Low Cost Wireless Network Camera Sensors for Data Collection and Traffic Monitoring (TxDOT #0-6432)

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Video traffic surveillance is **expensive** because of the high cost of initial investment, long term maintenance, communication service fee, and the requirement of operator monitoring of the visuals. **Low-** and **medium** cost cameras are proliferating. Coupled with the advance of **wireless communication** technologies, it is timely for TxDOT to investigate how to bring the costs of traffic surveillance down to **allow large coverage and safety**. The **objective** of this project is to enable TxDOT districts to deploy video surveillance cameras with ease and low cost. Towards this objective, we will achieve **four goals** in the project. The **first** goal is to compile a list of low cost camera technologies appropriate for traffic monitoring and compare them. The **second** goal is to survey the current communication technologies applicable to traffic video surveillance and compare the installation and maintenance costs. The compatibility of the video cameras with the telemetry methods will be investigated as well. The **third** goal is to propose and prototype a system architecture that will allow the detection of vehicles and pedestrians and transmit the processed data to a TMC. The **fourth** goal is to investigate video analytics to allow autonomous monitoring of typical situations and generate alarms when necessary. This approach can **free operators** for other important duties and allow continuous monitoring thus improving safety.

The system will be prototyped and tested on a selected freeway site and integrated with an existing TMC. We will examine the Core Technology Architecture of TxDOT to produce implementation guidance on how the developed system can be **integrated** with existing TMCs.

Adding Value to Sparse LiDAR Elevation Data (Texas NHARP #003594-0016-2009)

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LiDAR (a laser-based instrument that produces elevation maps when used from airborne platforms) is valuable for flood plain maps and approved by the Federal Emergency Management Agency (FEMA) as a source for digital flood insurance rate maps (dFIRMs). The vast majority of LiDAR is collected at low densities specifically for this purpose and, as a result, has little other value. Our ultimate goal is increasing the utility of low-density LiDAR. One way is to fuse the LiDAR data with visual images. The combination of LiDAR and visual imagery will be used to build large-scale 3D maps of the areas under observation which will be converted, in part, to GIS products.

LiDAR and optical imagery is presently used for urbanscape rendering, line-of-sight analysis, land-use classification, etc. Each of the application domains mentioned requires data density to be high and acquired at additional cost by flying missions at lower altitudes. The densities thus obtainable are 3-12 pts/sq m. The vast majority of LiDAR data will continue to be collected for flood plain maps. Since FEMA requires only 19ft. horizontal accuracy for contour maps, the density is typically 0.1-0.2 pts/sq m. As instruments improve, missions will be flown at higher altitudes to further reduce costs. It is the lower end of the density spectrum on which we concentrate.

The existing practice (previous paragraph) makes obvious two issues that must be addressed in creating new value from sparse LiDAR. **(1) Coregistration -** Coregistration of 2D images and 3D LiDAR is formulated as a correspondence problem, solved by matching techniques. This leads to derivative issues. For example, matching involves feature extraction, feature description, and search for correspondence across both modalities. Because we plan to build large-area maps (mosaiking), we must also address 2D to 2D and 3D to 3D registration. **(2) Rendering -** Rendering is the extraction of a 3D model for the purpose of visualization. In addition to the derived issues noted for registration, the issue of feature-level fusion exists. Underlying both coregistration and rendering is the problem of validation. This alone is rich in research opportunities and our work plan devotes adequate resources to it.

This research will lead to new technologies that increase the utility of sparse LiDAR in construction projects related to roadways, railways, oil and gas pipelines, electric transmission lines, communication networks, ports and harbors. LiDAR data has potential to be effective in disaster response planning, particularly during floods. In such projects, speedy collection of accurate topographic data is an important factor.

SGER: A New Tool for Economic and Environmental Planning – Expanding the Boundaries of LiDAR (NSF IIS-0722106)

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LiDAR (Light Detection And Ranging) is an active sensor now approved by FEMA for construction of digital terrain models (DTMs) and digital elevation models (DEMs). DTMs and DEMs, together with appropriate GIS layers, are key sources for the construction of digital flood insurance rate maps (DFIRMs). LiDAR use has not yet supplanted the USGS-generated DEMs and DTMs that have been available for decades. However, the momentum is in that direction. We wish to turn the attention of agencies at the state and local level to other possibilities for obtaining value from the LiDAR data they are already collecting.

To do so, we intend to show that LiDAR - combined with multispectral data - can (1) detect watersheds in urban areas that are at the scale of a neighborhood thus can be used for storm drainage management, and (2) collect sufficient detail of the urban structural landscape to be of real use in predicting property damage for given catastropic events such as floods or earthquakes.

We employ a set of tasks that include selecting urban sites for study. We have both the LiDAR and IKONUS multispectral imagery for New Orleans, Louisiana. By a combination of new analytical techniques, field observation, and comparison to standard datasets, we will increase the value of LiDAR data now owned by many jurisdictions. Key to our approach is the development of a set of information-fusion related algorithms that answer each of the questions: (1) Can present USGS DEMs and DTMs be improved by automatic detection of break lines and neighborhood-scale watersheds gleamed from LiDAR elevation data fused with multi-spectral imagery? (2) Can the heights, geometries, and footprints of buildings be determined with an accuracy sufficient for disaster assessment? (3) Can the fusion product provide a modeling tool to predict, given factors such as water rising level, the potential damage and provide valuable information for pre- and post-disaster planning?

An interdisciplinary team from the University of North Texas and Southern Methodist University is in place. It includes an environmental engineer and two computer scientists. Each is supported by capable technical staff and laboratory associates.

SGER: US/China Digital Government Collaboration: A New Tool for Economic and Environmental Planning - Expanding the Boundaries of LiDAR (NSF IIS-0737861)

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This proposal extends a funded Digital Government project entitled "SGER: A New Tool for Economic and Environmental Planning - Expanding the Boundaries of LiDAR" (proposal ID: 0722106). LiDAR (Light Detection And Ranging) is an active sensor approved by FEMA for construction of digital terrain models (DTMs) and digital elevation models (DEMs). DTMs and DEMs, together with appropriate GIS layers, are key sources for the construction of digital flood insurance rate maps. FEMA-specified LiDAR products are primarily designed for terrestrial floodplain mapping applications. In our previous proposal, the key was to develop information fusion related image understanding algorithms that answer three questions: (1) Can present USGS DEMs and DTMs be improved by automatic detection of break lines and neighborhood-scale watersheds gleamed from LiDAR elevation data fused with multi-spectral imagery? (2) Can the heights, geometries, and footprints of buildings be determined with an accuracy sufficient for disaster assessment? (3) Can the fusion product provide a modeling tool to predict, given factors such as water level rise rate, the potential damage and provide valuable information for pre- and post-disaster planning?

In this project, this collaborative work focuses on multispectral data aggregation and 3D visualization. Our goal is to answer the following question: *Can 3D model be generated and strategic planning questions, e.g. given a flood stage visualize the flooded area, possible breaching locations, and elevations of water around building footprints, be answered?* The China/US team plan two tasks to achieve this goal. First, we will develop a method to render photogrammetric and processed images over the "surface" of the reconstructed 3-D model from LiDAR data. Second, develop an integrated visualization tool. The data needed is the building footprints, building heights, and structural form of the roofs. These are similar to specific data products from the previous project and, with some additional effort, they can be extracted from the disaster maps. The data support will be extended to include a km^2 region of Hefei, China.