnesota Department of Transportation is engaged in testing The Infra-red Traffic Data Logging (TIRTL) system manufactured by Ceos Industrial. This system is portable and non-intrusive, and is claimed to be able to produce accurate axle counts for multilane roadways. Following this contact, the study team learned that Caltrans District 7 is also planning tests of TIRTL.

4.3 Vendors

This survey was sent to firms believed to be active in manufacturing or selling portable traffic data collection systems or their components. Firms were identified through advertisements in the Institute of Transportation Engineers (ITE) Journal, internet searches, and discussions with the Caltrans project monitors. A copy of the survey instrument is included in the Appendix. This survey instrument was sent by e-mail to a total of 18 firms. Unfortunately, response to this survey was disappointing in that responses were received from only three firms, and all of these turned out to provide products related to road tubes, which are not of interest. As a result, manufacturers and vendors of products that are being seriously considered for demonstration are being contacted directly.

5. PRELIMINARY EVALUATION OF TECHNOLOGIES

The preliminary evaluation of technologies is intended to provide a basis for selecting systems to demonstrate. It involves consideration of functional requirements, definition of general types of candidate systems, and preliminary assessment of the advantages and disadvantages of potential system components.

5.1 Functional Requirements

Functional requirements of candidate systems are based on the types of data to be collected, the duration of intended field deployment, and the specific requirements identified through the survey of Caltrans personnel.

The types of data to be collected include volume counts and speeds by lane, lane occupancies, vehicle classification by length, vehicle classification by number of axles, and turning movement counts. With the exception of lane occupancies, ability to collect these types of data is required explicitly by either the project proposal of the input provided by the Caltrans survey; lane occupancies are also required, however, if systems are to provide traffic surveillance data that is comparable to that produced by loop detectors. Of these types of data, it is believed that all sensors under consideration will provide reasonably accurate volume counts and speeds. In the most recent tests by Caltrans (conducted in 2003), these sensors were not capable of providing accurate lane

occupancies or vehicle classification by length (Wald 2004a); however, newer models are available, and one of the goals of the demonstrations will be to determine whether they can provide accurate occupancy and length classification. Of the sensors under consideration, only one – TIRTL – is claimed to be able to provide classification based on the number of axles, and this claim will need to be verified. To date, the only reasonably promising method for deriving turning movement counts from machine count data is the Time and Place System (TAPS) algorithm developed by researchers at the University of Missouri (Virkler and Kumar 1998, Tian 2004). This algorithm applies only to signalized intersections. Data required by TAPS are a log giving lane and time of detection for individual vehicles plus a log showing the times that each signal phase was active. Note that this implies some means of recording the condition of the signal, preferably directly from the output of the controller. Discussions with University of Missouri researchers indicate that TAPS has so far been implemented by hand only (personal communications, M. R. Virkler and J. Tien). In order for it to useful for routine data collection, it will be necessary to computerize it. Although TAPS could be applied in real time, the simplest approach appears to be to develop software (most likely in Visual Basic) to post-process data.

As determined by the Caltrans survey, the expected duration of field deployment for the proposed uses ranges from a few hours up to several years. Duration of deployment has significant implications for power supply and mounting system requirements. These are discussed in more detail in the next section.

It appears that most of the specific requirements mentioned in the Caltrans survey will be automatically met by the study design and the types of sensors under serious consideration for demonstration. Only non-intrusive devices are being considered. In most if not all cases, the sensors under consideration are believed to already function as part of integrated “plug-and-play” systems that provide for wireless communication and have the ability to deliver data in a variety of user-defined formats. It is believed that requirements for flexibility in power supply may be met by either manufacturer-supplied equipment or simple add-on devices. At this time it is not known whether any manufacturers are packaging GPS units with sensors; consequently, one goal of the demonstrations will be to determine whether these devices are already available and, if not, what would be involved in adding them to portable automated data collection systems.

5.2 Candidate System Definitions

Candidate systems may be classified according to sensor type, power supply, mounting system, and the presence or absence of auxiliary devices such as GPS units or video cameras to be used for verifying sensor performance. Because potential users have indicated that the duration of deployment may need to vary widely, it is expected that systems will be set up so that sensors can be easily switched among different types of mountings and power supplies.

