Development of MV3D Architecture and Enhanced FlyCast, Real-time Image Fusion and Panoramic Viewing Application

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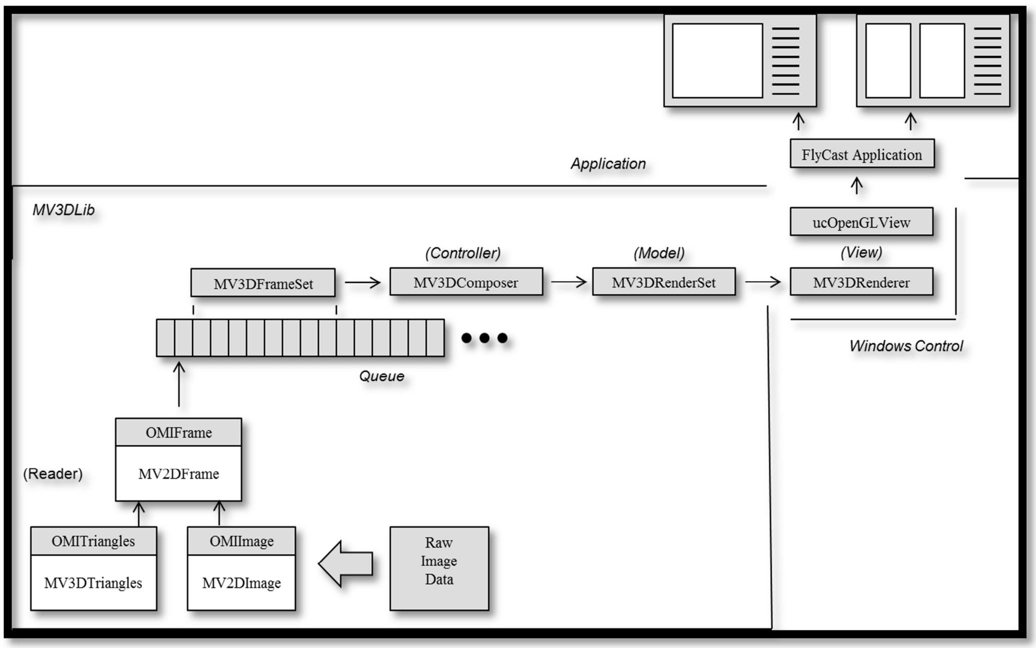
FlyCast is the generic name for our 3D and image fusion software applications. FlyCastDemo was created on the Air Force Real-time Image Processing project but that implementation was specific to a particular set of sensors and data formats. Over the past year, on internal funding, DII has continued to develop and refine the Multi-View 3D Architecture and the FlyCast application.

Multi-View 3D Architecture



The MV3D Architecture

A central concept of the MV3D approach is the MV3DFrame, a collection of 3D LIDAR and 2D multi-sensor data that can be rectified to a common image plane. For most applications, a MV3D frame represents a multi-sensor snapshot of a common scene. Sensor pods commonly have a fixed geometry which defines the transformations necessary to rectify the images. Usually these transformations are static and can be determined *a priori*. Within the frame, the 2D images are rectified to the 3D LIDAR image using the appropriate transformations. This allows the 2D sensor images to be texture mapped onto 3D graphics data produced from the LIDAR image. This enables operational 3D viewing with the most meaningful sensor data applied to the 3D structure. It also enables fusion of the data from the various 2D images to create textures that are optimally meaningful and perceptually tuned to the operator or analyst. The multi-sensor 2D images with a single MV3D frame illustrated below.

