RESEARCH PROBLEM STATEMENT #RW-503

I – Problem Title
Develop calibration procedure for airborne LIDAR terrain mapping system.

II – Research Problem Statement
Airborne LIDAR can rapidly generate very dense and precise digital terrain model data along highway corridors. Standard procedures should be developed for the calibration of LIDAR systems under airborne operational conditions to assure the generation of data of consistent and reliable quality.

III – Objective
To develop standard calibration procedures for LIDAR systems under airborne operational environment to correct for all the systematic errors produced by each system component. The primary objective is to develop the ability to plan for and use the system to consistently generate terrain data of reliable quality under varying conditions of flight altitude, laser scan angle, laser pulse frequency and other operational variables. This study supports the Department's goal of performance by increasing the efficiency of data acquisition for planning and design.

IV – Background
The Laser Image Detect And Range (LIDAR) terrain mapping system uses opto-mechanical scanning assemblies with the laser beam as the scanning sensor. There is an increasing demand for the use of this technology but due to the lack of standard calibration procedures, data of reliable quality is not always generated. Before LIDAR systems can be routinely adapted by Caltrans, there is a strong need to analyze the geometric principles embodied in such systems, and develop the ability for the modeling and characterization of all associated system errors. Based on this knowledge, procedures for the calibration of LIDAR systems must be designed and practically demonstrated to assure consistent data quality. Caltrans has carried out a study, as the first phase of this research, where all the error sources have been analyzed and modeled. The proposed research will use this outcome to develop and validate calibration procedures using data from LIDAR test flights.

V – Statement of Urgency and Benefits
The use of airborne LIDAR sensor provides the ability to capture terrain data even when it is covered with vegetation. Since such terrain cannot be mapped photogrammetrically, the new technology will replace field survey effort with consequent increase in the safety of field personnel and rapid project completion.

VI – Related Research
This research will be a logical continuation of the research study completed earlier. Some relevant publications are:

* Ackermann,F. (1999): Airborne Laser scanning — Present Status and Future Expectations. ISPRS Journal of Photogrammetry and Remote Sensing, 54 (2-3), 64 –67.

* Axelsson, P. (1999): Processing of Laser Scanner Data – Algorithms and Applications, ISPRS Journal of Photogrammetry & Remote Sensing, Vol. 54, pp 138-147.
* Baltsavias,E. (1999): A Comparison Between Photogrammetry and Laser Scanning, ISPRS Journal of Photogrammetry and Remote Sensing ,54 (2-3),83 –94.
* Baltsavias,E. (1999): Airborne Laser Scanning: Basic Relations and Formulas, ISPRS Journal of Photogrammetry & Remote Sensing, Vol. 54, pp 199-214.
* Csathó,B., T.Schenk, R.Thomas and W.Krabill (1995): Topographic Mapping by Laser Altimetry. In Proceedings of SPIE, 2572, 10 –20.
* Schenk,T. (1999): Photogrammetry and Laser Altimetry. In International Archives of Photogrammetry and Remote Sensing, 32 (3W14).

VII – Deployment Potential

Caltrans has immediate interest to routinely deploy this technology since it will enable Caltrans to:

* considerably reduce the need for field survey and the associated safety concerns,
* generate more precise terrain map data in a much shorter time,
* map vegetated terrain which cannot be mapped with existing practice of photogrammetric mapping,
* use a set of calibration procedures and specifications to qualify mapping vendors,
* assure that data of consistently reliable quality is produced by different vendors.