Systems will be referred to by means of an acronym consisting of three or more letters. The first letter refers to the sensor technology, the second to the specific sensor model, the third to the power supply and mounting option, and the fourth or higher to auxiliary devices, if included. Power supply and mounting system options are classified according the expected duration of deployment. These are (*a*) *short-term* – mounting system is portable pole and power supply is storage battery without field recharge; (*b*) *intermediate* – mounting system is portable pole and power supply is storage battery with field recharge; and (*c*) *long-term* – mounting system is semi-permanent attachment to a fixed object such and a light standard and power supply is storage battery with field recharge. It is not known at present whether the intermediate option will actually be required. The overall code is as follows:

Sensor technology:

M = microwave radar
I = infrared
V = video image processing

Sensor model:

E = EIS (RTMS, current model)
W = Wavetronix (Wavetronix HD)
T = TIRTL

Mounting/power supply option:

S = short-term
I = intermediate
L = long term

Auxiliary devices:

C = video camera
G = GPS unit

For example, *MWSC* refers to a system consisting of a Wavetronix microwave radar sensor, intended for short-term deployment, and including an attached video camera to be used for verification of sensor performance.

5.3 Preliminary Evaluation of Components

The principal components of portable automated data collection systems are sensors, power supplies, and mounting systems. Preliminary evaluation of potential components includes documentation their intended uses, their perceived advantages and disadvantages, and any currently unanswered questions; and a preliminary recommendation about whether to include them in the demonstrations.

5.3.1 Sensors

Sensors commonly used for collection of traffic data include loop detectors, magnetometers, piezoelectric devices, automatic counters for road tubes, video image processors, microwave radar sensors, and infrared sensors. Of these, loop detectors, magnetometers, piezoelectric devices, and road tubes are installed in or on the roadway surface, and hence are outside the scope of the project. Evaluation of the remaining sensor types is as follows:

Component: **Video image processor (several brands)**

Intended use: In principle, these can be used for volume counts, speed, occupancy, length classification, and turning movement counts

Advantages: Proven technology; can provide good data under favorable conditions

Disadvantages: For some units, high cost. In all cases, major difficulties in getting accurate counts in unfavorable light conditions (low sun in field of view, transition from daylight to darkness).

Questions: None

Recommendation: Do not demonstrate; problems with unfavorable light conditions are fatal

Component: **Microwave radar sensor (EIS-RTMS)**

Intended use: Volume counts, speeds, turning movement counts, possibly occupancy and length classification

Advantages: Proven technology, accepted for use in California (older model), reasonable cost

Disadvantages: Older model units hard to calibrate (apparently corrected), older units would not do accurate occupancies or vehicle length classification

Questions: Does output include traffic log listing time of detection for each vehicle? Are setback requirements compatible with use at signalized intersections? (Needed for turning movement counts)

Recommendation: Participate in ongoing demonstration by District 11 of short-term uses. Extend to long-term uses and to turning movements if it can provide data in the required format and setback requirements can be met at signalized intersections

Component: **Microwave radar sensor (Wavetronix SmartSensor HD)**

Intended use: Volume counts, speeds, occupancy, and length classification

Advantages: Proven technology, easy to calibrate, new model includes improved radar that may solve past problems with occupancy and length data, accepted for use in California (older model), reasonable cost

Disadvantages: Older model would not do accurate occupancies or vehicle length classification

Questions: Will it do accurate occupancies and length classification?

Recommendation: Demonstrate for short term volume counts, speeds, occupancies, and length classification. Extend demonstration to long-term uses.

Component: **Infrared sensor (several brands) mounted above roadway**

Intended use: Volume counts, speed, occupancy, length classification, and turning movement counts

Advantages: No known advantage over microwave radar

Disadvantages: In some cases, high cost

Questions: None

Recommendation: Do not demonstrate

Component: **Infrared sensor mounted axle-high (TIRTL)**

Intended use: Vehicle classification by number of axles; unit is also claimed to be capable of volume counts, speeds, occupancy, length classification, and turning movement counts

Advantages: Only non-intrusive sensor system that claims ability to do axle-count classification, able to provide most other types of data required

Disadvantages: Very high cost, requires components to be set up on both sides of the roadway (possible safety issue), setup and calibration said to require a "learning curve," will do only one direction at a time on a freeway, possible problems with high crowns (not issue with freeways since it will do only one-half at a time), performance in rain, and performance with stop-and-go traffic,

Questions: Will it live up to the manufacturer's claims?

Recommendation: Participate in planned test by District 7

5.3.2 Power Supplies

Component: **Storage battery without field recharge**

Intended use: All short-term uses

Advantages: Low cost, standard equipment for all sensor packages under consideration

Disadvantages: Can be used for a limited time only

Questions: How long will battery last without recharge, especially if auxiliary equipment in use?

