Quarterly Report on Project TO 6327

Deliver a Set of Tools for Resolving
Bad Inductive Loops and Correcting Bad Data

For the period of 10/01/07-12/31/07

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Due to short of funding in November and December 2007, we limited our effort on the
development of hardware and software to obtain ground truth in last quarter. We
successfully demonstrated the system we have developed to Caltrans DRI project
manager Mr. Joe Palen. The following was Joe’s comments the next day about the demo:
“I was impressed by both the hardware and software I saw yesterday … ”.

1. Progress on Task 2, 3, 4, and 5

T-2. Collect data, formulate and estimate models of communication failure.
T-3. Collect data, formulate and estimate models of electrical failure.
T-4. Collect data, formulate and estimate models of synchronized failure and investigate
possible causes.
T-5. Collect data, formulate and estimate models and algorithm to diagnose and classify
loop detector faults systematically.

We still spent certain time to look at systematically loop fault detection from a control
cabinet level. We are investigating it in three aspects: (a) loop fault detection based low
level signals; (b) data correction is possible; and (c) data imputation for lost data or no
signal.

2. Progress on Task 7, 8

T-7 Preliminarily Code the “Reporter Generator” software and establish data connection
with PeMS.

T-8. Code the software tool for scheduling and tracking the suspect loop detectors for on-
site diagnostics.
This is basically an off-site task based on loop data analysis. No much progress on those two tasks in this quarter. However, in the development of TOPL project, it has been found that high level loop fault detection in PeMS level performs reasonably well. But data imputation part is not perfect yet. It can identify suspicious faulty loops.

3. Progress on Task 9

T-9. Hardware and relevant software development.
   9.1. Install retractable pole on a PATH van for mounting PTZ camera.
   9.2. Develop software for wireless communication and synchronization of two computers: at cabinet and on the van.
   9.3. Develop an interface with 170 controller cabinet.

(1) **Installation of the hardware system for roadside data collection and real-time image processing:**
   We have preliminarily installed the digital video camera on the retractable pole and tested on the side of I-580 for real-time data collection and vehicle tracking;

![Figure 1. Mobile retractable pole with digital camera mounted on top at I-580](image)
4. Progress on Task 10

T-10: Preliminarily develop roadside ground truth estimation based on PTZ Camera for vehicle tracking.

We have been focusing on this task this quarter. In particularly, we have completed the installation of hardware and software for obtaining video camera data from roadside for real-time processing.

In the last quarter, we have designed a computer vision system for the Virtual Loop Detection Project, in order to verify the efficiency of the physical loop. The whole system consists of three parts: (1). the vision sensor (Canon VC50i pan-tilt-zoom communication camera); (2). the moving platform; (3). A linux-based video processing software.

The Canon VC50i camera provide us a wide range of view by panning through a broad reach of 200 degree, tilting of 120 degree, as well as a 26x optical zooming. The camera itself provides a remote control with around 5 meters distance. We also developed control software through the RS-232 serial port communication, in case that the camera is mounted beyond the remote control distance.

Frame grabber has been used to convert the analog video data into digital. In the video processing software, we propose a vehicle detection and tracking approach that combines the background subtraction algorithm and the feature tracking and grouping algorithm. An augmented background subtraction algorithm is presented which uses a low-level feature tracking as a cue. On the other hand, the resulting background subtraction cues are used to improve the feature detection and grouping. All the software is developed under Linux environment and written by CPlusPlus and OpenCV library. At current stage, by manually creatig a virtual loop in the video; the software can detect the
vehicle when it approach and cross the virtual loop. In addition, it can record the time that the vehicle arrive and leave the loop.

The following (Figure 3) are two sample images comparing when the vehicle is approaching and just crossing the virtual loop.

![Figure 3a. Approaching](image1) ![Figure 3b. Crossing](image2)

**Deliverables this quarter:**

1. A demonstration to Caltrans DRI project manager Mr. Joe Palen on 12/20/07 for real-time roadside vehicle tracking using mobile mounted digital video camera;

2. Video clips for hardware setting up procedures of mobile trailer mounted retractable pole on roadside;

3. Algorithms (based on previous paper of ZuWan Kim) for real-time vehicle detection and tracking within limited time-distance window with roadside mobile mounted camera.