Virginia Tech Smart Infrastructure Laboratory

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VT-SIL UPDATE

A multidisciplinary test bed for research, education and outreach

March, 2014 Issue 1

Our First Newsletter!

Welcome to the first VT Smart Infrastructure Laboratory (VT-SIL) newsletter. Through these newsletters we will keep you up-to-date on the latest news about what is happening in our laboratory. VT-SIL has quickly grown and now features: twelve VT faculty, 3 external faculty (Univ. of Michigan, Stanford and Duke), 3 staff members for VT and 3 graduate students. Our lab also boasts of 7 undergraduate students and 2 members of the California Strong Motion Instrumentation Program with the California Department of Conservancy. The multidisciplinary nature of our members has created a unique research community and is uniquely facilitating the transformation of the new VT Signature Engineering Building into a one-of-a-kind full-scale laboratory. Our VT-SIL members span across many different disciplines and colleges, providing a very distinct culture. As of today, we are represented by the host VT Mechanical Engr. Dept as well as other VT departments including the Civil and Environmental Engr. Dept., Myers-Lawson School of Construction; School of Visual Arts; the Institute for Creativity, Arts, and Technology; School of Performing Arts; the School of Music; and the Virginia Tech Library.

Given that it is our first newsletter, we would like to begin with a big ***thank you*** to all our sponsors, collaborators and members who have helped this project get off the ground. In the following sections, you will read about our ongoing projects and status. Enjoy!

- Dr. Tarazaga and Dr. Kasarda

Update on instrumentation status:

Over the past few months, the Signature Engineering Building (SEB) instrumentation project has progressed from planning to its implementation phase. This has been a major step forward and an exciting time for everyone involved. The first step was taken when installation of the accelerometer mounts began, as shown in the picture to the right. At this date, 136 mounts (capable of supporting 5 unique sensors each) have been installed, concluding the first phase of the project. These mounts have been placed in key structural locations to capture the building dynamics, in addition to some hallways and office spaces, for human motion studies. The installation image is a photo of a mount being installed (welded) along a floor support girder. To the right, is an image of a completed mount installed with three PCB® accelerometers in place for pilot testing purposes. The SEB construction firm, Gilbane, Inc., has been instrumental in the success of this first step of the implementation (special thanks to David Childress and Eric Hotek) as well as VT's own Todd Shelton (capital projects manager for Virginia Tech) and Ed Nelson (Associate Dean and Chief of Staff, College of Engr.).

The second step of this implementation phase has been the installation of cable for the accelerometers. Finding a suitable cable that met the stringent testing specifications and needs of VT-SIL, while meeting the demands of building codes, proved to be a tougher challenge than expected. In the end, Dytran Instruments, Inc. was able to find a suitable cable that met these demanding needs. Plus, it came in a stylish Hokie-orange, making it difficult to say no. At the building site, the electrical sub-contractor, Varney, Inc. has started installation of the 35,000 feet of cable to access a planned 240 individual accelerometers. The image to the right shows one of the cable spool racks being used during this installation.

- Joe Hamilton, ME, PhD Candidate

Free-Field Sensor:

In addition to the sensors located inside the building, a free-field accelerometer installed outside the building will measure the motion of the ground. This sensor is important for determining how the building is affected by seismic motion due to earthquakes, blasting at the nearby rock quarry and other mines in central Appalachia as well as motion resulting from passing automobiles and campus activities. We are currently investigating the optimal location for this sensor, details of an enclosure design to protect the sensor, and communication options between the free-field sensor and the data acquisition equipment inside the building. Dr. Martin Chapman and Jake Beale from the Geoscience department are instrumental in this process, and we send out a special thank-you to them both!

- Bryan Joyce, ME, PhD Candidate

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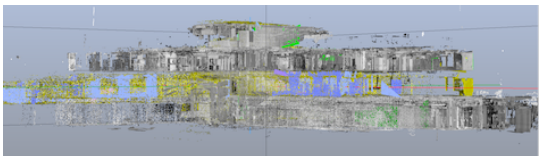
The SEB in 3D

Using a FARO 3D scanner, we have scanned the interior of each floor of the SEB at Virginia Tech. The 3D laser scanner produces detailed 3D color images and a dense point cloud. On each floor, we have placed over 130 locator markers at the base of each accelerometer mount. The markers are used in the Scene Software to accurately locate them in the SEB space. The scans have been imported to a variety of software packages to accurately capture the environment (and sensor mount locations) *within a millimeter*. A sample image is seen below.

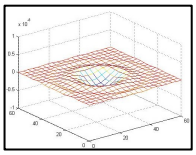


The resulting data sets will serve in helping us triangulate the data from the accelerometers. This will also allow all sensors to be accounted for in the building, and the location and orientation of each sensor will be accurately measured (a very difficult task in such a large environment). This in turn, will be used to compare the response with predictive models and assure that the correct location is being compared. The efforts of Dongsoo Choi in stitching all this data together are greatly appreciated!

- Thomas Tucker
Associate professor, School of Visual Arts

Path Tracking:

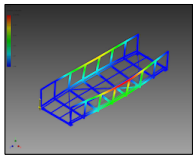
Localization of human motion though floor vibrations is still in the early stages of development. Models are being refined to accurately predict the characteristics of wave propagation. Our French intern from the university of ICAM Lille, Rémi Leullieux, is working on triangulation algorithms to accurately locate the source of vibration. Preliminary testing of these localization algorithms will start by finding the impact point of a hammer on a thin metal plate instrumented with accelerometers. Next, we will begin modeling human footsteps together with our wave propagation model to predict the dynamic response of the floor from footsteps to sensors.



- Mico Woolard, ME, M.S. Candidate

Blacksburg's Huckleberry Bridge test:

In the Fall of 2013, several members of VT-SIL performed a one-day modal test on the Huckleberry Trail, a pedestrian bridge that crosses Southgate Drive in the town of Blacksburg. The dynamic test was conducted using a specially instrumented, 3-pound hammer (on loan from AVEC LLC) in order to create a series of small impacts on the bridge, with a set of accelerometers to measure small vibration levels on the structure. Data collected will be used to help students learn how to model dynamic characteristics of bridges (as shown in picture on right) and teach students how to perform dynamic testing and analysis of real structures in the field. This exercise teaches students how to use vibration data for model validation in order to build confidence in predictive models. Photos of the test day can be seen in the photo section on our VT-SIL website.



-Chris Keener, ME, Undergraduate

VT Shake senior design team:

VT SHAKE is a senior design team in Mechanical Engineering with the mission to design and fabricate a building seismic response demonstrator. This device will be similar to an educational demonstrator that one may find in a hands-on science museum. Our demonstrator will have the ability to exhibit vibration terminology; such as natural frequency, resonance, amplitude of vibration and mode shapes associated with typical motions of buildings to the general public. Our design consists of a building model that has three floors and is placed on top of a shake table. Through a developed user-interface, the user will be able to control the frequency of the shake table to view how the building model responds at various frequencies. The team started testing the demonstrator and will have the final product moved into the Signature Engineering Building at the end of the semester. The team members are Derek Carpenter, Matt Kriete, Ian Shannon, Jake Culley, Ryan Carr and Andreas Brown.

-Derek Carpenter, ME, Undergraduate

Message from the Directors:

Thanks for reading our newsletter. For more information and collaborative opportunities, feel free to contact Dr. Tarazaga or Dr. Kasarda or visit our website (www.me.vt.edu/vtsil).

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