Recommendation: Use for all short-term demonstrations

Component: **Solar collector for field recharge of battery**

Intended use: Intermediate and long-term uses

Advantages: Can be used anywhere, no cost for purchasing power (probably negligible)

Disadvantages: First cost of acquiring, may be target for theft

Questions: Under what circumstances will these really be needed?

Recommendation: Demonstrate for intermediate and long-term setups, if appropriate

Component: **Adaptor for AC current**

Intended use: Long-term uses

Advantages: Reliable, low first cost

Disadvantages: Not available everywhere – requires semi-permanent mount, cost for purchasing power (probably negligible)

Questions: What fraction of long-term deployments will be able to use AC power?

Recommendation: Demonstrate for long-term setups where available

5.3.3 Mounting Systems

Component: **20’ Pole clamped to sign post or similar object**

Intended use: Short term or intermediate uses with microwave radar sensors

Advantages: Low cost, can be installed near most locations where data needed, can be easily secured

Disadvantages: Cannot be set up just anywhere, may violate clear zone requirements (does not alter breakaway or yield features of object to which attached, but does alter mass and center of gravity), difficult to adjust sensors or cameras in the field

Questions: Is there a clear zone problem? What would be involved in increasing to 30’ for camera mount?

Recommendation: use for short term or intermediate demonstrations

Component: **10 m pneumatic pole with portable base (Clark Masts SQT10/HT)**

Intended use: Short term or intermediate uses with microwave radar sensors

Advantages: Can be set up anywhere, easy to adjust sensors or cameras in the field

Disadvantages: Security, relatively high cost, oil seals may leak if left out too long, may not be stable under all conditions without tethers, may violate clear-zone requirements if located in clear zone

Questions: How long is too long for oil seals?

Recommendation: Do not demonstrate unless poles clamped to signs prove unsatisfactory

Component: **Light standard**

Intended use: Mount for long-term use with microwave radar sensors

Advantages: Has been used previously, AC current is available for battery recharge

Disadvantages: May not be located where data collection needed, tend to be located near merges, so sensors may be less accurate (missed or double-counted vehicles due to lane changing), requires bucket truck to install sensor

Questions: Sensor accuracy; for what fraction of long-term uses would they be available?

Recommendation: Demonstrate for long term use

Component: **Overhead sign side support**

Intended use: Mount for long-term use with microwave radar sensors

Advantages: AC current is available, makes locations available that do not have other permanent objects suitable for mounting

Disadvantages: Height and setback may not be satisfactory, large diameter may make sensor installation difficult, bucket truck required for installation

Questions: Can these provide satisfactory mounting heights and setbacks? How accessible is AC power supply?

Recommendation: Consider demonstration for long term use

Component: **Bridge support**

Intended use: Mount for long-term use with microwave radar sensors

Advantages: Makes locations available that do not have other permanent objects suitable for mounting

Disadvantages: AC current not available, height and setback may not be satisfactory, large diameter may make sensor installation difficult, bucket truck required for installation, may be security problem if equipment can be reached from overpasses.

Questions: Can these provide satisfactory mounting heights and setbacks?

Recommendation: Consider demonstration for long term use

Component: **Wooden pole**

Intended use: Mount for long-term use with microwave radar sensors in construction zones

Advantages: Lower cost than “permanent” pole, can be located anywhere

Disadvantages: Cost of installation, no AC power unless also used for light standard, etc., probably does not meet clear zone requirements unless behind barrier, requires bucket truck for installation

Questions: How common are these in construction zones?

Recommendation: Consider demonstration for long term uses; do cost analysis

Component: **"Permanent" metal pole with concrete foundation**

Intended use: Very long-term use with microwave radar sensor

Advantages: Can be located anywhere, very stable

Disadvantages: Cost, may require construction contract

Questions: Would this ever be cost-effective?

Recommendation: Do cost analysis, but do not demonstrate

6. DEMONSTRATION PLANS

The following demonstrations are planned. The schedule for conducting the demonstrations will depend on acquisition of equipment and the availability of District 11 staff to set up systems.

MESC_1. EIS sensor will be installed using District 11's portable pole and used for ramp counts. This is part of the district's ongoing test of deployment of the EIS sensors for portable use. The study team will observe and document the setup and removal procedures and the time required to set up and remove the system and will evaluate the accuracy of volume counts in uncongested traffic

MESC_2. EIS sensor will be installed using Distract 11's portable pole and used for volume, speed, occupancy, and length classification at a multilane site that experiences heavy congestion. The study team will evaluate the accuracy of the volume counts, speed, occupancy, and vehicle length classification under congested conditions. This is intended as the primary validation of the sensor's capabilities.

