# Research Quarterly Progress Report
Partners for Advanced Transit and Highways

**California Program Plan: Intersection Decision Support - Task S (Conduct Supporting Research)**

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**1) MOU:** 5601
**2) Project Title:** California Program Plan: Intersection Decision Support - Task S (Conduct Supporting Research)
**3) Project Leader(s):** Samer Madanat
**4) Fiscal Year:** 2004 / 2005, **Quarter:** 2, **Version:** 1

**5) Schedule**

| Task Number | Description | Initially proposed: | | Current: | |
|---|---|---|---|---|---|
| | | Start | End | Start | End |
| 1 | S1.0 Intersection Simulation Tool Requirements | 11/01/2003 | 12/31/2004 | 11/01/2003 | 12/01/2004 |
| 2 | S1.1 Develop Models and Simulation Infrastructure | 07/01/2004 | 12/31/2004 | 07/01/2004 | 12/01/2004 |
| 3 | S1.3 Develop Analysis Tool | 07/01/2004 | 12/31/2004 | 07/01/2004 | 12/01/2004 |
| 4 | S2. Evaluation of COTS and Emerging Technologies Components | 11/01/2004 | 12/31/2004 | 11/01/2004 | 12/01/2004 |

**6) Describe what was accomplished in the last quarter.**

During this quarter, we continued our efforts in surveying, procuring, testing, and evaluating the Commercially-Off-The-Shelf (COTS) products as well as any emerging detection technologies that could be used in IDS detection system. The following products were procured during this period:

1. Video Detection System by Traficon
2. Vantage Video from Iteris
3. RTMS by EIS
4. Photo-Electric Infrared Relay System by Philmore

From the above devices, the first two have been installed at our Richmond Field Stations intersection testbed and the third one is on hold until we can find a manufacturer that could make a proper mast arm for our non-standard signal/light pole. We also have procured an additional input rack file for our ITS-340 cabinet since we were running out of detector card slots for future products that would be added to our intersection testbed. This new input rack file will be added to our cabinet at the beginning of the next quarter.

IDS team conducted a few evaluation tests during this quarter. They included testing of VDS by Sensys Networks. The results indicate that, in general, the percentage error between the actual speeds obtained from our automated Buick vehicle and speeds given by these devices was on average between 0.3% and 6.9%. The runs were between 5 to 35 mph. There was no clear indication of a pattern for the percentage error at any particular speed. We also observed, there was no trend of over or under-estimation in the error results.

Another set of tests were done on Video Detection System by Traficon. The speed estimation error between the speeds obtained from our automated Buick vehicle and those from this system is immense (~25%) and fluctuates wildly between runs of 10 to 35 mph. As can be clearly seen, the speed estimations using the camera furthest down the road are more than twice as poor as the estimations using the nearest two detection boxes. The high-angle view of the near detection areas makes detection as well as distance gauging for speed calculations much easier and more accurate. After contacting Traficon regarding these results, we were informed that a new firmware has been released and it would provide much more accurate speeds. This new firmware will be installed and tested in our cabinet at the start of next quarter. It should also be noted that during our test, we noticed many false detections of standing water on the test site by this system. We also have to terminate our test runs due to the dwindling lights. The new firmware is supposed to be good under any lighting conditions with no adjustments needed. We plan to test this system under rain and standing water also.

We also accomplished the following COTS tasks:

1. Test of micro-loops and radar to achieve raw data for vehicle detection including the presence of vehicle, moving distance and thus D2I. Two methods have been adopted: (1) to retrieve loop start detection time; (2) Te retrieve raw presence.

2. These two types of data are analyzed loop-by-loop for their characteristics, for example time sequence recorded verses the loop sequence the moving vehicle encountered. It turn out that, the presence is more consistent in this aspects which is very important for vehicle speed estimation.

3. Three ways are used for the estimation of vehicle speed based on the above two types of loop data:

a. Moving average;
b. Overall average;
c. Kalman filtering.

The first methods are used based on the following considerations:
(i) The lop data is very noise because of the sensitivity of those loops are not homogeneous. For example, for the 24 micro-loops serially arranged along the vehicle moving direction, even if vehicle is running almost constant speed, the distance for each loop beginning to catch the vehicle is different. Besides, this time instant is somewhat vehicle speed dependent. To achieve more precise estimation,

extensive calibration for each loop is necessary to characterize the sensitivity. Then this loop-dependent sensitivity should be used to set up threshold for each loop respectively.

(ii) Time delay caused to speed estimation is significant: The distance between two micro-loops are 2.7 physically. Before vehicle arrive the second loop, there is not estimation of the speed. So, the time delay is at least 2.7/v where v is the vehicle speed. Besides, some other delay will aggravate the situation if a low pass filter is used.

We also developed a graphical user interface for the simulation tool ("Tool 1" in the documents referenced below) developed previously in the project during 2004Q2. In addition, we ported the software to windows, while preserving Unix/Linux compatibility.

The primary purpose of Tool 1 and the purpose for which the GUI is optimized, is evaluating sensor designs relative to various vehicle approach scenarios. The tool can be used to evaluate sets of countermeasures (each with its own sensor positions, sensor characteristics, and alert system parameters) against sets of LTAP/OD scenarios (each with its own SV and POV approach patterns). We measure the performance in terms of the difference between the output of a prototype warning system using the given sensor set and one using "perfect sensing". We have applied this tool to perform a preliminary study which suggests that large classes of possible sensor designs are unsuitable for IDS; countermeasures based on these designs should be rejected. This research, performed during 2004Q3, has been submitted for publication. The successive tools, Tool 2 and Tool 3, will be used to perform more detailed analyses on the remaining countermeasures, which are more narrowly defined.

As of December 31, the user interface for simulation design is finished, including documentation. However, the parts of the GUI that let the user (a) control executing simulations and (b) specify post-processing and plots are not finished.

The IDS simulation project is documented and distributed at

http://PATH.Berkeley.EDU/~vjoel/ids/EvalTool/

All the project deliverables (documents and software) will be placed at this site as we release them. Currently, the site includes an overview of the project and its three tools, a glossary, and the documents covering Tool 1.

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**7) Explain any differences between actual accomplishments in the last quarter and what was proposed.**

No differences.

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**8) Please list all papers, reports, or other products completed during this quarter under this project (provide complete reference and status).**

No papers.

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**9) Briefly describe the work planned for the next quarter relative to the project schedule (see 10 if**

**changes are required).**

For the upcoming quarter, we are planning to devise a test plan using Photo-Electric Infrared Relay System that we purchased to measure latency of the in-pavement loop detectors. In our efforts, we could not find any previous reliable test done for this purpose. We believe since these loops are so widely used in the field they should be fully tested for inclusion into IDS detection system.

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**10) Change in Plan: If you need to make changes in your work plan (changes in dates, tasks, or deliverables), please describe them here. Changes to task schedule do not require PATH approval (but should be justified). Changes in task content, deliverables, and deliverable completion dates require PATH approval.**

No change expected.

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# Signatures:

| | Person who submitted | PATH Manager/Engineer |
|---|---|---|
| **Signature:** | James Misener (username: jmisener / userid: 317) | Approved by: James Misener (username: jmisener / userid: 317) |
| **Date:** | 2005-01-20 22:39:12 | 2005-01-20 23:08:52 |