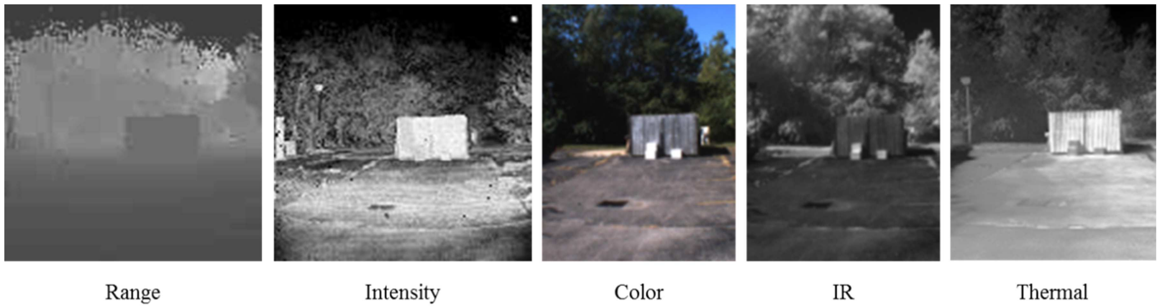
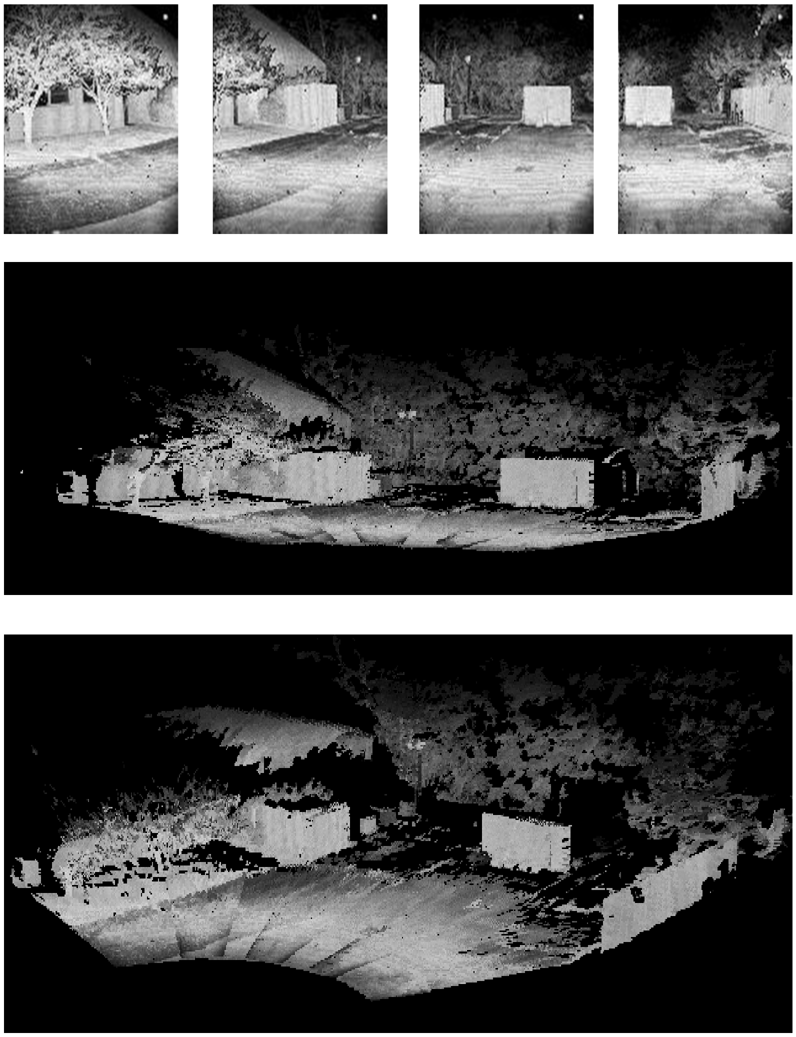


Image textures associated with a MV3D frame

Another central concept associated with the MV3D design is the ability to calculate inter-frame sensor pose (position and attitude) very precisely. Accurate calculations enable the creation of applications that operate across multiple MV3D frames. This enables the development of applications that combine the 3D and 2D data across frames to construct panoramic views. An example is illustrated below. The first panel shows the 2D intensity images. The second panel shows the constructed 3D panorama with the 2D intensity data texture mapped over the 3D structure. The third panel shows an elevated view of the constructed 3D panorama. Accurate pose calculation also enables the development of high-definition 3D video applications that use the alignment of multiple frames under motion to 1) eliminate sensor dropouts, 2) improve sensor resolution, and 3) identify moving objects. The MV3D design uses a set of OpenCV algorithmic methods (Keypoint Generation, Keypoint Matching, RANSAC outlier detection, Bundle Adjustment) to determine sensor pose. This method has proven successful for constructing 2D panoramas from a set of photographs. Previous work by the principal investigators also successfully demonstrated use of this 2D approach to stitch together 3D panoramas.



Combining MV3D frames into panoramic views

FlyCast Application Enhancements

On this internal project, many enhancements have been integrated into the latest version of FlyCast. These include:

- Accept standard input image formats for the 2D and 3D data
- Additional options for key-point matching
- Enhanced RANSEC module which speeds computations
- Improved integration with the latest open system tools, OpenCV, OpenGL, and SBA
- Multi-texture switching
- Graphical viewpoint navigation