MESC_3. Four EIS units will be set up at a signalized intersection and used to provide volume counts to be reduced by the TAPS algorithm to turning movement counts. The study team will observe and document the setup and removal procedures and the time required for setup and removal and will evaluate the accuracy of the turning movement counts.

MEL__1. EIS sensor will be mounted on a light standard with the power supply connected to the AC current used for the lights. The camera used for count verification will be removed following count verification. The study team will observe and document the setup and removal procedures and the time required to set up and remove the system, and will evaluate the volume counts. If MESC_2 results in satisfactory occupancy data, occupancy will also be evaluated in this demonstration.

MEL__2. EIS sensor will be deployed in a "semi-permanent" mounting on some object other than a light standard, if any such object can be identified. A solar panel will be installed and the power supply will be connected to the solar collector. The study team

will observe and document the setup and removal procedures and the time required to set up and remove the system, and will evaluate the volume counts. If MESC_2 results in satisfactory occupancy data, occupancy will also be evaluated in this demonstration.

MEI__1. EIS sensor will be installed using District 11's portable pole. A solar panel will be installed and the power supply connected to the solar collector. The study team will observe and document the setup and removal procedures and the time required to set up and remove the system.

MWSC_1. Wavetronix sensor will be installed using District 11's portable pole. The study team will observe and document the setup and removal procedures and the time required to set up and remove the system and will evaluate the accuracy of the volume counts, speed, occupancy, and vehicle length classification under congested conditions. This is intended as the primary validation of the sensor's capabilities.

MWL__1. Wavetronix sensor will be mounted on a light standard with the power supply connected to the AC current used for the lights. The camera used for count verification will be removed following count verification. The study team will observe and document the setup and removal procedures and the time required to set up and remove the system, and will evaluate the volume counts. If MWSC_1 results in satisfactory occupancy data, occupancy will also be evaluated in this demonstration.

ITS__1. The study team will observe and document test of TIRTL by District 7. The study team will observe and document the setup and removal procedures and the time required to set up and remove the system, and will evaluate the axle counts and the axle-count based vehicle classification.

Other demonstrations may be conducted (or some of the ones above deleted or revised) depending on the outcome of prior demonstrations and possible advances in technology.

7. CONCLUSION

Activities during the first fiscal year of the study included a literature survey, surveys of potential users and vendors, preliminary evaluation of portable data collection technologies to select technologies for demonstration, and development of plans for demonstrating candidate systems. Major conclusions resulting from these activities are:

1. Most literature related to portable automated data collection systems documents, compares, or evaluates non-intrusive sensors. Unfortunately, most to this literature is out-of-date.

2. Surveys of potential users show that there is demand for portable automated data collection systems for a variety of uses related to planning, traffic operations, traffic census, and traffic surveillance functions. The most commonly-requested type of data is volume counts, but respondents also expressed interest in speed, occupancy, travel time, vehicle-length classification, and axle-based vehicle classification data.

Potential system uses imply duration of field deployment ranging from a few hours up to several years.

3. Potential users are looking for systems that minimize traffic disruption and exposure of crews to traffic, are "plug-and-play," have IP-addressable communications capability, can provide data in a variety of formats, and have flexible power supplies.

4. Candidate systems for demonstration should include microwave radar sensors for volume counts, speeds, occupancy, and length-based vehicle classification; and low-mounted infrared systems (TIRTL) for axle-based vehicle classification. Power supplies and mounting systems should provide for a wide range deployment duration options, including short-run systems utilizing portable poles and storage batteries, intermediate systems utilizing portable poles and solar collectors, and long-run systems utilizing fixed objects in the right of way (e. g., light standards) and either AC current or solar collectors.

5. Current plans call for nine different demonstrations to test different sensors, power supply and mounting options, and data collection tasks. Demonstration plans may be modified based on the results of prior demonstrations and technological developments.

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APPENDIX

Caltrans Survey

San Diego State University is carrying out a research project funded by the California PATH Program entitled "Evaluation of Portable Automatic Data Collection Technologies." We are contacting you because your name has been given to us by the Caltrans Project Monitor as someone who has expressed interest in traffic monitoring techniques. One of the goals of the project is to identify Caltrans' requirements for such systems, so that these requirements can be used as benchmarks for evaluating candidate systems that will be deployed in District 11 on a demonstration basis.

The proposal identifies three types of traffic data collection tasks for which portable automatic data collection may be appropriate. These are multilane counts, vehicle classification counts, and turning movement counts. Although we anticipate that the study will focus on these tasks, you are welcome to suggest others.

