**BDD Project Progress Report**

**Dec 03, 2016**

**Project Title:** Real-Time Perception/Prediction of Traffic Scene with Deep Learning for Autonomous Driving  
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### 1. Scope of Work and Tasks in Year 1

The following are the practical tasks to be accomplished in this project with the funding level. The tasks are less from what was listed in the proposal for two reasons: (a) actual funding is much less than what was proposed; (b) we are not aware of any effective real-time learning deep learning algorithm. Therefore, all the video camera data will only be collected for off-line processing and analysis. Only the fixed bean lidar will be used for real-time control.

- Develop software for video/lidar data collection; to be put in BDD Repository
- Install 2 video camera on the 3rd CACC (Cooperative Adaptive Cruise Control) Truck to collect wide angle video data of front including front left/right traffic scenes
- Install two fixed beam Lidar to capture other vehicle cut-in/cut-out and merging
- Calibrate the camera, and lidar to synchronize them in time and space
- Use Volvo truck driver behavior test on freeway traffic for traffic/environment scene data collection; to be put in BDD Repository
- Investigate the availability of real-time Deep Learning algorithm and code
- Use lidar data for real-time traffic scene detection of the following scenarios: (a) short distance cut-in; (b) other vehicle merging from onramp and conflicting with CACC Truck (Fig. 1); the software developed will be used in real-time for CACC; the code will be put in BDD Repository

Fig. 1. Two scenarios to be considered in this project: (a) other vehicle short distance cut-in; (2) other vehicle merging from onramp
2. Overall System Structure

The overall system structure is shown in Fig. 2. The lower left block is related to this BDD project. Hardware: using a (BDD video) laptop connected with central PC-104 computer with Ethernet. The Real-time Operating System (RTOS) for BDD laptop will be QNX or Linux (TBD) to be determined by the type of interface and river availability. The BDD laptop will host lidar and video data collection, and processing, including deep learning in the future.

![Fig. 2. Overall system structure; lower left block is related to BDD project](image)

3. Project Current Status

Software: we need to develop the following modules: (a) digital video data acquisition: PATH only had experience and real-time code for analog video data collection before but not for digital video camera data; the module needs to streamline the data to database, to store them on HD, and to use them for real-time learning in the future; (b) streamline real-time lidar data, conduct target detection, association, and tracking; (c) send output (target availability, relative position, relative velocity) to central PC-104 computer for control. It is noted that the software for each block is relatively independent from the other.

The project has been lagged behind due to several reasons: (1) PATH does not have software to grab real-time data and streamline to computer and logging and for future real-time processing; to interface with the cameras takes time; (2) interfacing with the Fixed Beam Infrared Lidar is also new to PATH software engineer; (3) heavy load on truck CACC project including an extensive fuel econ test in Montreal Canada for 21 days in October this year. However, the project team will catch up in the next four months.
Current status of the project: PATH hardware and software staffs are working on the interface and data acquisition of lidar and video camera. We have tried two generations of cameras already. The first generation camera we purchased had too large delay and therefore has been abandoned. Once this has been done, the units will be mounted on the 3rd truck in the CACC string and synchronized with other sensors.

4. Project Schedules

The table in next page is the practical schedule of the project of year 1:
<table>
<thead>
<tr>
<th>No.</th>
<th>PROJECT TASKS</th>
<th>16-Aug</th>
<th>16-Sep</th>
<th>16-Oct</th>
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<th>17-Jun</th>
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<tbody>
<tr>
<td>1</td>
<td>Develop software for (a) video/lidar data collection; to be put in BDD Repository</td>
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<td>2</td>
<td>Install 2 video camera on the 3rd CACC (Cooperative Adaptive Cruise Control) Truck to collect wide angle video data of front and side traffic scenes</td>
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<td>3</td>
<td>Install two fixed beam Lidar to capture other vehicle cut-in/cut-out behaviors</td>
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<td>4</td>
<td>Calibrate the camera, and lidar to synchronize them in time and space</td>
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<td>7</td>
<td>Use lidar data for real-time traffic scene detection of specific scenarios</td>
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