We are especially interested in your responses to the following three questions. Please feel free, however, to add any other comments you think appropriate.

1. Do you have any interest in portable automatic traffic data collection systems?

2. For what data collection tasks would you use portable automatic traffic data collection systems if they were available? Please describe briefly how you are currently carrying out these tasks and what parts of them you would like to replace with portable automatic systems.

3. What features or characteristics of such systems would you consider: (a) Essential? (b) Desirable but not necessarily essential?

Thanks in advance for your response. If you have any question, do not hesitate to contact us.

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Survey of Other State Departments of Transportation and FHWA

San Diego State University is carrying out a research project funded by the California PATH Program entitled "Evaluation of Portable Automatic Data Collection Technologies." The proposal identifies three types of traffic data collection tasks for which portable automatic data collection may be appropriate as an alternative to hand counts or to existing permanently-installed data collection systems. These tasks are multilane counts, vehicle classification counts, and turning movement counts. In the case of vehicle classification counts, we are primarily interested in systems based on non-intrusive (above pavement) sensors that can be used to classify vehicles according to length and that can be moved about among a number of designated count stations.

We are contacting you because we believe you may be knowledgeable about traffic monitoring technologies and because we are trying to learn about experience with portable automatic traffic data collection systems in other states. If you believe that someone else in your organization would be better able to respond to this, or if you think someone else might be able to provide additional information, please feel free to forward this message.

We are especially interested in your responses to the following questions. Please feel free, however, to add any other comments you think appropriate.

1. Has your organization developed any portable automatic traffic data collection systems in-house? If so, please describe.

2. Are you aware of any commercially-developed traffic data collection systems that might be suitable for portable use?

3. Has your organization used portable automatic traffic data collection systems? If so, for what data collection tasks?

4. If not, do you have any interest in using portable automatic traffic data collection systems?

5. For what data collection tasks would you use portable automatic traffic data collection systems if they were available? Although we anticipate that the study will focus on the tasks listed in the first paragraph, you should feel free to suggest others.

What features or characteristics of such systems would you consider: (a) Essential? (b) Desirable but not necessarily essential?

Thanks in advance for your response. If you have any question, do not hesitate to contact us.

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Vendor Survey

San Diego State University is carrying out a research project funded by the California PATH Program entitled "Evaluation of Portable Automatic Data Collection Technologies."

The project proposal identifies three types of traffic data collection tasks for which portable automatic data collection may be appropriate as an alternative to hand counts or to existing permanently-installed data collection systems. These tasks are multilane counts, vehicle classification counts, and turning movement counts. In the case of vehicle classification counts, we are primarily interested in systems based on above pavement sensors that can be used to classify vehicles according to length and that can be moved about among a number of designated count stations. Input from potential users suggests that systems may need to remain in the field for periods ranging from a few hours to several months per deployment. Consequently, we are interested in (possibly separate) systems that could address deployment periods from (a) one hour up to one day, (b) from one day up to one week, and (c) from one week up to a year or more.

One of the goals of the project is to identify candidate data-collection systems that can be deployed by the San Diego District of Caltrans on a demonstration basis. Following the demonstration, these systems will be evaluated on the basis of their accuracy and reliability, cost-effectiveness, and practicality for deployment on a portable basis.

Due to the time and financial constraints of the research project, we will consider for demonstration only systems (1) whose accuracy and reliability have already been demonstrated and (2) that are already fully integrated from power supply through data delivery. We are also very much concerned with the practicalities of quickly installing and removing systems in a variety of roadway environments. In the case of systems designed for very short term deployment (say up to one week) we are especially interested in innovative systems for mounting sensors on a temporary basis (portable poles, etc.)

We are contacting you to determine whether your firm can provide equipment meeting the requirements outlined above. We are especially interested in your responses to the following questions. Please feel free, however, to add any other comments you think appropriate.

1. Are you able to provide any fully-integrated (power supply through data download) systems that could be used for automatic traffic data collection on a portable basis? If so, please describe and provide system and component specifications.

2. Are you able to provide any devices that might be useful as components for such systems? If so, please describe and provide specifications.

3. Can you provide customer references for any systems or components you might provide?

4. Do you have documentation to establish that the accuracy any traffic sensors you could provide is reasonably similar to that of loop detectors?

5. If one (or more) of your products were selected, would you be willing to lend the equipment to the project for demonstration purposes?

6. If one or more of your products were selected for demonstration, would you be willing to provide training for the Caltrans crews installing the system?

Thanks in advance for your response. If you have any question, do not hesitate to contact us.

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